

Sea Level Rise Adaptation and Mitigation Planning in Charleston, South Carolina

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Executive Summary

As we progress through the 21st century, the impacts of climate change on coastal cities are becoming increasingly obvious as increased flood events, more frequent and more intense hurricanes, and rising sea levels continue to occur on a global scale. Because South Carolina currently lacks a comprehensive state-wide approach, coastal cities in the state are individually trying to determine the best way to prepare and adapt to these climatic changes, particularly sea level rise.

Specifically, due to its low elevation, rates of land subsidence and highly developed coastline, Charleston, South Carolina is particularly vulnerable to sea level rise. From 1957 to 2013, Charleston experienced a 409% increase in the number of flood days per year. As such, Charleston was ranked 7th by the National Oceanic and Atmospheric Administration (NOAA) for cities in the United States with increased nuisance flooding, highlighting its vulnerability to sea level rise. Charleston is not alone in this fight, however. Numerous other coastal cities in the United States, such as Baltimore and New Orleans are also at high risk for the devastating effects of sea level rise. In order to effectively prepare and plan for these inevitable changes, some cities have begun to develop their own strategies for sea level rise adaptation and mitigation, while others have organized regional collaboration to address the issue on a larger scale.

This report examines how the area of Charleston, South Carolina would potentially be impacted by sea level rise given different sea level rise scenarios and how the community is currently preparing for sea level rise and considering these changes in their management plans. Additionally, this report reviews the Southeast Florida Regional Climate Compact and the efforts of the Norfolk, Virginia area to determine potential ways in which Charleston could better prepare and adapt to these changes.

Ultimately, through this report, the following recommendations are given:

- the creation of a regional climate compact amongst the five coastal counties within the state of South Carolina

- increased initiative and political will at the local level with more community engagement and educational outreach
- revision of the Beachfront Management Act to no longer allow movement of the baseline for development seaward

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Introduction

As sea level rise continues to occur at an accelerated rate, coastal cities are quickly trying to determine the best ways to adapt to these rapidly occurring changes and how they can become more resilient in the future. In addition to physical infrastructure and large percentages of their populations, the historical and cultural significance and traditions of these cities are at risk due to sea level rise. Charleston, South Carolina is a city rich in history, with historical significance dating as far back as the American Revolution. Chris Carnevale with the Southern Alliance for Clean Energy highlights this stating that, “Charleston is a place of significant cultural and historical heritage, but the impacts of climate change – such as sea level rise and ocean acidification – threaten our way of life and our connection to past generations”⁴. According to analysis completed by Climate Central, global sea levels could rise as many as 4 feet within the next 100 years⁴. With more than 800 square miles lying below the level of the estimated 4 foot rise⁴, South Carolina is particularly vulnerable. Specifically, as many as 54,000 homes and \$24 billion in property values would be influenced statewide, with the majority located in Charleston and Beaufort counties⁴. Should the 4 foot rise occur, one in six homes in Charleston would be threatened by sea level rise! With such a high amount of infrastructure, property value, and historical and cultural significance at risk, Charleston needs to begin planning adaptation and mitigation strategies for accelerated rates of sea level rise to ensure the city’s future in coming centuries.

The History of Charleston, South Carolina

The city of Charleston is a unique coastal city located on a peninsula along the coast of South Carolina where the Ashley River and Cooper River merge and meet the Atlantic Ocean. As the oldest city in South Carolina, the city itself has strong historical and cultural significance and value, beginning with its founding as ‘Charles Towne’ in 1670 by the British. Because of its location along waterways and its accessibility to the Atlantic Ocean, Charleston historically was utilized as a port city, just as it is today. Because of its location on the peninsula, however, Charleston was often subject to

attack from both land and sea, most notably by Edward Teach, more widely known as Blackbeard the Pirate. By 1770, however, Charleston had developed into a flourishing port city, ranking as the fourth largest port in the colonies²². As such, when the American Revolution began, the British attacked the city, ultimately leading to the siege of Charleston, one of the greatest American defeats in the war. The British occupied the city until 1782, at which time the name of the city was officially changed to Charleston.

From then until the Civil War, the city entered 'the Antebellum Era' from 1785-1861. During this time, the city truly flourished with the population exceeding 23,000 people and the creation of numerous community resources, such as the First and Second Bank of the United States and Market Hall and Shreds²⁵. On December 20, 1860, however, the state of South Carolina seceded from the Union and turmoil erupted. On January 9, 1861, shots were fired on the *Star of the West*, a Union ship, as it was entering the Charleston harbor. Following this, again on April 12, 1861, Fort Sumter, being held by the Union at this time, was attacked from the harbor. After thirty-four hours, the fort was surrendered by the Union and the Civil War officially began. As a result of its historical relevance to the Civil War, Charleston contains numerous historical sites that contribute to its cultural value, as well as, its booming tourism industry. In particular, the Battery and White Point Garden, commonly referred to as 'Battery Park', attract thousands of people each year as a result of their historical value and stunning views. Ironically, the Battery is actually a defensive seawall in Charleston, named for the artillery defense battery found on the site. It is located right on the edge of the Charleston Peninsula, where the Cooper River and Ashley River meet to flow into the Charleston Harbor. Because of its close proximity to the water, frequent flooding occurs here during high tides, intense rainstorms, or hurricanes¹⁰. In 2004, the city completed an evaluation on the Battery and found serious flaws in its structural composition. The report states that, "In its present deteriorated condition, it seems doubtful that the concrete extension of the High Battery seawall could successfully withstand the direct onslaught of a major hurricane without substantial damage... [if the wall] should be significantly breached during a major hurricane, hurricane driven waves could propel flood waters well into the southeastern portion of the peninsula" ⁷. As a

result, in 2012, the city committed to a \$3.2 million project to repair and strengthen the wall and keep such a historically significant part of the city intact⁷.

After the end of the Civil War in 1865, the city slowly worked to pick up the pieces and rebuild through the 1900s. Although racial tension was certainly present and riots undoubtedly occurred, the area transitioned into an integrated community and continued to rebuild the city back to its former status as a flourishing port city. Unfortunately, however, on August 31, 1886, an earthquake of a 7.3 magnitude on the Richter scale hit Charleston, causing \$6 million in damage. Although \$6 million may not sound significant by today's standards, at this point in time, all of Charleston's buildings' combined valued an estimated \$24 million²¹. As such, this one earthquake not only ruined a vast majority of progress towards rebuilding the city after the Civil War, but also caused damage amounting to as much as 25% of the city's physical worth²¹! Since then, however, restoration efforts have continued to rebuild and preserve the city's historical and cultural focal points.

Charleston, South Carolina Today

Through the 1900s and into present day, the City has continued to flourish and now is the second largest city in the state with an estimated 127,999 people in 2014⁵. The city itself covers 127.5 square miles, with 109 square miles of land and 18.5 square miles of water. As such, the population density of Charleston averages around 1,152 people per square mile, with the highest densities found in downtown Charleston. The Charleston area is relatively flat with elevations typically just at or under 3 meters (10 feet) above sea level. Some small areas are as high as 5.5 meters (18 feet) above sea level though. Because of the low elevation of the city, in addition to its location on a peninsula, storm surge, flooding and in particular, sea level rise, are collectively important scenarios to plan for. As climate change continues to occur at an accelerated pace, Charleston needs to begin to consider how to adapt and prepare for a potential increase in the frequency and intensity of hurricanes, increased storm surge, more 'rain bomb' events, more extreme weather events and rising sea levels.

How Sea Level Rise Currently Impacts the Area and Sea Level Rise Projections for the Future

Historically, local sea level rise along the South Carolina coast averaged 1.2 inches per decade¹⁶. The area of Charleston, in particular, not only experiences sea level rise but also land subsidence, further exacerbating the effects of sea level rise. Eustatic changes in sea level are those that occur on the global scale and are commonly associated with a change in the volume of water within the ocean, such as the melting of glaciers. Land subsidence, however, refers to the physical process of land sinking. Combined, eustatic sea level changes and land subsidence rates determine the amount of local sea level rise in a particular area. A study completed in 1984 estimated that since 1922, the Charleston area has seen a eustatic sea level rise of .12 cm/year (.05 inch/year) and a local land subsidence rate of .13 cm/year (.05 inch/year) to collectively result in a .25 cm/year (.1 inch/year) local sea level rise¹⁰. According to new data and analysis completed by Climate Central, moving forward, however, levels will rise at a much faster rate, with sea levels along the coast of South Carolina rising as many as 13 inches by 2050 and as much as 4 feet within the next 100 years¹⁶. This is particularly concerning considering Charleston is already experiencing negative impacts from current sea levels, particularly in terms of flooding.

In June 2014, NOAA released a technical report, *Sea Level Rise and Nuisance Flood Frequency Changes around the United States*, analyzing changes in nuisance flooding in 45 different locations throughout the country. Nuisance flooding is flooding, generally one to two feet above local high tide, which results in frequent public inconvenience such as road closure, overwhelmed storm drains and/or compromised infrastructure¹⁸. The report found that nuisance flooding has increased by 300 to 925 percent since the 1960s on all three of the United States' coasts¹⁸. Specifically, eight of the top ten cities with increased nuisance flooding are located on the East Coast. Charleston, South Carolina ranked 7th on NOAA's list of top ten cities in the United States with increased nuisance flooding¹⁸. As seen below in Figure 1, in Charleston, sea level reaches .38 meters above the mean high water mark. Additionally, the city experienced a 409% increase in average nuisance flood days from 1957 to 2013. From 1957 to 1963, Charleston recorded an average of 4.6 nuisance flood days per year.

From 2007 to 2013, however, Charleston experienced an average of 23.3 nuisance flood days per year.

Top 10 U.S. Areas with an Increase in Nuisance Flooding				
City	"Nuisance Level": Meters above mean higher high water mark	Average Nuisance Flood Days, 1957-1963	Average Nuisance Flood Days, 2007-2013	Percent Increase
Annapolis, MD	0.29	3.8	39.3	925%
Baltimore, MD	0.41	1.3	13.1	922%
Atlantic City, NJ	0.43	3.1	24.6	682%
Philadelphia, PA	0.49	1.6	12.0	650%
Sandy Hook, NJ	0.45	3.3	23.9	626%
Port Isabel, TX	0.34	2.1	13.9	547%
Charleston, SC	0.38	4.6	23.3	409%
Washington, D.C.	0.31	6.3	29.7	373%
San Francisco, CA	0.35	2.0	9.3	364%
Norfolk, VA	0.53	1.7	7.3	325%

Figure 1: The top 10 cities experiencing an increase in nuisance flooding in the United States
Source: The National Oceanic and Atmospheric Administration (NOAA) ¹⁸

Holly Bamford, assistant administrator of the National Ocean Service through NOAA, hopes that “The nuisance flood study provides the kind of actionable environmental intelligence that can guide coastal resilience efforts” ¹⁶. Additionally, the report’s lead author, William Sweet, highlights that flooding no longer only occurs after a strong storm or during a hurricane. Rather, “Flooding now occurs with high tides in many locations due to climate-related sea level rise, land subsidence, and the loss of natural barriers. The effects of rising sea levels along most of the continental U.S. coastline are only going to become more noticeable and much more severe in coming decades, probably more so than any other climate-change related factor” ¹⁶. Not only are these floods becoming more severe and reaching higher levels, they are also occurring more frequently, reducing the time between each flood event. As a result, depending on the

amount of water flooding the area and the area's response and clean up of the flooding, flood events could occur on top of each other, further increasing the damage and negative impacts of the water on surround infrastructure and property.

Charleston's Current Action and Planning for Sea Level Rise

Although the effects of sea level rise are already impacting Charleston, action at the local level is limited. Charleston is currently one of the fastest growing municipalities in the state, highlighting the influx of people moving to the area and utilizing its resources. As such, the area is being rapidly developed and urbanized, increasing the demand for and value of coastal property. In light of high demand for property and resulting high property value, decisions to limit or restrict development along shorelines to combat sea level rise are not generally well received. Additionally, because the Charleston coastline is quite dynamic and accretes, erodes, and shifts often, regulation and planning efforts are more difficult. Moreover, the state of South Carolina has no state wide plan or course of action for sea level rise mitigation or adaptation planning and as such, offers little to no guidance to coastal cities in regards to how to prepare for, adapt to, and manage resources in light of sea level rise. As a result, cities are left to their own individual planning, funding, and staff to try to handle the issue. Although Charleston may have completed little planning for sea level rise, it has developed some initiatives to become more sustainable; some local environmental groups and businesses are also beginning to consider how to prepare for these changes in sea level.

The Charleston Green Plan

In April 2007, Charleston's City Council authorized their Green Committee to "provide leadership and practical solutions to ensure a prosperous community that will sustain healthy lives for our citizens and a healthy earth"⁸. As part of this authorization, the Green Committee strived to do seven things: 1) create a local action plan for climate change 2) work with the City, and give advice when needed, on the continual implementation of the plan 3) monitor progress throughout the implementation and lifetime of the plan 4) identify potential grants and other available funding opportunities

to further enhance the implementation and goals of the plan 5) build on existing City initiatives as a means to promote an integrated community-wide approach to sustainability 6) sponsor, promote, and endorse education events and 7) promote regional cooperation⁸. Specifically, the plan targets better, more efficiency building design, cleaner energy use, more sustainable community development, improved transportation, zero waste initiatives, and increased 'green education'⁸. Although at first glance the plan appears to be rather comprehensive, sea level rise, a devastating consequence of climate change that is already impacting the community, is hardly mentioned. Found under the 'Sustainable Communities' section, 'creating a sea level rise adaptation plan' is a proposed action (See Figure A.5 and A.6 in Appendix). However, of the 187 pages of the document, only about 1 ½ are dedicated to discussing the implementation and creation of a sea level rise adaptation plan. Additionally, although the City Council received the plan on February 23, 2010, it was never fully implemented or developed into a law and as such, few, if any, of its original goals have been met, including the development of a sea level rise adaptation plan⁸.

South Carolina Businesses Against Rising Seas

The South Carolina Businesses Against Rising Seas (SCBARS) is a local interest group consisting of businesses that will be affected by sea level rise and support sea level rise adaptation and mitigation planning by the government. The group is part of a project developed by the South Carolina Small Business Chamber of Commerce, the American Sustainable Business Council and the Southern Alliance for Clean Energy¹³. The group originally began as part of an educational effort in May 2013. In order to demonstrate to people how much sea level rise would impact their community, members used blue tape to mark the projected high tide levels for 2100 on the interior and exterior of participating buildings. Accompanying the tape were signs and directions, directing onlookers to a website with more information concerning exact predictions, impacts of sea level rise, information regarding why it is happening, and even a sample letter which businesses could print off and send to their member of Congress, asking for a reduction in carbon pollution. Additionally, afterward, participating businesses displayed blue tape with 'SCBARS.org' printed on it in their

windows to encourage customers to go to the website, learn more about sea level rise, and reach out to their government to take action. Although the group is no longer active, it was quite successful in educating people about sea level rise, as well as, demonstrating that sea level rise does matter to local citizens and small businesses in the area and people do support government action against sea level rise¹³.

State-wide Management Plans and Reports

Although not focused solely on Charleston or sea level rise, statewide management plans and technical reports address the adverse effects of climate change and potential management strategies in light of these changes. In 2013, the Blue Ribbon Committee released its report on recommendations for improved shoreline management²³. Although the document only mentions sea level rise once, it lists numerous recommendations on how to increase the resiliency of the shoreline, ultimately helping mitigate the effects of sea level rise. Additionally, the South Carolina Department of Natural Resources recently released “Climate Change Impacts to Natural Resources in South Carolina”⁶. Section 3.1 of this document is dedicated solely to sea level rise and the concerns that the Department of Natural Resources have in relation to management strategies and the livelihood of the area’s natural resources⁶. However, the report lacks quantitative data to support its claims and recommendations; additionally, it is focused solely on the state level, assuming a higher amount of resources than the city of Charleston most likely has.

Environmental Advocacy Groups

Numerous environmental groups within the area are also beginning to look at sea level rise and consider its effects on Charleston within their own organization. Some of these organizations include the Cape Romain National Wildlife Refuge, the Coastal Conversation League, the Southern Alliance for Clean Energy, NOAA, the South Carolina Sea Grant Consortium, and the Nature Conservancy. At this time, their efforts typically remain within their own organization; however, it is encouraging to see so many organizations beginning to consider the issue.

Adaptation vs. Mitigation

As we progress through the 21st century, the impacts of climate change are becoming glaringly obvious as increased flood events, more frequent and more intense hurricanes, and rising sea levels continue to occur on a global scale. In relation to preparing for these climatic changes, two terms are commonly used: adaptation and mitigation. The Intergovernmental Panel on Climate Change (IPCC) defines climate change adaptation as, “adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities”¹⁹. Adaptation and adaptive strategies seek to reduce exposure or susceptibility to climate changes and its repercussions. Adaptation strategies include (but are not limited to) building seawalls, river embankments, reservoirs etc. as well as infrastructure enhancements and the relocations of people, buildings, cities, etc. to safer grounds. Mitigation, however, in some ways can be viewed as a subset of adaptation. Mark Pelling, author of Adaptation to Climate Change: From Resilience to Transformation, describes mitigation as, “an adaptive act aimed at ameliorating or reversing the root causes of the anthropocentric forcing processes behind climate change”²⁰. Mitigation more commonly refers to policy initiatives and legal stimulations supporting adaptive changes. For example, mitigation efforts could include legislation mandating specific carbon reductions or a renewable portfolio standard (RPS) to help reduce our impact on Earth and the potential effects of climate change. Additionally, mitigation measures commonly occur on a national or global scale, whereas, adaptation and adaptive strategies are more commonly found on local agendas. Furthermore, mitigation techniques commonly deal with the present and future (ie: what can we do now to reduce the effects of climate change from here on) whereas adaptation strategies commonly work retroactively, working to move forward in light of whatever has already happened (ie: strategies on how to move forward in light of an occurrence).

For the past few decades, the primary response to climate change in the United States has focused on mitigation strategies to reduce greenhouse gas emissions³. Although mitigation efforts, specifically in relation to greenhouse gas reduction, are a great start to coping with climate change, these efforts are not enough to prepare us for the inevitable change resulting from already existing emissions and atmospheric

conditions. Mitigation efforts work proactively and affect the present and future in terms of emissions rates, atmospheric concentrations of carbon dioxide, and the rate at which our atmosphere is changing, primarily as a result of anthropogenic causes. However, Alice Kaswan, a University of San Francisco School of Law professor focused on climate change, states that “even if stringent global emissions reductions and mitigation efforts over the next decades prove to be successful, further climate change seems to be inevitable”¹¹ as a result of previous emissions already present in the atmosphere. As a result, “reducing greenhouse gas (GHG) emissions is necessary but not sufficient to address the potential damage”¹¹ and adaptation strategies must be considered to fully address all the effects of climate change.

The implementation of adaptation strategies occurs through political will, compatibility with other current policies, suitable timing and sufficient human resources (active, knowledgeable people taking a leading role). An ideal adaptation strategy will consider these key motivating and implementing factors, as well as, frame climate change in a positive light to transform “barriers to enablers and... [enhance] public and political action”³. Currently, the United States’ adaptation policy focuses on the reduction of greenhouse gases, with hopes of one day reversing the effects our greenhouse gas emissions have already had on our environment¹⁵. As heroic as it would be to reverse the effects of climate change, the reality of that happening is very slim considering current projections for future emissions and carbon dioxide levels. As such, the United States has two options: treat adaptation as a societal challenge and let the market dictate decisions or develop policies which integrate more realistic adaptation strategies into our own climate change agenda. As Alice Kaswan highlights, “relying on “market forces” to adequately prepare for disasters and other climate change impacts will fail to provide an adequate adaptation response because reliance on private action fails to protect those without the knowledge or means to act”¹¹. Furthermore, the lack of knowledge, lack of capacity (for timely adaptation), lack of self-interest, and lack of cohesion (multiple actors, multiple opinions) present in the free market approach destine it for failure in terms of a successfully serving as a solution for adaptation to climate change³. Instead, federal, state, and local governments need to

take initiative and develop effective adaptation and mitigation strategies to prepare for the accelerated rate of climate change.

Examples of Successful Regional and Local Planning

Regional Planning: Southeast Florida Regional Climate Compact

At the regional level, the Southeast Florida Regional Climate Compact provides an excellent example of how regional cooperation can successfully lead to proactive climate adaptation planning and more resilient cities. The Southeast Florida Regional Climate Compact was created in January 2010 and consists of four southeast Florida counties: Miami-Dade, Broward, Monroe, and Palm Beach¹. The Compact was created as a means to “coordinate mitigation and adaptation activities across country lines”¹ as well as “to allow local governments to set the agenda for adaptation while providing an efficient means for state and federal agencies to engage with technical assistances and support”¹. Overarching plans of the Compact also include the development of annual legislative programs that would advocate for joint state and federal policies and funding, dedicated staff and resources for the creation of a climate action plan including both mitigation and adaptation strategies, and an annual meeting at the Regional Climate Summits in order to discuss progress towards intermediate goals and identify various emerging issues¹. Perhaps most importantly, however, the Compact has encouraged collaboration and established a uniform methodology for assessing vulnerability of specific areas to climate change impacts, as well as, mapping sea level rise and its impacts¹. Essentially, it has served as a unifying mechanism, ensuring that all counties are looking at these issues in the same way and considering the effects in similar manners.

Since its creation in 2010, the Compact has been very successful in collecting data, raising awareness, educating the public, gathering resources, and organizing planning efforts and documents in light of climate change. Specifically, in October 2012, the Compact released its regional climate action plan, *A Region Responds to a Changing Climate*. The plan lists 110 action items that are to be completed within five years from the release of the document (2017) with yearly progress reports¹. The action items are divided amongst seven different goal areas: 1) sustainable communities and

transportation planning 2) water supply, management and infrastructure 3) natural systems 4) agriculture 5) energy and fuel 6) risk reduction and emergency management and 7) outreach and public policy¹. This document, in particular, is significant because it provided a working model for how the state and federal governments can become involved with local action and concerns surrounding climate change. Additionally, the Compact has been very active releasing numerous implementation guides and scientific documents such as *A Unified Sea Level Rise Projection for Southeast Florida*, *Regional Greenhouse Gas Emissions Inventory: Baseline Period 2005-2009, Policy and Advocacy Implementation Report*, *Analysis of the Vulnerability of Southeast Florida to Sea Level* and *Adaptation Action Area Pilot Research Report*.

At both the State and Federal level, the success of the unique regional compact has not gone unnoticed. Specifically, as a result of the Compact's work, the state legislature created an Adaptation Action Area (AAA) designation for areas that are particularly vulnerable to climate impacts, specifically sea level rise¹. These Adaptation Actions Areas are commonly areas just at or below mean higher high water levels, areas that are designated evacuation zones due to storm surge, and areas which have some type of hydrological relationship to coastal waters. Areas with the AAA designation are prioritized above areas without the designation in terms of funding for infrastructure needs and/or adaptation planning in regards to climate change. Additionally, the White House has recognized the Compact, choosing the region for a White House Council on Environmental Quality listening session in June 2010¹. The Compact has also been recognized in the Progress Report of the Interagency Climate Change Adaptation Task Force on Climate Preparedness and Resilience¹. Additionally, in 2012, the Senate highlighted the Compact as an excellent example of local response to climate change. Margaret Davidson, the Director of the National Oceanic and Atmospheric Administration Coast Science Center also recognized the Compact for its excellence stating, "This is a great model of a partnership and there will be a lot of us looking to promulgate this as a model"¹. As demonstrated, the Southeast Florida Regional Climate Compact presents a thorough and successful example of regional planning for coastal resilience. The city of Charleston and surrounding region should

look to the Compact as an example of how to utilize regional resources to develop local planning and adaptation strategies.

Local Planning: Norfolk, Virginia and Hampton Roads Area

At the local level, the planning efforts, educational outreach, and coordinated work of the Norfolk, Virginia and Hampton Roads area demonstrates how adaptation and mitigation planning can also be successful on a smaller scale at the local level. Similar to Charleston, Norfolk, Virginia and the Hampton Roads area is not only experiencing eustatic sea level rise but also land subsidence, further impacting the area. According to NOAA tidal gauge stations, local sea levels have risen more than 18 inches since the 1930s. In fact, the city of Norfolk is considered the second-largest population center at risk due to sea level rise, with the city needing an estimated \$1 billion to keep water out of coastal homes and businesses, as well as, to replace damaged infrastructure due to sea level rise¹⁴. Additionally, Norfolk is home to the United States' Naval Base, the largest naval operation in the world. As such, the Norfolk area in particular is concerned about sea level rise and very interested in adaptation and mitigation planning for their area.

Although at this time, the Norfolk, Virginia area is not as developed in their sea level rise adaptation and mitigation planning as the four counties in Florida, the area is headed in the right direction by acknowledging that sea level rise is impacting their area at an accelerated rate and beginning to organize efforts and discussions to enable further planning in the near future. Specifically, as a means to promote federal, state, and local action on sea level rise, Congress members, Virginia mayors, state and local officials and concerned citizens came together to discuss the issue at the 'Rising to the Challenge' conference in June 2014. The conference was held at Old Dominion University, which is also striving to increase knowledge and planning efforts surrounding this topic through their Climate change and Sea Level Rise Initiative beginning in 2010. As a result of the discussions and presentations at the conference, it was generally agreed that "coordination with all levels of government to move from technical discussion of sea-level rise to working policies"⁹ was needed. Words such as

“resilience”, “risk mitigation” and “public engagement” were often used throughout the discussion and appear to be priorities in the planning process.

Unfortunately, however, making these changes requires large amounts of money that currently are not budgeted for. Moreover, aside from Federal Emergency Management Act (FEMA) monies, obtaining federal funds is difficult as there is no federal program set up to offer cities/states proactive ways to mitigate the effects of climate change and sea level rise. As for now, Norfolk and the Hampton Roads area is doing the best that they can with their resources. Specifically, an ordinance was recently passed requiring that new buildings or any major renovations be elevated three feet above the flood plain (previously it was only required to be one foot above) ¹⁴. Additionally, numerous outside organizations are coming to Norfolk to conduct analyses and studies on various mitigation and adaptation strategies and tools. For example, in December of 2013, Norfolk was chosen for the 100 Resilient Cities Network to later be equipped with planning tools in light of climate change. With so many resources and people at risk, it is clear that Virginia needs some sort of local, or even regional, plan in place to effectively combat these issues. Although they may not have a structured, concrete plan yet, hopefully as Norfolk continues to raise awareness, gain factual evidence, and garner even more political support, the Norfolk area will be able to effectively mitigate for the effects of climate change and rising sea levels.

Recommendations for Charleston, South Carolina Moving Forward

Create a regional climate compact with the four other coastal counties

As Charleston works to gain momentum in their own local agenda against sea level rise, we recommend efforts on the larger scale with the creation of a regional climate compact similar to the Southeast Florida Regional Climate Compact. The Compact would ideally consist of the five coastal counties in South Carolina: Horry County, Georgetown County, Charleston County, Beaufort County, and Jasper County. At times, resources can be inadequate at the local level, with limited available funding and staff to properly address environmental issues such as sea level rise. For example, currently, the city of Charleston does not have one sole person dedicated to addressing and coordinating efforts associated with sea level rise and the inevitable impacts of

climate change. While it may be a part of someone's job responsibilities, it is not the sole focus of any one person's day-to-day workload. At the regional level, however, perhaps with the resources of five counties, more funding and staff could be hired with the sole responsibility and focus on sea level rise and adaptation and mitigation planning along the coast. Furthermore, sea level rise is not just a localized issue unique to Charleston. The entire coast is experiencing sea level rise and as such, perhaps utilizing more resources and developing a strategy for the entire coast would be more effective overall.

Additionally, should the five counties come together to form a climate compact, perhaps the state of South Carolina will realize the importance of the issue and take an initiative towards action at the state level. These five coastal counties of South Carolina contain numerous profitable, tourism-centered beach towns such as Myrtle Beach in Horry County, Georgetown in Georgetown County, Charleston and the surrounding areas of Mount Pleasant, Isle of Palms and Folly Beach in Charleston County, and Hilton Head in Beaufort County. Combined, these beach towns bring in significant revenue for the State; should their tourism industries or seafood industries be impacted due to sea level rise or other climatic changes, the state of South Carolina would certainly feel its effects. Additionally, at the State level, perhaps even more funding or resources would be available to enable these coastal cities to prepare and adapt to sea level rise more adequately.

Increase initiative and political will at the local level with more community engagement and educational outreach

While an overarching regional climate compact or State involvement in the adaptation and mitigation planning would be ideal, initiative and political will to address the issue at the City and local level are still needed. Currently, the City commonly cites their 'Green Plan' and storm water management improvements as their initial preparations for sea level rise and climate change. However, this is not enough and does not address the full scope of the issue. The City has yet to even formally address sea level rise and as stated earlier, does not have even one dedicated person working and considering the issue specifically. This is rather shocking considering the results of

a recent Winthrop Poll of South Carolinians completed in November 2014. According to this poll, 68% of people living in one of the five coastal counties of the state are 'very sure' or 'somewhat sure' that sea level rise is happening or will be happening¹². Statewide, the poll found that 57.3% of South Carolinians believe that levels will rise while only 8% did not believe they would rise at all¹². Residents of South Carolina also seem to understand that this problem is not going away in the near future: 9% of respondents believe that the impacts of sea level rise are currently substantial, 18.7% believe that they will be substantial within the next 10 years, 18.9% anticipate they will be significant within the next 25 years and as many as 46% believe that the impacts of sea level rise will be felt within the lives of most state residents¹². While this data clearly demonstrates some acknowledgement that sea level rise is happening and that its impacts will affect the livelihoods of many South Carolinians, especially those living on the coast, the poll also found that 73.3% of those polled said they supported state and/or local government action to make the coastal communities of South Carolina more resilient to sea level rise¹²! As such, while resources and political will at the local level appear limited, we suggest an increase in community engagement and education to continue to raise awareness on the issue and begin to strategize what planning mechanisms and options would work best for the citizens in Charleston. The organization of more conferences and discussions involving a myriad of stakeholders such as local scientists, concerned community members, legal professionals, business owners, and other environmental advocates (similar to the efforts of Norfolk, Virginia) could facilitate the sea level rise adaptation and mitigation planning which people are asking for, or at the very least, demonstrate how concerned the people of Charleston are regarding this issue.

Additionally, research at the local level, including changes in sea level, financial impacts of sea level rise, amount of infrastructure impacted, etc. could further support funding requests or resources from the State, should it decide to get involved in coastal resiliency efforts. For example, if the State decides it is going to grant a certain amount of money or resources to specific cities, depending on the financial impact of sea level rise or the amount of people suffering adverse effects, it is important that Charleston already have or be working towards obtaining that information.

Revise the Beachfront Management Act (1988) to no longer allow movement of the development baseline seaward

In 1988, South Carolina's Beachfront Management Act authorized a statewide beachfront management program with the overarching goal of protecting, preserving, and enhancing the beach and dune systems. Specifically, as a means to further regulate the new construction, repairs to or reconstruction of existing buildings and erosion control structures, this statewide management act created jurisdictional baselines and setback lines for permanent structures². If a building or structure is located within a 'setback area', it is subject to regulation under the S.C. Code of Regulations 30-13 and 30-21²². As such, South Carolina's Department of Health and Environmental Control (DHEC) reviews the baseline every 8-10 years, with the option to move it landward or seaward²².

Currently, the baseline is located "at the crest of the primary oceanfront sand dune in standard zones of the beachfront and at the most landward point of erosion over the last 40 years in unstabilized inlet zones"²². Under S.C. Code Ann. Regs. 30-1 D (43), the 'primary dune' must be at least 500 feet long and 3 feet high²². Movement of this baseline can occur depending on long-term erosion and accretion patterns, survey data, as well as, the historical position of the shoreline. For example, the baseline can move landward if persistent erosion occurs, whereas, the baseline can move seaward if chronic accretion occurs. Landowners may also seek to move the baseline on their specific property following beach renourishment by submitting a petition to the local government²².

The jurisdictional setback line is then established at a minimum of 20 feet landward of the baseline or as much as forty times the average annual erosion rate²². If new construction is built within this setback area, it can be no bigger than 5,000 square feet²². However, if a building is already located within the setback area and is destroyed for whatever reason, it can be restored or rebuilt to original dimensions. Similarly, new erosion control devices (seawalls, bulkheads, etc) cannot be built in the setback area²². However, if an erosion control device already exists within the setback area, it can be repaired according to specific guidelines²².

Although under state legislation DHEC may review and move the baseline landward or seaward every 8-10 years, some cities and local municipalities such as Pawleys Island have developed stricter regulations which surpass the state regulation and strive to keep development further away from the dynamic coastline²². In order to better protect its beach system and shoreline, Charleston should implement stricter development regulations along the coast, specifically by prohibiting any seaward movement of the baseline in the future. While some may feel this could lead to a 'regulatory taking', it does not; property owners cannot assume that their property will accrete, providing additional land for private use and therefore cannot argue that something of economic value was 'taken' from them. Additionally, beach accretion should be considered as further protection from coastal erosion, not room for further development. As such, Charleston should implement stricter regulations surrounding development on the shoreline by prohibiting any seaward movement of the baseline in the future.

Conclusion

As sea level rise continues to occur on a global scale, coastal cities need to be evaluating the risk and potential impacts it will have on their communities and developing adaptation and mitigation strategies to effectively handle these changes. With projections anticipating a sea level rise as high as four feet within the next 100 years, Charleston needs to be considering strategies to preserve and protect its coastlines, historical and cultural assets, natural resources, and its infrastructure. Currently, the City has taken little initiative to proactively plan and adapt for the impending effects of sea level rise. Although the Charleston Green Plan demonstrates an interest in the resiliency and sustainability of the City, it is not a sufficient or comprehensive response to sea level rise. As such, we recommend that Charleston seek regional support through the creation of a regional climate compact between the five coastal counties in South Carolina. By collaborating in a regional compact, more resources, staff, and funding will be available to work on strategic planning than would otherwise be available at the local level. Additionally, regional collaboration will demonstrate to the State that sea level rise is an important issue to these coastal

counties and support at the state level is needed. Secondly, more initiative and political will is needed at the local level to promote more sustainable practices and encourage collaboration between local scientists, residents, policy makers, business owners, etc. in order to create a plan of action for sea level rise. Ideally, the City would hire a dedicated staff member to serve as the primary contact for planning, as well as, lead community engagement, education, and outreach programs. However, if that is not an option, local government should provide platforms (conferences, meetings, educational opportunities, etc.) for the community to begin discussing the ways in which they would like to see the city take action against sea level rise. Thirdly, while beachfront development may be profitable for the region, it further erodes the beach and is at high risk of being destroyed in light of sea level rise. As such, Charleston should revise the Beachfront Management Act of 1988 to no longer allow DHEC to move the baseline seaward, regardless of accretion processes. Although Charleston's sea level rise adaptation and mitigation strategy may still be unclear, with sea level rise predictions as high as 4 feet within the next 100 years, it is clear action is needed to preserve and protect the city for generations to come.

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Appendix

Figure A.1: Aerial map of Charleston, South Carolina; *Source: Google Maps*

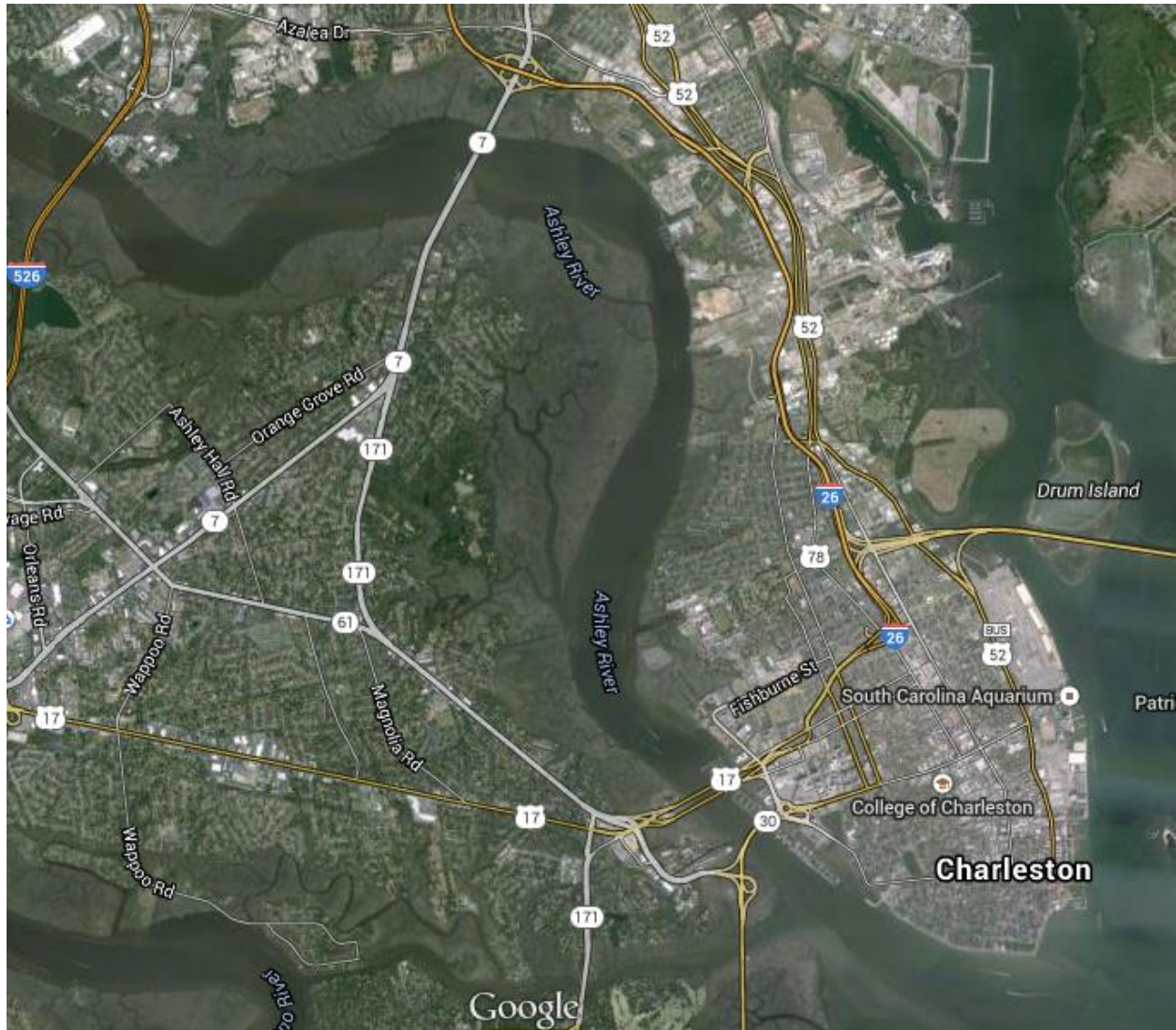


Figure A.2: Aerial map of downtown Charleston showing the high development along the shoreline; *Source: Google Maps*

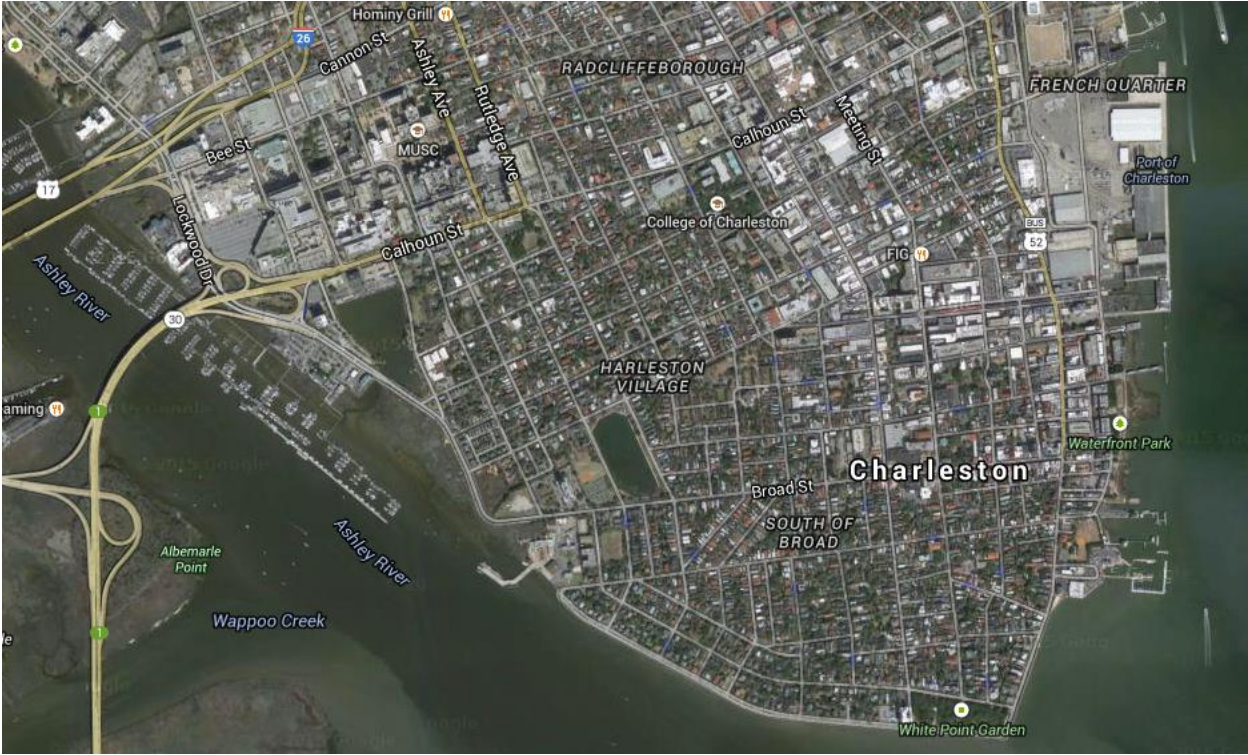


Figure A.3: Social vulnerability of Charleston, South Carolina as a result of a 4-foot rise in sea level (yellow = low, orange = medium, red = high)
Source: *Climate Central*¹⁶

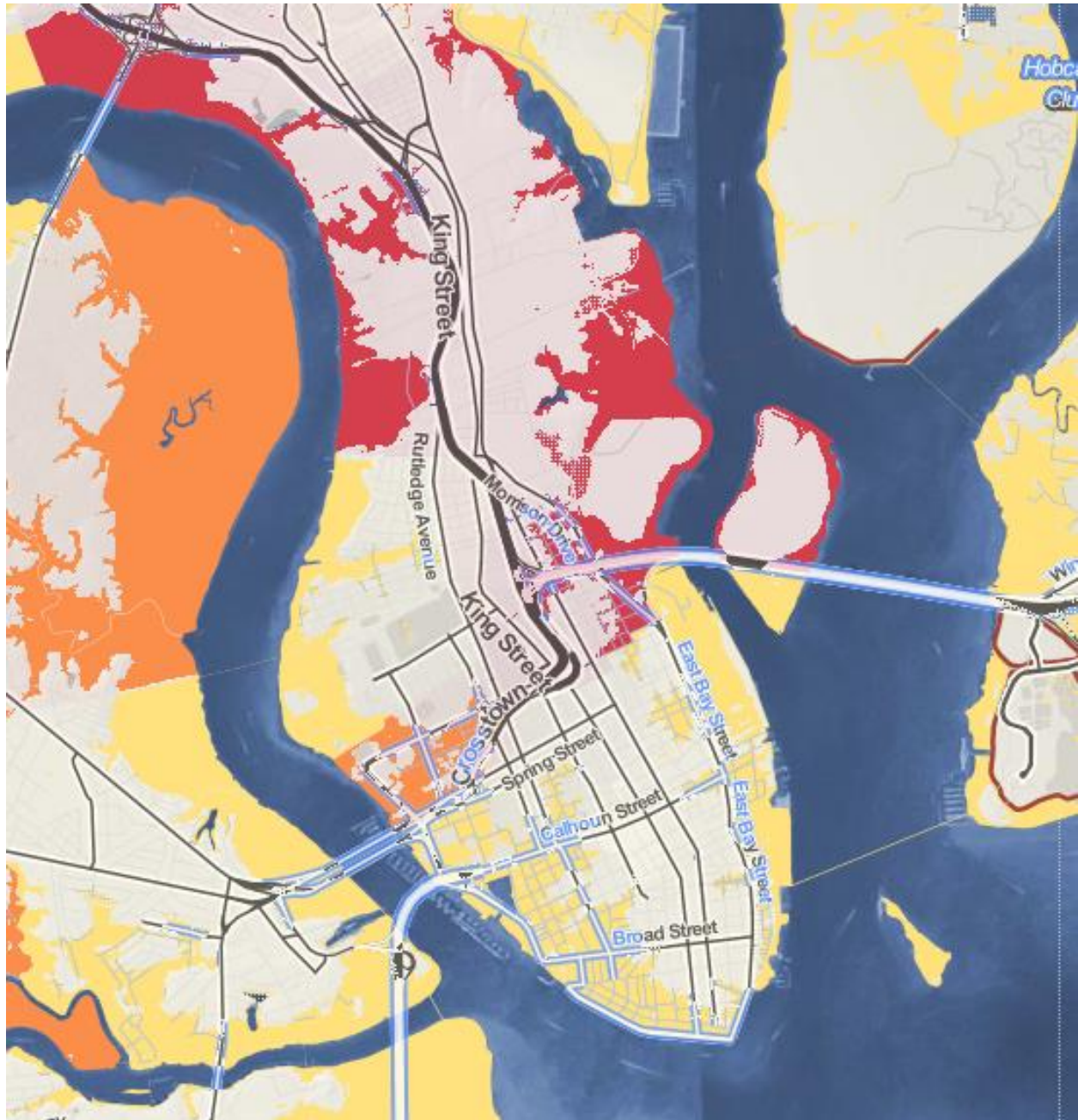


Figure A.4: Population of Charleston, South Carolina impacted by a 4-foot rise in sea level; *Source: Climate Central* ¹⁶

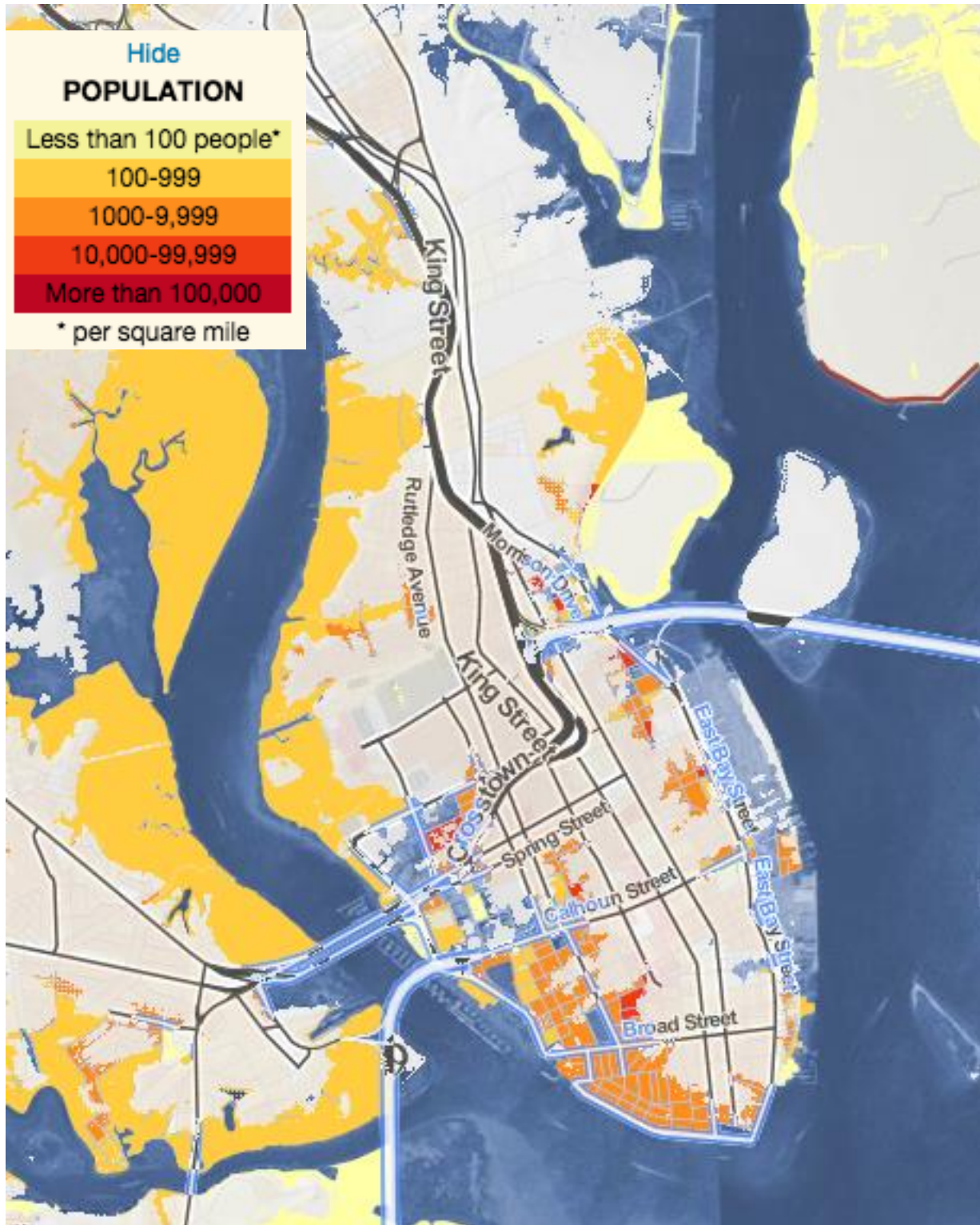


Figure A.5: The Charleston Green Plan and its reference to a sea level rise adaptation plan; *Source: The Charleston Green Plan* ⁸



systematically facilitated through practices such as waived impact fees, streamlined permitting, and assistance in obtaining public financing.

Specific Recommendations

- **Training/Liaison:** The City should invest in training on sustainable design and construction for staff members who review development plans. During a transitional period, the City should establish a special liaison to help guide sustainable development projects through the review process. An objective third-party standard should be used to determine which developers the liaison can assist - for example, LEED-ND.
- **Regional Coordination:** The liaison and other relevant staff should also be trained to help developers of sustainable communities coordinate intergovernmental and interagency review (involving, for example, counties or state agencies).
- **Process Improvement:** The City should investigate development review processes used in cities friendly to sustainable design and construction, and revise its own process to facilitate sustainable projects.
- **Incentives:** The City should waive impact fees, assist with public financing, and guarantee expedited permitting for those developers whose practices meet a certain objective, third-party standard - for example, LEED-ND. Impact fees should be based on actual impact, rewarding developers of infill communities and requiring higher fees for developments far from the urban core.

C4. CREATE A SEA LEVEL RISE ADAPTATION PLAN.

Sea level is conservatively projected to rise at least one foot over the next century. While many nations and communities are taking steps to reduce greenhouse gases, there is already a buildup in the atmosphere, and Charleston will experience some effects of climate change for years to come. Thus, it is essential that the city plan to adapt to projected impacts.

Specific Recommendations

C-4A: Establish a commission to create the plan.

The City should empanel a “Blue Ribbon” commission, representing local stakeholder groups. The commission should be established as soon as possible, and should be charged with developing this plan within one year.

- **Impacts:** The plan should identify potential short-term, mid-term, and long-term impacts of climate change scenarios likely to affect the City. Issues to be addressed include accelerated sea level rise; increased flooding; intensification of tropical storms; drought; saltwater intrusion into coastal rivers and aquifers; increases in pollen and mold spores; increases in heat-related illness; increases in ground-level ozone; impacts on the insurance and tourism industries; loss of homes and communities; displacement of residents; wildlife and fishing impacts; and insect vectors.
- **Options:** The plan should identify policy options for addressing the impacts of climate change on residents (particularly temperature-sensitive

Figure A.6: The Charleston Green Plan and its reference to a sea level rise adaptation plan, page 2; *Source: The Charleston Green Plan*⁸

populations); vital infrastructure and public facilities; economic systems; energy systems; transportation systems; communications systems; natural systems (including farmland, forests, and wetlands); and all other areas of concern throughout the city.

- **Process:** The commission should: (1) review available reports and state and national adaptation plans; (2) create an inventory of adaptation policy options, relying on examples from flood-prone communities like New Orleans and Holland; (3) analyze the cost-effectiveness of these options, as well as the potential risks and costs associated with inaction; (4) prioritize selected policy options based on the certainty and severity of adverse impacts to citizens, ecosystems, and local economies; (5) include suggested policies to be used in considering major capital investments; (6) include a plan and suggested sources of funding for developing accurate assessments of sea level rise; (7) include a plan and suggested sources of funding for public education and outreach; (8) provide specific goals, as well as a time line, for recommended actions; and (9) call for periodic update of the plan (at least every five to ten years.)

C-4B: Involve all affected agencies and sectors.

The commission should involve and coordinate with all appropriate federal, state, and local agencies (e.g. NOAA, DHEC), organizations (e.g., Save The Lowcountry Coalition), and institutions (e.g., universities) to ensure that all potential impacts and solutions are identified. Further, the plan should complement and be coordinated with related efforts, including:

- **Emergency Response:** State and local emergency management response plans address short-term responses to natural disasters, including violent storms.
- **CECAC:** The Governor’s Climate, Energy, and Commerce Advisory Committee (CECAC) developed a state Climate Action Plan which specifically addresses adaptation.
- **OCRM:** The Office of Ocean and Coastal Resource Management (OCRM), a division of the state Department of Health and Environmental Control (DHEC), has formed a Shoreline Change Advisory Committee. The Committee’s charge is to identify research needs and policy options to address storms, coastal erosion, and sea level rise.

C-4C: The plan should be implemented with reasonable speed.

Public education and outreach efforts about the need for adaptation should begin immediately. “Low-hanging fruit” opportunities should be addressed as rapidly as possible, and proactive adaptation initiatives should begin within the next two to three years.

C5. CREATE PUBLIC EDUCATION PROGRAMS

The City has access to a wide range of resources related to public education, both within its various departments and among the public agencies and non-profit groups whose missions include educating Charleston residents about sustainable community planning and development. In educating the public about the Climate Change and Sustainability Plan, opportunities for collaboration abound.