Adaptation Planning in the Town of Nags Head:

Vulnerability, Consequences, Adaptation, Planning Scenarios (VCAPS) Report

Photo by Matt Lusk

August 2017

Sea Grant North Carolina | NC STATE UNIVERSITY | Coastal Studies Institute | CISA | BINGHAMTON UNIVERSITY STATE UNIVERSITY OF NEW YORK

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INTRODUCTION

The Town of Nags Head is an approximately 6.6-square mile beach community with 11 miles of ocean shoreline and 45.6 miles of estuarine shoreline located in Dare County on the Outer Banks. The town includes an abundance of natural resources beyond the beach that includes a maritime forest and unique geologic features that includes Jockey's Ridge. These natural resources directly contribute to Nags Head's high quality of life both as a popular vacation destination and year round community. According to the 2010 U.S. Census, Nags Head has a year-round population of 2,757. However, the town's population can increase to 40,000 during the tourist season.

Due to its proximity to the Atlantic Ocean and Roanoke Sound, the town and its infrastructure are vulnerable to many hazards, including storm surge inundation from tropical storms and nor'easters, nuisance flooding, coastal erosion, and sea level rise. These hazards threaten the life and safety of residents and visitors, and have the potential to damage or destroy both public and private property and disrupt the local economy and overall quality of life. Flooding during hurricanes, tropical storms, and nor'easters impacts the ocean and estuarine shorelines, as well as adjacent development that is vulnerable to the impacts of storm surge. Flooding also impacts many areas of the town with low ground elevations and/or high groundwater tables. The town has experienced significant ponding, as much as 3 feet in some areas of town, during heavy rainfall events due to limited drainage features, flat topography, and high groundwater elevations. High groundwater tables prevent infiltration of rainfall and stormwater. Flooding not only causes public safety hazards due to flooded roadways, but can also be a public health hazard if septic tanks and drainfields become covered.

The State of North Carolina, through the Federal Emergency Management Agency's (FEMA's) Cooperating Technical Partnership, has assumed primary ownership and responsibility of the Flood Insurance Rate Maps (FIRMs) for all North Carolina communities. The FIRM maps depict the 1% annual chance of flooding (i.e. there is a 1% chance in any given year that the town will experience a 100-year flood event) in the Town of Nags Head. These are called Special Flood Hazard Areas. There are two types of Special Flood Hazard Areas in the town; the VE zone and the AE zone. The AE zone includes areas subject to flooding from the 100-year storm event. The VE zone includes areas subject to flooding from the 100-year storm event as well as wave action of three feet or more. The town also includes areas vulnerable to flooding beyond the Special Flood Hazard Areas depicted on the maps. Properties in the X zone are considered to be outside the Special Flood Hazard Area and are not required to have flood insurance nor do they need to meet minimum construction standards. These properties are considered low or moderate risk and have .2% annual chance of flooding. According to FEMA, while these areas have a reduced risk nearly 25% of all flood claims come from properties in an X flood zone.

The Town of Nags Head wants to improve its *resilience* to preserve the community's distinctive heritage and unique lifestyle, critical natural resources and coastal ecosystem, and core values as reflected in the 2017 Comprehensive Plan. A resilient Nags Head means our community will be better able to withstand, respond to, and recover rapidly from disruptions due to hazards without long-term damage to our economy or environment. It means the town will ideally require less government and/or private funding to recover, rebuild, and redevelop after a hazard occurs. Sustaining natural systems improves resilience by providing ecosystem services that directly or indirectly support our community's survival and quality of life. As stressors, like accelerating sea level rise, alter the damage we see from future hazards it may not be enough to repeat actions the town has used in the past to recover. Therefore, we must identify, study, and implement *adaptations* – the actions the town, its residents, and business owners need to take to maintain and improve our resilience.

Nags Head has adopted a comprehensive plan, hazard mitigation plan, and land use regulations such as zoning, stormwater, flood, and dune protection to help guide and manage development in this vulnerable environment. As reflected in the vision for the comprehensive plan, the town recognizes that it must be a good place to live before it can be a good place to visit. The town further strives to preserve and protect the Nags Head character, environment, tourism based economy, and sense of place in order to ensure a high quality of life for residents and a memorable family vacation experience for present and future generations. This requires that the town seek to balance its economic needs while preserving community character, the natural environment, and maintaining the quality of life through the funding of projects such as beach nourishment, beach access amenities, and multi-use paths. In addition, the town is beginning to plan for sea level rise and climate change, but currently seeks to enhance its understanding of its vulnerabilities and adaptation options as well as the legal and policy barriers to successfully implement planning tools to address the negative impacts of sea level rise.

Nags Head initiated a comprehensive planning process in 2015, known as FOCUS Nags Head, in order to better plan for the future. The Comprehensive Plan was adopted in July 2017. The plan includes policies and actions that will require continued commitment to examine how sea level rise and climate change will impact the town and what the town and its citizens can do to protect vital infrastructure, preserve community character, and maintain a thriving local economy.

Concurrently with the Comprehensive Planning Process, Nags Head contacted North Carolina Sea Grant to conduct an extension project to provide Nags Head with the data, legal and policy analysis it needs to understand its vulnerabilities and more effectively plan for the future. This project is rooted in a public process that involves generating community feedback to increase the publics' understanding of sea level rise. In a 2015 Board of Commissioners retreat, town staff developed several sea level rise adaptation goals, which this project will help Nags Head begin to:

I. Determine the factors that make Nags Head vulnerable;
II. Explore adaptation and mitigation practices that may be used to offset negative impacts of sea level rise at a local scale;
III. Obtain scientific information to enable effective decision making to address threats posed by sea level rise;
IV. Identify areas vulnerable to sea level rise;
V. Develop progress toward improving resiliency; and
VI. Adopt a risk-based approach in planning policies.

In order to assist in meeting these goals, this project also will help the town to understand the legal and policy implications of adaptation alternatives, including issues of environmental justice. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. As part of the initial phase of this extension project, North Carolina Sea Grant utilized the Vulnerability Consequences and Adaptation Planning Scenario (VCAPS) process in the summer of 2015 (Table 1). Background research and semi-structured interviews were conducted during the summer, and a public VCAPS workshop was held on December 7-8, 2015.

Date	Task
Early 2015	Board Approval
Summer 2015	▪ Research & Preparation ▪ Stakeholder Interviews
Winter 2015	Vulnerability, Consequences, Adaptation, Planning Scenarios (VCAPS) Workshop
Spring 2016	▪ Drafting of Findings & Report ▪ Formation of Coastal Resiliency & Sea Level Rise Committee
Summer 2016	Follow Up Meetings *June 2016- Review of Draft Plan* *August 2016- Prioritization*
Fall 2016- Current	▪ Finalize Report ▪ Incorporate actions and policies into Comprehensive Plan
Spring/Summer 2017	▪ Final Committee Meeting ▪ Presentation to BOC & Adoption

Table 1: VCAPS process timeline in Town of Nags Head.

This report provides a summary and analysis of the public workshop, and subsequent meetings of the Climate Adaptation and Sea Level Rise Committee formed after this project was

initiated. The VCAPS workshop was open to the public and included three breakout groups resulting in three initial diagrams documenting Nags Head's vulnerabilities to sea level rise and potential public and private actions the town and residents could take to reduce these vulnerabilities.

DESCRIPTION OF VCAPS PROCESS

Decisions about environmental hazards can be extremely complex to make. Communities may experience difficulties generating ideas about adaptations and determining the best strategies for improving resilience. One way to help decision-makers start these critical conversations is the Vulnerability, Consequences, and Adaptation Planning Scenarios — or VCAPS — process. Implemented in 17 coastal communities throughout the United States, VCAPS is a flexible, facilitated participatory methodology that provides a structure for resilience discussions. The Social and Environmental Research Institute and Carolinas Integrated Sciences and Assessments, along with the South Carolina Sea Grant Consortium and North Carolina Sea Grant, developed VCAPS with funding from the National Oceanic and Atmospheric Administration's Sectoral Applications Research Program.

The VCAPS process is intended to help communities become more hazard resilient. During VCAPS, community members:

- Engage in dialogue about future hazards.
- Integrate local knowledge and experience about how the community will be impacted.
- Identify gaps in data, knowledge or understanding.
- Think strategically about how to prevent harm by taking action in both the short and long-term.

VCAPS works best with a diverse group of participants who are knowledgeable about a community or region. Participants usually include elected officials, staff from local and state government, regional planners, business owners, residents, and other interested groups or organizations. The three phase process helps local decision makers produce scenarios, represented by diagrams, linking natural hazards to local consequences. First, interviews with a sample of local community stakeholders and decision-makers help prepare facilitators by highlighting potential challenges to hazard resilience. These interviews also identify scientific information that may be helpful information for everyone participating in the second phase of group meetings.

In the second phase of a series of group meetings, stakeholders engage in facilitated conversations about the impacts and consequences of hazards in their community that are supported by real-time diagramming. At the beginning, facilitators provide scientific information on the community's future hazards based upon concerns expressed by local residents during

pre-meeting interviews and the best available science for the region. During the conversations, participants engage with scientists to clarify their understanding and assumptions. They also answer questions about the hazards and adaptation challenges to future resilience faced by their community. Facilitators help create diagrams of the causal pathways of hazards and impacts, which are projected onto a large screen for viewing. These diagrams allow group members to identify adaptation opportunities and actions appropriate for their community. Real-time diagramming helps each group discuss and express how hazards harm their community, making it easier to identify adaptation opportunities and actions that can make their community more resilient to an uncertain future. This type of collaborative fact-finding process that involves the community has proven to be crucial in gaining trust and buy-in leading to greater commitment and more successful implementation.

VCAPS diagrams have several key elements, and are created using freeware from Tufts University called VUE (vue.tufts.edu). Key hazard nodes are management concerns, hazard stressors, outcomes, and consequences.

- **Management concerns** are any topics or areas of focus that can be relevant to the resource systems a community manages (e.g. shoreline management, public health, or emergency management).
- **Hazard stressors** are any event related to a natural hazard that puts stress on the community.
- **Outcomes** are processes or events that occur in the social or ecological systems because of the hazard.
- **Consequences** are implications of the outcomes that affect individuals, communities, institutions, or ecosystems that reflect losses that people care about or benefits that could be exploited.
- **Adaptation actions** are proactive or reactive actions to mitigate hazard stressors, outcomes, or consequences. These can be taken by either public entities or private entities, and are denoted by boxes stacked above the nodes.
- **Contextual factors** for each node may also be considered, which are things in the local physical or social environment that help shape the form of a hazard stressor, outcome, consequence, or action (i.e., things that make a node or action bigger, smaller, better, worse, or different).

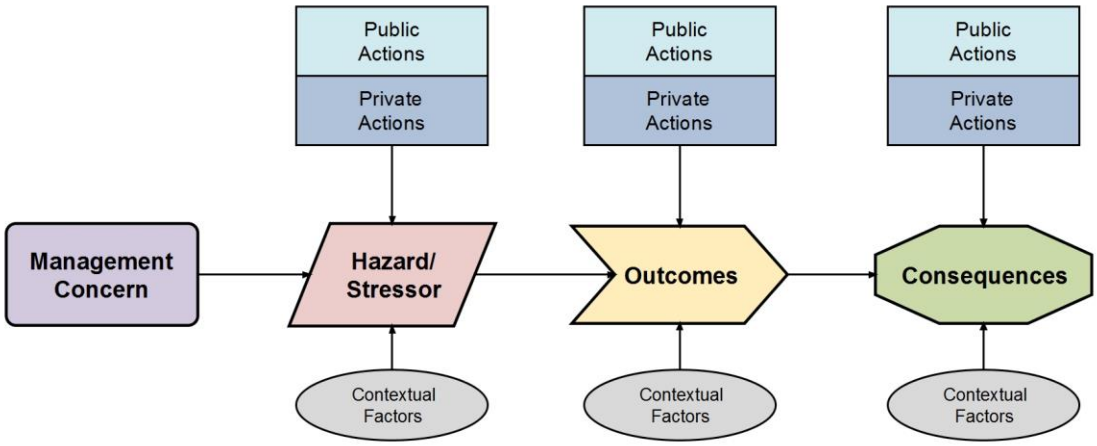

Figure 1: Building blocks of a VCAPS diagram.

In the third phase, reports are created by using the diagrams to list adaptation actions that can be taken by public entities (local, county, regional, state, and federal governments) and by private entities (e.g., homeowners, business owners, and non-governmental organizations NGO). In the Town of Nags Head, this phase also included synthesizing the diagrams from three different breakout groups and having a town subcommittee go through a prioritization exercise to highlight important adaptation actions to consider first. This report represents the outcome of this third phase. Such reports can be used by participating communities as a roadmap to develop adaptation plans, or to consider strategizing adaptation actions into existing community plans and processes.

VCAPS encourages participants to explore the countless number of environmental, economic, health, social and other impacts that may emerge in their community. Many people can benefit from VCAPS. Local governments can improve emergency services and ensure that key utilities, such as water, sewer, electricity and transportation, remain operational during emergencies. Individuals and organizations can take other actions to protect their health, property and livelihoods.

VCAPS PROCESS IN NAGS HEAD

Stakeholder Interviews

In August 2015, the North Carolina Sea Grant team conducted 19 formal semi-structured interviews of local decision-makers and stakeholders, lasting between 30 minutes to two hours each. The semi-structured format means that new follow-up questions were allowed to emerge based on respondent answers, and that some questions were skipped if answers to those questions were already answered during the course of responses to previous questions. Because the primary purpose of the interviews was to inform VCAPS meetings, they were not rigorously coded for research analysis. There were 11 interviewees from the Town and Dare County municipalities (town staff, town elected officials, and Dare County staff), seven from the private sector (business owners, retirees with extensive knowledge of the Nags Head area, or NGO members), and one was from the North Carolina Department of Transportation. The team also had an informal discussion with a federal employee for informational purposes only (federal employees must go through an extensive review process to participate in research, and the research team judged that sufficient advice on synergistic federal activities, if any, could be received through informal discussion). North Carolina State University's Institutional Review Board (IRB) reviewed the interview script and approved the interviews as human subjects research under the condition that confidentiality of the interviewees was protected. While some interviewees permitted us to quote them, some did not, and as such no identifying information is included with quotes in this report.

Only three interviewees characterized themselves as having little understanding of sea level rise. However, even two out of those three interviewees described that hazards, such as storm surge, could be affected by sea level rise. When asked if sea level rise was already happening, interestingly no interviewees expressed clearly that sea level rise is not occurring. There were five other interviewees that gave extremely nuanced views. Several described that some hazards have changed although the interviewee could not attribute a cause. For example, one business owner did not attribute changes to sea level rise but expressed that s/he has seen drainage and standing water become more of a problem and noted that water remained longer after Hurricane Irene in 2011. One Town of Nags Head employee stated s/he understood that sea level rise is happening, but did not have evidence that current changes can be attributable to sea level rise: "Is beach erosion caused by sea level rise? I don't know, I know the beach erodes away and the marsh erodes away. If sea level rise is driving this I don't know. Marsh washes away when overtopped by water. I don't believe it's a cycle, it's pretty much man made." Even in the case of a Dare County employee who described him/herself as not knowing whether sea level rise is occurring, the interviewee credited the Town of Nags Head for having the "strategic vision" to consider the possibilities of damaging "worst case" scenarios.

Key potential impacts listed by interviewees included erosion on both the ocean front and the sound side, and negative consequences of erosion including lost homes and the need to move Nags Head Woods Road, as well as the past loss of Surfside Drive and threats to Seagull Drive, as examples. Rising groundwater was also frequently cited, with potential impacts to septic function and underground utilities. Flood events were also cited, including two town staff members who expressed concern about eventual impacts to flood insurance. Locations frequently cited as being of concern to interviewees were South Nags Head, Vista Colony, Whalebone Junction, and the Causeway. One interviewee observed that during his/her residency in Dare County some of the marshy islands behind Whalehead Junction have been lost.

Interviewees cited the need for education and awareness, including one interviewee who cited the need for more public forums. Five interviewees cited the need for visualizations of sea level rise; however, one interviewee expressed extreme concern about this strategy given that publicly available mapping tools may lack context to help someone understand what the levels of inundation mean and therefore may unfairly devalue property through perception. Several interviewees also described the need to develop ways to incentivize adaptation measures.

Interestingly, cost was infrequently cited as a barrier to implementing adaptation planning and strategy – only three interviewees cited cost first when asked about barriers. More frequently, interviewees cited government processes – including the speed with which government works and the roles, responsibilities, and authorities to set policy between the state and local governments – as barriers to adaptation (e.g., one interviewee gave an example that building codes exist but the NC General Assembly sets the number of inspections to ensure those codes are met). The need for awareness and communication was also cited as a barrier to adaptation planning, including public perception of the lack of an immediate threat from sea level rise. One interviewee expressed that encouraging the town and its staff in efforts to be creative would help reduce the effect of many barriers.

VCAPS Meetings

The VCAPS groups were convened at a public meeting on December 7 and 8, 2015. Invitations were sent to Nags Head committee members, as well as through public meeting notices including posts on social media. Print media coverage of the meetings and interview results led to a larger than anticipated public response, with 58 attendees who signed in.

After introductions, meeting attendees viewed a presentation given by Drs. Reide Corbett and J.P. Walsh of the UNC-Coastal Studies Institute and East Carolina University. Dr. Jessica Whitehead then gave an introduction to the VCAPS process. To set the context for small group diagramming, Dr. Whitehead led a discussion about the values and visions the Town of

Nags Head has for resilience, based upon elements in the Town of Nags Head vision statement. With these goals and values in mind, attendees broke into three small groups to participate in the active VCAPS diagramming sessions. Because VCAPS diagrams rely on group discussion and large groups can inhibit participation, and the project team could only staff three trained VCAPS teams, participation in group discussion was limited to attendees who live (own or rent), work in, or work for the Town of Nags Head (including North Carolina Department of Transportation employees whose responsibilities include the town). Attendees spent approximately 1.5 hours diagramming before recessing the meeting until December 8th. After an additional 1.5 hours of diagramming time on December 8th, the breakout groups reassembled and reported out their findings in order to refine the statements of values and visions for resilience.

In April 2016, the Town of Nags Head formed the Climate Adaptation and Sea Level Rise Committee, tasked with reviewing the initial draft of this report to ensure the diagrams were inclusive and reflective of all discussions among the three groups. The Committee completed this task in June and then asked Sea Grant and Nags Head town staff to combine all three group diagrams into a single synthesis diagram that reflected input from all groups. However, due to the complexity of the issues in each diagram, a single synthesis diagram was too complex to be meaningful and readable. Instead, Sea Grant and town staff produced two topical synthesis diagrams: one on adaptations for ocean and estuarine shoreline management, and another on adaptations for the built environment, including drinking water, septic, and stormwater management (encompassing risks to roads and structures). The Committee worked together to consolidate a number of suggested adaptation actions to 90 actions for public entities (local, state, and federal entities including public universities) and 35 actions for private entities (citizens, businesses, and NGOs). The actions generally fell into five categories: ocean management, estuarine shoreline management, stormwater management, water (ground/surface) management, and common cross sector topics mentioned in all groups (both diagrams).

SYNTHESIZED DIAGRAM RESULTS

All Groups (Both Diagrams)

As referenced in Section I, VCAPS diagrams proceed from hazard, to outcome, to consequence. In combining the breakout groups' individual diagrams into two topical diagrams, the team realized that nodes representing the hazards and some immediate outcomes from those hazards related to erosion appear on all topical diagrams. In other words, hazards like sea level rise and tropical storms and the immediate outcomes of these hazards for ocean side and sound side erosion are drivers that impact both shoreline management and stormwater and water management. Tropical storms, hurricanes, and nor'easters are all meteorological hazards which produce storm surges and overwash, both of which lead to shoreline erosion, which the Committee classified as its own natural hazard.

Importantly, all three breakout groups identified sea level rise as an additional hazard of concern. The resulting higher ocean and sound water levels as additional hazards and outcomes of sea level rise could alter historic patterns and rates of oceanfront and sound side erosion. These elements are common to both management diagrams, and remaining outcomes, consequences, and adaptations follow. As a result, the hazards and outcomes appearing on both topical diagrams are also prioritized in their own category, because they represent the important forces behind all adaptations discussed.

Ocean and Shoreline Management Diagram Description

The Town of Nags Head is experienced in coping with ocean side erosion and has taken many actions to adapt. This includes a locally funded beach nourishment project and formation of a Shoreline Management Committee. Due to the extent of work and focus on this hazard, many of the outcomes of erosion and consequences are well developed and thought out. The diagram for shoreline management is discussed below.

It was noted through the diagramming that erosion contributes to sand loss on the beach, narrowing it and reducing protective barriers, such as dunes (Figure 2). This loss of protective dune barriers has consequences for infrastructure (including roads, water lines, and septic systems) as well as structures. Beachfront property loss leads to fewer properties being built and maintained as well as outmigration from the oceanfront, leading to a loss of property value. This, combined with infrastructure loss, would lead to a reduced tax base for the Town of Nags Head, resulting in lost public services, increased taxes, and a reduced ability to pay for mitigative and adaptive actions. Additionally, any beach narrowing that leads to a decline in beach aesthetics or loss of public trust use of the beach could impact tourism negatively,

resulting in job losses. While a full discussion of proposed actions follows below, it is worth noting that one proposed action to reduce beach loss – a beach nourishment coalition to synchronize multiple beach towns' needs and plans without sacrificing control – could result in the benefit of cost savings from coordinating nourishment projects. This is particularly useful if beaches need to be nourished more frequently than in the past.

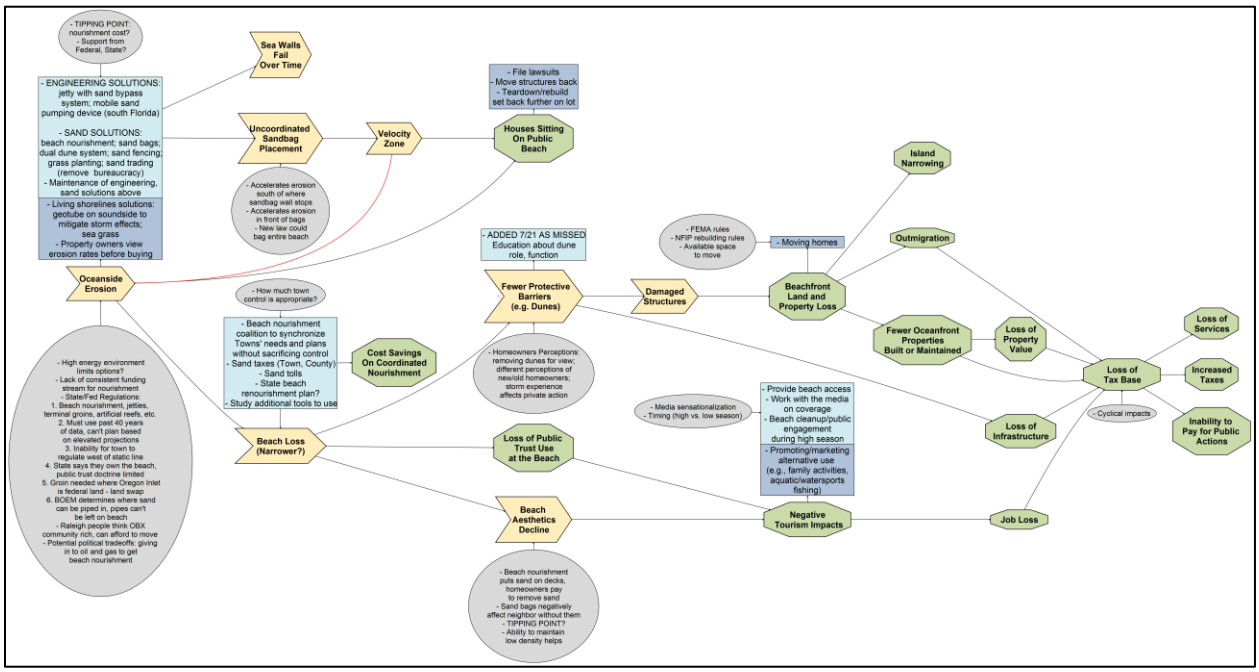

Figure 2: Sample section of VCAPS diagram demonstrating pathway from oceanside erosion to beach loss to damaged structures and ultimately lost tax base. A discussion of sand transport was also noted as an additional outcome of altered ocean side erosion due to storms and sea level rise. Concerns were raised about whether the depth of Oregon Inlet could be compromised, leading to Inlet closure (although this has not been verified as an actual cause). Dredging and maintenance were mentioned as strategies, but installing a groin at the southern end of the town could also have unknown and unintended effects that could increase cost pressures on the Town of Nags Head.

The synthesized diagram raised the question of when sea level rise and storminess could force a tipping point in beach renourishment costs or force limitations on beach renourishment frequency through limits on available beach-quality sand, which would increase pressure on the town. Adaptive actions, such as uncoordinated sandbag placement, could alter velocity zones that accelerate erosion, leading to houses sitting on the public trust beach. Additionally, groups noted that sand bags (acting as sea walls) fail over time. One group discussed jetties to help retain sand and reduce renourishment frequency. However, they also expressed concern that a

jetty could accelerate erosion on Pea Island, leading to difficulty accessing Hatteras Island due to Pea Island road and bridge impacts.

Erosion on the sound side also raised concerns (Figure 3), and groups noted the severity of the problem would depend on the rate of marsh accretion versus sea level rise rate – i.e., whether sea level rise will proceed slowly enough that marshes can build up in response, or if sea level rise will accelerate to a rate fast enough to inundate marshes. Marsh loss and sound side erosion would lead to infrastructure protection loss, loss of private property, and structure damage. This could lead to a decrease in property values. Marsh loss would also degrade nursery areas for fisheries, possibly leading to a loss of habitat for marine life. Losses to recreation and both commercial and recreational fisheries would lead to reduced business revenue, jobs, and quality of life. These would have consequences to the Town of Nags Head through lost tax revenue, including through loss of residents and decreased tourism revenue.

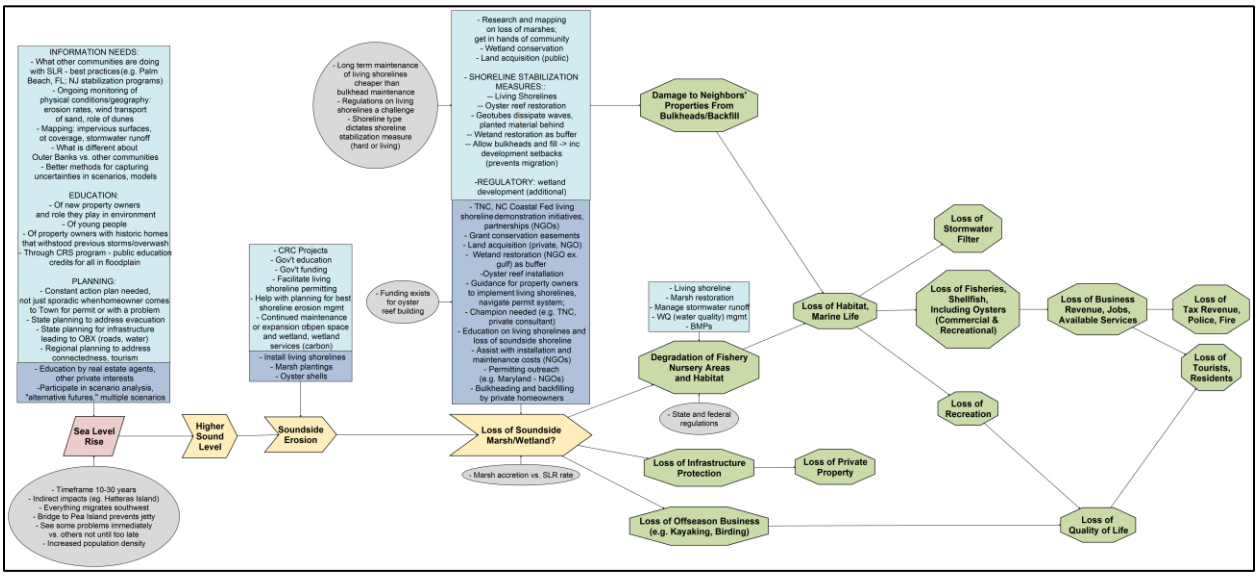

Figure 3: Sample section of VCAPS diagram showing pathway of sea level rise to sound side erosion to loss of sound side shoreline. Important consequences include damaged properties, lost infrastructure, and degraded fisheries habitat.

Ground and Surface Water Management Diagram Description

All three groups noted that both sea level rise and heavy rainfall events may be contributing to a rising water table in Nags Head. Heavy rainfall events, coupled with runoff from increased impervious surfaces, in addition to the intrusion of salt water into groundwater, act to raise the water table and decrease the depth of the unsaturated zone between the water table and the

surface. If the water table is high enough, it can contribute to standing water on land. Based on the science presentation, participants also noted that it is important to these sectors if new inlets are formed in response to ocean side and sound side erosion and storms.

The Town of Nags Head purchases drinking water from the Dare County Regional Water System, sourced from ground water wells in the Skyco area of Roanoke Island (Upper Yorktown Aquifer), Kill Devil Hills, and Nags Head (Mid Yorktown Aquifer). Participants were concerned about whether sea level rise could lead to increasing saltwater intrusion into the surficial aquifers that recharge deeper aquifers used for drinking water. Changes in the balance of fresh and salt water balance could lead to a change in the availability of fresh water and, if severe, a need to change drinking water sources.

Additional connections with drinking water include the issue of importing groundwater from the mainland and other areas of the Outer Banks with discharge as wastewater into the surface water table through septic systems. This issue, in combination with both stormwater runoff and sea level rise, could contribute to higher water tables. Higher water tables have several implications, including increased standing water above ground during times of extremely high water tables. One group identified a key potential tipping point for further investigation – this includes examining when the cost to treat standing water due to stormwater and high water tables would exceed the revenues that are available to deal with these problems.

Higher water tables are critically relevant to potential changes in septic function, an issue that is only now beginning to be studied in coastal areas. Elevated water tables are already an occasional seasonal problem in parts of Nags Head, leading to a decrease in the unsaturated zone and reduced recovery time. These may increase the risk of septic system malfunction (Figure 4), especially depending on the system type, soil type, maintenance history, age compared to the design life of the system, and whether or not the system meets current code. All these factors increase the risk that a septic system will not continue to function properly when exposed to higher water tables or direct damage from inundation or sound-side and ocean-side overwash. If conditions from water table height or inundation occur frequently enough to lead to septic system failure, this could lead to the condemnation of homes due to the inability to treat wastewater.

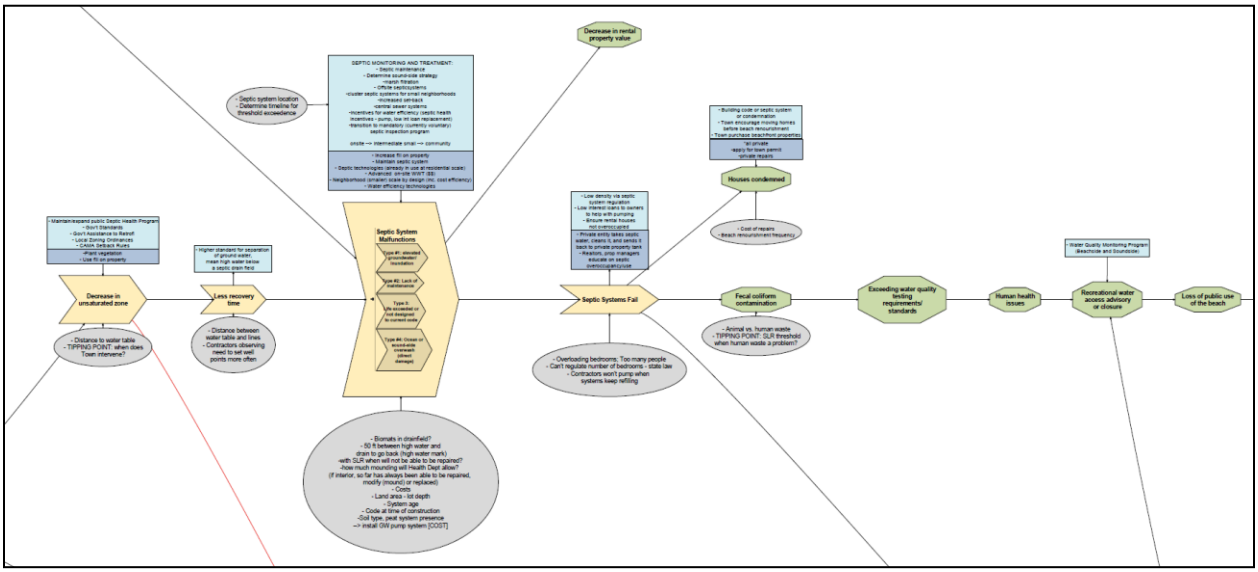

Figure 4: Sample section of VCAPS diagram with pathway from decreased unsaturated zone to multiple stressors contributing to septic system malfunction and potential failure. Should consequences include exceeded water quality standards, in time this may even lead to human health impacts and lost beach use.

Should this occur with enough homes, fecal coliform contamination could begin to become a concern, especially once water quality standards are exceeded. Participants identified the need to define a tipping point at which sea level rise reaches a threshold when septic function declines enough that human waste becomes a problem. However, this is an emerging area of scientific research so not enough information exists to define if or when this could become a significant problem in the Town of Nags Head.

The consequences of fecal coliform contamination include human health issues and recreational water access advisories or closures that could lead to the loss of public use of the beach. Poor public perception of water quality may eventually impact tourism, leading to job losses and loss of tax base. A reduced tax base would mean fewer public services, higher taxes, and an inability to pay for adaptive options, decreasing the quality of life in Nags Head. Declines in water quality – both from septic system failure and from increased standing water due to water table height – could also have consequences for ecological health. Poor water quality could lead to a decline in fish and shellfish health and even fish kills, negatively impacting the fishing industry.

Finally, sound side and ocean side inundation, stormwater runoff, or a combination of both can lead to the flooding of roads, ditches, and structures in Nags Head. Road and ditch flooding may lead to sand deposits in roads and ditches. Additionally, flooded roads and ditches pose public safety and infrastructure concerns, including elongated recovery times. Inundated roads prevent property access, and, if inundation occurs frequently enough, roadways could become structurally compromised, limiting accessibility for emergency managers. Utilities, such as

electric lines and water lines, can also be affected. Flooded structures, whether public or private, result in property damage and infrastructure loss, which degrade property value if not repaired or if flooding occurs frequently. Any loss in property value reduces the Town of Nags Head tax base. Once houses become impacted, emergency management responds and, if impacts are severe enough, the disaster response and recovery process begins.

ACTION PRIORITIZATION

Following the April 2016 committee meeting, the actions from the diagrams were further sorted and grouped into five major categories: ocean management, estuarine shoreline management, stormwater management, water (ground/surface) management, and common cross sector actions mentioned in all groups (both diagrams). A complete spreadsheet of all the scoring and actions are located in Appendix 3 and 4.

In August of 2016, Sea Grant led the Climate Adaptation and Sea Level Rise Committee through a prioritization exercise. Participants were asked to rank the actions within each of the five topic areas. Each participant was given five stickers for voting within each topic area. Participants could utilize as many votes, or stickers, per action as they desired. Each sticker represented one vote. Additionally, participants were asked to rank their overall priorities among all five of the topic areas. Each participant was given six stickers that were numbered one through six. For prioritization purposes, the value of the stickers were weighted - one being the action they felt was most important (with a value of six points) and six being the action they felt was of lesser importance (with a value of one). Again, participants could place as many stickers or "votes" on any action they desired. A summary of the actions prioritized by topic area and how they ranked in overall importance is located in Appendix 3 and 4. Completion of this prioritized action exercise identifies key priorities and establishes the foundation for the town's adaptation strategy.

In May 2017, the Climate Adaptation and Sea Level Rise Committee met to discuss the draft report and the results of the prioritization. The committee, by consensus, focused their discussion on the overall priority action items. The committee indicated that the overall priority action items encompassed the key items that should be the focus for implementation. The committee then grouped the overall priority action items by level of priority (1=highest and 3=lowest) and requested that staff add additional columns in the tables for resources, status, and responsible department.

IMPLEMENTATION TABLES

In coordination with the Climate Adaptation and Sea Level Rise Committee, Town staff and North Carolina Sea Grant worked to translate the prioritized actions into the VCAPS Implementation Table.

The actions in Table 2, VCAPS Implementation Table- Overall Priority Actions, below are sorted into three tables by level of priority (1=highest and 3=lowest) based on the prioritization exercise described earlier. Due to resource constraints, the priority level guides the town toward achieving the most crucial actions. However, since some high priority actions

have longer time frames and budgets, it is possible that lower priority items are more readily achieved. As resources become available or community needs and desires change, the priority level may also change. To ensure consistency and clarity across planning efforts, those strategies or actions that overlap with or are included in FOCUS Nags Head contain the same language to allow for easier coordination and implementation.

For each action, Table 2 outlines the following: town lead or primary department responsible; key partners; acknowledgement if significant private support or coordination is needed; expected time frame (short, intermediate or long); applicable revenue type or financial mechanism; the overlap or integration with FOCUS Nags Head; and current implementation status. Additionally, an asterisk found in the 'status' column signifies that the action is an 'adaptive management' action, meaning it requires iterations to accommodate new information as it becomes available. The table also indicates how an overall strategy addresses or is related to one or multiple of the five goals found in FOCUS Nags Head which can be found in Appendix 2.

The actions in Table 2 are further identified by their "ID". In the ID column, there is an "O" or overall priority action ID and a root ID shown in parenthesis. The root ID shown in parenthesis indicates the original five major categories from the diagramming. These include ocean management (OM), estuarine shoreline management (ES), stormwater management (SM), water (ground/surface) management (WM), and common cross sector actions mentioned in all groups (AG). The number associated with each ID indicates its' ranking both within the overall priority action items and within the root ID with the number "1" indicating the top ranking action. The original ranking for both five major categories from diagramming and the overall action priority can be viewed in Appendices 3 and 4 and the discussion on the process for prioritization of these items can be found in the previous section on Action Prioritization.

It is important to note that the actions in the implementation table were originally derived from public input at the VCAPS workshop and may not have been fully inclusive of all actions needed to build and maintain resilience to sea level rise in the Town of Nags Head. There may be gaps in the information suggested given the time available for the meetings, who attended, and new information on best practices for adapting to sea level rise that continues to become available. Therefore, the implementation table does not serve to outline every single possible step to achieve the town's goals, but rather serves as a starting point for a more concerted and detailed sea-level-rise planning strategy.

The following terms and acronyms will be helpful in reviewing the implementation tables below:

CA & SLRC	Climate Adaptation and Sea Level Rise Committee
CISA	Carolinas Integrated Science Assessments
CIP	Capital Improvements Plan
CSO	Coastal States Organization
EPA R4	U.S. Environmental Protection Agency Region 4
FR	Fire
HAZUS	Hazards US
HOAs	Home-Owners Associations
NPS	National Park Service
NCCF	North Carolina Coastal Federation
NC-CRC	North Carolina Coastal Resources Commission
NC-DEQ	North Carolina Department of Environmental Quality
NCEM	North Caroline Emergency Management
NCSG	North Carolina Sea Grant
NC-SWC-CCAP	North Carolina Division of Soil and Water Conservation Community Conservation Assistance Program
NOAA	National Oceanic and Atmospheric Administration
OB-COC	Outer Banks Chamber of Commerce
OBVB	Outer Banks Visitors Bureau
OR	Ocean Rescue
P & D	Planning & Development
TNC	The Nature Conservancy
PW	Public Works Department
TM	Town Manager (Includes Town Engineer)
SHI	Septic Health Initiative
SLMC	Shoreline Management Committee

Table 2: VCAPS Implementation Table- Overall Priority Actions

PRIORITY 1

PRIORITY 1	ID	Action	Town Lead	Key Partners	Requires Significant Private Support or Coordination	Time Frame (short: <2 yrs; intermediate: 2-5 yrs; long: 5+ yrs)	Revenue Type (grant, staff time, facility fees, or capital reserves)	Overlap with FOCUS Nags Head (Action #)	Status
	O-1 (WM-1)	Maintain and expand the Septic Health Initiative (retrofits, homeowner assistance, groundwater sampling, peer review data, groundwater mapping, transition towards mandatory inspections with other incentives)					FOCUS NAGS HEAD Goal Addressed: 2, 3, 5		
			P&D	SHC	No	Short	Staff Time	NR-26, NR-16, NR-16e	-
	O-3 (AG-4)	Develop a comprehensive education and outreach program for K-12, residents, and property owners implemented by both public and private actors. Include topics such as: SLR, storms, soundside/oceanfront erosion, beach renourishment, and CRS.					FOCUS Nags Head Goals Addressed: 1, 2		
			P&D	SLMC, CA & SLRC, NCCF, TNC, NCSG, OB-COC	Yes	Short	Grant, Staff Time	NR-16, NR-16d	-*
	O-4 (ES 1)	Develop an estuarine shoreline management plan that establishes policies, procedures, and an overall management strategy for the town's estuarine shoreline. This plan will work to develop projects and strategies to prevent estuarine flooding in the future. The plan should research, identify and map marsh loss, "soft" stabilization methods that are appropriate for Nags Head's estuarine shoreline, potential opportunities for land acquisition, and potentially restorable wetlands. Additionally, it should develop incentives that can be utilized for the protection of natural shorelines.					FOCUS Nags Head Goals Addressed: 1, 2, 5		
			TM	P&D, TNC, NCCF, NC-SWC-CCAP	No	Intermediate	Grant, Staff Time	NR-1, NR-16	In FY 2017-2018 Budget
	O-6 (AG-2)	Develop a plan for adaptation that includes a suite of SLR scenario/probability distributions (update since CRC and consider longer timescale for infrastructure).					FOCUS Nags Head Goals Addressed: 1, 2, 3, 4		
			P&D, TM	NCSG	Yes	Short	Grant, Staff Time	NR-16, NR-16c	-

PRIORITY 1

PRIORITY 1	ID	Action	Town Lead	Key Partners	Requires Significant Private Support or Coordination	Time Frame (Short: <2 yrs; Intermediate: 2-5 yrs; Long: 5+ yrs)	Revenue Type (grant, staff time, facility fees, or capital reserves)	Overlap with FOCUS Nags Head (Action #)	Status
	O-7 (AG-1)	Develop a long-term shoreline management plan that considers the environmental, legal, financial, physical, and regulatory issues and constraints that will need to be addressed to conduct ocean shoreline management over a 30-year time horizon. The plan should consider the following: • Multiple strategies including nourishment, structure relocation, sand fencing, dune vegetation, alternative shoreline stabilization techniques, and the potential for structure acquisition in limited circumstances. This includes agreement from the public and elected leaders on a target beach condition which becomes the town's goal to achieve through consecutive nourishment cycles. • A streamlined and programmatic approach to permitting that allows for a shorter window for construction projects. • Best practices for dune management including minimum disturbance by property owners (i.e. cutting away dunes to enhance views or significant dune removal to clear structures), regular sand fencing and dune vegetation planting, and proper siting and construction of structures. • An improved design utilizing dune vegetation, sand fencing, and adjustments to the beach and dune nourishment profile to limit impacts to oceanfront property owners from migrating sand. • Appropriate trigger points for maintenance cycles that address project goals. • A long-term funding strategy that provides consistent revenue for the town and reasonable and predictable tax rates for oceanfront and non-oceanfront property owners. • A coordinated approach with Dare County and other municipalities on a long-term funding approach to nourishment which provides a consistent and predictable source of revenue for maintenance and construction projects. • A coordinated approach with Dare County and other municipalities to determine if and how regional planning can improve project efficiencies and achieve cost savings. • A comprehensive communication strategy to educate town property owners and residents on the importance of the beach and the strategies the town is utilizing to maintain the beach and provide public access.					FOCUS Nags Head Goals Addressed: 1, 2, 5		
			TM	P & D, SLMC, CA & SLRC	No	Short	Staff time	NR-17, NR 18, NR 19, NR 20, NR-21	In FY 2017-2018 Budget

PRIORITY 1

PRIORITY 1	ID	Action	Town Lead	Key Partners	Requires Significant Private Support or Coordination	Time Frame (Short: <2 yrs; Intermediate: 2-5 yrs; Long: 5+ yrs)	Revenue Type (grant, staff time, facility fees, or capital reserves)	Overlap with FOCUS Nags Head (Action #)	Status
	O-8 (SW 1)	Address stormwater at the source through best management practices (e.g., low impact development, reduced amount of impervious surface, etc.)					FOCUS Nags Head Goals Addressed: 2, 4, 5		
			TM	P&D, NC-SWC-CCAP	No	Short	Staff Time	MS-16	*
	O-9 (SW-2)	Decrease amount of impervious surface in the future. Examine regulations for road and parking lot requirements and explore ways to reduce impervious coverage associated with development.					FOCUS Nags Head Goals Addressed: 2, 4, 5		
			P&D	TM, Planning Board, BOC	Yes	Medium-Long	Staff Time	-	Can be included in the UDO update
	O-12 (SW 5)	Develop long-range plans for progressively improving the town's stormwater drainage infrastructure. This plan includes documentation of the type, size, and location of existing drainage features within the town, including rights-of-ways and outfalls. Additionally, the plan should document existing nuisance and problem areas that experience frequent flooding.					FOCUS Nags Head Goals Addressed: 1, 2, 4, 5		
			TM	P & D, NCCF, NC DOT, TNC	No	Short	Staff Time	MS-15	In proposed FY 2017-2018 Budget

PRIORITY 2

PRIORITY 2

ID	Action	Town Lead	Key Partners	Requires Significant Private Support or Coordination	Time Frame (Short: <2 yrs; Intermediate: 2-5 yrs; Long: 5+ yrs)	Revenue Type (grant, staff time, facility fees, or capital reserves)	Overlap with FOCUS Nags Head (Action #)	Status
O-2 (AG-3)	Conduct ongoing monitoring of physical conditions/geography including erosion rates, wind transport of sand, and dune capacity as part of the long-term ocean shoreline management strategy					FOCUS Nags Head Goals Addressed: 2, 5		
		TM	P&D, Contractors, USGS	No	Short-Intermediate	Staff Time, CIP	NR-16	*
O-11 (WM-2)	Develop higher standards/regulations in permitting for separation of groundwater and mean high water below a septic drain field					FOCUS Nags Head Goals Addressed: 2, 4, 5		
		P&D	EPA R4, County Co-Op	Yes	Intermediate	Staff time	NR-16, NR-24, NR-28,	-
O-14 (ES-3)	Acquire land with estuarine shorelines that can be persevered in their natural state or that can be retrofitted with living shorelines.					FOCUS Nags Head Goals Addressed: 2, 4, 5		
		TM	P&D, TNC, NCCF, State Parks, NPS	Yes	Intermediate	Grant, Staff Time	NR-1, NR-2, NR-4	Ongoing*
O-15 (WM-3)	Advocate for the continued enforcement of rigorous standards environmental health standards for onsite wastewater systems					FOCUS Nags Head Goals Addressed: 1, 5		
		-	NC DEQ, County EHS	No	Short-Intermediate	Staff time	NR-24, NR-26, NR-27	Ongoing
O-18 (AG-7)	Conduct State level planning for evacuation planning and vulnerable infrastructure leading to OBX (roads, water) in light of SLR					FOCUS Nags Head Goals Addressed: 3, 4, 5		
		NCEM	County EM, NC DOT	No	Long	Staff time	NR-10, NR-11, NR-16	-

PRIORITY 3

PRIORITY 3

ID	Action	Town Lead	Key Partners	Requires Significant Private Support or Coordination	Time Frame (short: <2 yrs; intermediate: 2-5 yrs; long: 5+ yrs)	Revenue Type (grant, staff time, facility fees, or capital reserves)	Overlap with FOCUS Nags Head (Action #)	Status
O-10 (OM-2)	Study additional engineering, financial tools to use to mitigate against beach loss.					FOCUS Nags Head Goals Addressed: 2, 5		
		TM	P&D, NCCF, NCSG	No	Medium-Long	Staff Time	NR-17	*
O-13 (ES-2)	Develop an education and outreach program for property owners on permitting living shorelines, loss of estuarine shorelines, how to construct living shorelines, and explain why they are important.					FOCUS Nags Head Goals Addressed: 1, 2		
		P&D	NCCF, HOAs, TNC,	Yes	Short-Medium	Staff Time	NR-1, NR-2, NR-3	*
O-16 (AG-6)	Explore the use of neighborhood scale design approaches. This could include utilization of off-site septic and cluster septic systems.					FOCUS Nags Head Goals Addressed: 2, 4, 5		
		P&D	TM, Developers, County EHS	Yes	Intermediate-Long	Staff time	NR-24, NR-26, NR-28	
O-17 (AG-6)	Utilize and establish living shoreline projects in the town. This includes installation of demonstration projects on town owned property or private property. Public-private partnerships are critical to the implementation on private property.					FOCUS Nags Head Goals Addressed: 1, 2, 4		
			P & D, NCCF, TNC	Yes	Short-Intermediate	Grant, Staff Time	NR-2	*

GAPS IDENTIFIED

During Diagramming

Of the actions considered high priority by the subcommittee, only one action – state level sea level rise planning on roads and water infrastructure leading to the town and for evacuation – fell into the planning category. The remainder of the high priority action items were classified as information needs, education needs, policy, or implementation. However, the team noted that many of these prioritized actions – such as adapting best stormwater management practices, beach nourishment, decreasing the amount of impervious surface – are all actions which will require significant planning before becoming established policy or implemented adaptations. As the Town of Nags Head moves forward on these priority actions, *it will need to consider how to plan strategically for successful implementation*. In some cases, i*ncremental steps (including actions which may have been noted during the process but not considered high priority) may be necessary*. Additionally, *plans should also identify how to monitor progress and adjust course when necessary, especially as new scientific information becomes available on projected sea level rise scenarios and impacts*.

Post Diagramming

The diagrams, created in December 2015, did not have many detailed nodes related to excessive rainfall events because discussion focused instead on sea level rise and storm surge during the limited time periods. Stormwater runoff and flooded roads and ditches were included in the outcomes and adaptation actions. However, during the prioritization meeting some noted that flooding due to extreme rainfall events could have consequences not adequately captured by the December meetings. In October 2016, official National Weather Service rain gauge readings in Dare County ranged from 8.6-9.6" of storm total rainfall during Hurricane Matthew. In the town, measurements ranged between 11.7 and 13.7". The volume of water that fell, combined with storm surge and higher fall tides holding water levels above stormwater outfalls, meant stormwater was unable to drain quickly. Areas of the town were flooded, including between the highways in the north end of the town as well as in several west side neighborhoods. Needs identified during recovery included a better pre-disaster plan for staging, permitting, and deploying pumps to supplement the ocean and sound outfall facilities. However, this action and others that may also assist with extreme rainfall events of this magnitude were not part of the initial VCAPS discussion. *Subsequent planning exercises should seek to include other long range adaptation measures for recurrent extreme rainfall events to ensure that the suggested adaptations for stormwater management are adequate.*

New proposed Flood Rate Insurance Maps (FIRMs) were released during summer of 2016. Participants in VCAPS knew this release was forthcoming and discussed anticipated issues,

including that a number of properties were proposed to be removed from Special Flood Hazard Areas. Following Hurricane Matthew, research by Town of Nags Head staff determined that many of the areas which flooded during the storm were not mapped into flood hazard areas. Further research by staff indicated this is because modeling used in FIRM development includes only flooding due to coastal storm surge (ocean and sound), not flooding due to rainfall. As a result, the proposed FIRMs do not represent the true risk of flooding from all possible sources. Effectively, they underestimate the true risk of flood damage to Nags Head properties. FIRMs have an important role in incentivizing flood-resilient building and development, but *additional tools and adaptation strategies beyond those identified during VCAPS may be necessary to ensure that properties mapped outside of Special Flood Hazard Areas also reduce their* risk *from flooding.*

NEXT STEPS

Funding has already been secured for some initial follow-up steps. Nags Head was included as the selected North Carolina pilot community under the Southeast Sea Grant Regional Resilience Grant competition. Led by the University of Georgia, with the UNC Chapel Hill School of Law and North Carolina Sea Grant as partners, "Advancing Understanding of Risk: Increasing Accuracy of Hazard Damage Assessment Tools by Improving Base Data and Analyzing Opportunities and Barriers for Use in Adaptation Planning" will fund mapping of sea level rise impacts for the town (including the use of first floor elevations dataset to adapt HAZUS damage estimates for structures under storms and sea level rise). UNC will also continue to analyze the opportunities for and legal barriers to studying and implementing adaptive policies. Finally, staff support for the project will continue to provide additional technical assistance to the town as it determines whether and how to move forward with adaptation planning.

There are several options for adaptation planning moving forward, as indicated by the examples in Appendix 6. Some communities prefer to develop a stand-alone adaptation plan or strategy, which outlines implementation steps across multiple plans. Others incorporate adaptive measures into other municipal plans as they are updated. This is commonly done with a comprehensive plan, as was the case in Beaufort County, South Carolina, who used VCAPS in 2012 to scope sea level rise measures but did not include input from their report until the comprehensive plan update passed in 2017. FOCUS Nags Head was completed on a parallel timeline to this project and contains broad policy statements. These broad policy statements are meant to serve as a starting point for additional research and planning that is needed in order to develop specific strategies and implementing measures.

The VCAPS Implementation Table above provides the foundation for developing a more complete sea-level-rise strategy that, if pursued by the Town, could effectively guide and integrate both new and existing planning efforts. This type of strategic document would contain the culmination of knowledge, research findings, and actionable steps needed for the Town to make progress in adapting to sea-level-rise and other hazards. The project team, including North Carolina Sea Grant, remains committed to providing adaptation planning assistance to the Nags Head Board of Commissioners and assisting Town staff in applying for grant funding to implement measures already identified and those which may emerge.

However the most important and immediate next step, prior to engaging in any long range planning efforts and studies identified in the overall priority actions, will be to develop a suite of SLR scenario/probability distributions. This step is documented in Table 2 as action O-6 (AG-2). The scenarios would not predict future changes, but describe future potential conditions in a manner that supports decision-making under conditions of uncertainty allowing the town to

analyze vulnerabilities and impacts associated with these possible, uncertain futures. The scenarios could be used to develop and test decisions under a variety of plausible outcomes. This approach strengthens an organization's ability to recognize, adapt to, and take advantage of changes over time. Once the suite of SLR scenarios are developed, they could be utilized for long range planning such as O-4 development of an estuarine shoreline management plan, O-7 development of a long term shoreline management plan, and O-12 development of long range plans for progressively improving the town's stormwater drainage infrastructure.

APPENDICES

APPENDIX 1:

Synthesis of Initial December Group VCAPS results

This text is written to highlight main points in the three diagrams produced by each breakout group from the December 2015 meeting. It was provided as an initial draft report to the Climate Adaptation and Sea Level Rise Committee to aid its work in consolidating diagrams and developing the prioritization strategy. At this phase the purpose of the written text is to allow the Town of Nags Head staff and a steering committee the opportunity to review the project team's written materials and provide feedback to ensure information was captured correctly. This is especially important given that the Nags Head meetings represented the first time VCAPS was used in a public rather than invited forum. Additionally, the only previous case with multiple groups creating diagrams (City of Boston, Massachusetts, hazard mitigation plan update) used a different strategy where participants were invited to groups based on single technical areas of expertise (e.g., all hazard mitigation planners) to discuss individual management issues at once. As such, the individual diagrams could be added by issue into a single report. In the Town of Nags Head, because the participants represented an exceptionally broad spectrum of sectors and many attended without the project team's prior knowledge of their expertise or roles, the groups were not constrained by single issues. Discussions, and therefore diagrams, overlapped in content, and the structures of each diagram reflect the broad variety of participants' expertise and perspectives, presenting a challenge for synthesizing the information and actions provided in a way that respects attendees' input given in each group. In Beaufort County, South Carolina, this draft interim discussion formed the backbone for additional workshops to prioritize actions with additional public input, as well as further GIS analysis of issues identified during VCAPS. The draft VCAPS report and the results from the additional public engagement led to a final, expanded full project report delivered to inform Beaufort County's next comprehensive plan update (link).

This text does not provide line by line discussions of each diagram; past VCAPS communities have indicated that this is too much detail, though it can be provided by the project team if the Town of Nags Head and its residents believe it will be useful. For further detail, see the full diagrams provided that represent the work of each individual group. Diagrams have been modified in structure by Dr. Whitehead from their original format, which may have included broken links, overlapping links, duplicative nodes, or incorrectly labeled nodes (an outcome may have been intended as a consequence). Additionally, because group discussion can move faster than the facilitation team can capture, notes have been used to supplement concepts discussed but not included in the diagrams as they stood at the end of group discussion on December 8. In the discussion below, groups are labeled B, C, and L by location (Board Room, Conference Room, and Library).

A. Hazards

All three groups agreed that sea level rise and heavy rainfall were hazards and used these as starting points for their discussions. Group C further identified tropical storms, hurricanes, and nor'easters as a similar hazard node leading to storm surge and overwash. Group B also defined storm surge as an individual hazard node, but further included shoreline erosion processes,

aging transportation and wastewater infrastructure, increased population density, and inter-aquifer water transfer as additional hazard nodes. Some of these hazards were captured by other groups as outcomes. Consequently, these different conceptualizations led to different diagram structures despite covering similar outcomes and consequences clustered conceptually below.

Two of the three groups (B and L) identified 16 public actions and two private actions specific to the primary sea level rise, heavy rainfall, and shoreline erosion hazards. These actions were generally oriented toward supporting further research, developing education campaigns, and supporting planning efforts. Studies and research needs included: monitoring changing physical conditions in Nags Head and the northeastern North Carolina region; comparing how the Outer Banks sea level rise impacts may differ from other communities; and obtaining better information on the roles of paving, lot coverage, and stormwater runoff on sea level rise impacts. The town can take a role in educating young people and can partner with real estate agents to educate property owners. One group identified CRS (Community Rating System) public information programs as an opportunity to include sea level rise education components for possible CRS points. Planning efforts suggested were not limited to reviews of local zoning ordinances or setbacks, erosion rates, and flood zones that may also be helpful for sea level rise: regional planning to address connectedness with other vulnerable areas of the Outer Banks (including Hatteras Island) and tourism are necessary. Group B noted a role for the State of North Carolina to assist in specific sea level rise related planning to address any changes in evacuation that become needed, as well as sea level rise impacts to regional and state infrastructure, including roads (especially Highway 64 access under sea level rise) and drinking water resources.

B. Beachfront management

Attendees noted that in addition to beach erosion from sand transport processes and episodic storm surge events, sea level rise will contribute to a higher ocean level that alters and may accelerate erosion, and therefore beach loss. The groups expressed concern that without sufficient action this accelerated erosion may lead to the loss of protective barriers like dunes and a decline in beach aesthetics. These losses may have negative consequences for tourism as there would be less space for use of public trust beach, possibly decreasing tourist visitation and impacting jobs and tax base as fewer visitors require services. If the point is reached where beachfront property and infrastructure are either less well maintained or lost as well, the loss of property value would further erode local tax base. In time this may lead to lost services, outmigration of residents, and a reduced ability to pay for public adaptations.

The primary action suggested by all groups was beach nourishment, but two groups had questions about where the tipping point lies between choice of the ability to fund nourishment as a strategy and continued deterioration of beach condition. The groups outlined the need for a Shoreline Management Plan that includes additional research for assessing the viability of different erosion control options (both permitted options like sand bags, though these were noted to have negative consequences when bag placement is uncoordinated and may accelerate erosion, and options that are not currently permitted, like engineered or artificial reefs and surfbreaks), and determining the optimal solution. Group L also discussed the use of jetties, which are not currently permitted, noting that they may reduce nourishment frequency but

accelerate Pea Island erosion and therefore lead to pressure on bridges that could restrict Pea Island access.

Each group noted a need for the Town of Nags Head to coordinate with other governments regionally and with the state on beach nourishment. Attendees noted coordination would be useful on determining how to fund erosion control via town and county taxes, and one group also noted that coordinated nourishment among multiple Outer Banks towns may result in a cost savings. However, some participants noted that any type of beach nourishment coalition would need to synchronize the towns' needs without sacrificing individual municipalities' control. Each group also suggested roles for private homeowners such as installing dune vegetation and sand fencing, viewing erosion rates before purchasing beachfront property, and moving homes when necessary (either by moving the structures or tearing down and rebuilding on lots with larger setbacks).

One group, group C, had an extensive discussion of sand transport and its role in inlet management. Sand transport leads to a compromised Oregon Inlet depth, with closures detrimental to the fishing and recreational boating industry. Terminal groins were suggested as an adaptation strategy, but participants were concerned about unknown and unintended consequences of terminal groins. Inlet dredging and management were also proposed as strategies, with alternative ways to raise revenue and fund groin costs also needed.

C. Soundside shoreline management

All three groups recognized sea level rise as a driver behind sound side erosion. One group further noted the role of erosion processes outside of sea level rise, while another group also connected storm surges as episodic events. This erosion also leads to loss of estuary and soundside marsh. In addition to property loss and infrastructure consequences similar to those outlined for beachfront shoreline loss, groups further noted the loss of nursery habitat and therefore marine life, leading to degraded fisheries and shellfisheries for commercial and recreational use and even shellfish bed closures. This habitat also provides filters for stormwater, degrading water quality. The loss of fisheries as well as good quality areas for off-season recreation (e.g., kayaking and birding) contributes to a reduced quality of life and loss in business revenue, possibly contributing to tourism and tax revenue losses.

All groups discussed living shorelines as potential strategies both for the town to support as well as for private entities to consider and support. The groups noted here that assistance from non-governmental organizations, especially The Nature Conservancy and NC Coastal Federation as champions, are necessary for owners to learn about living shorelines, navigate the permitting process, and get appropriate designs installed. In addition to living shorelines, oyster restoration and vegetation planting can help reduce land loss, and one group suggested exploring the use of geotubes. Groups noted that private property owners will still bulkhead and backfill properties. One group noted that the Town of Nags Head's beachfront management plan could be expanded to a shoreline management plan to include the soundside, thereby providing additional educational, technical, and perhaps even financial support for sound side property owners on best erosion management practices. Land acquisition and continued maintenance and expansion of open spaces will be critical to the town's role in preserving wetland ecosystem services.

D. Water and wastewater management

All three groups noted that both sea level rise and heavy rainfall events may be contributing to a rising water table in Nags Head. Heavy rainfall events, coupled with runoff from increased impervious surfaces, in addition to the intrusion of salt water into groundwater, act to raise the water table and decrease the depth of the unsaturated zone between the water table and the surface. If the water table is high enough it can contribute to standing water, but the groups' discussions focused more on the role of the reduced recovery time leading to the malfunction of septic systems and, if unaddressed, the failure of septic systems. Septic malfunction can be caused by elevated groundwater tables and inundation of drain fields, ocean or sound side overwash directly damaging the system, lack of property owner maintenance (including pumping and drain field care), or by older systems reaching the design lifetime or not being built to current code. Should septic system failure proceed, water quality declines could occur, and water quality impacts were identified as a key tipping point for intervention. Declining water quality could result in swimming area closures due to fecal coliform– especially in cases where increased pollutants in runoff also contribute to ocean outfall failure. This would lead to bad publicity, declines in tourism, property devaluation, reduced tax base and increases in taxes to make up for losses, lost services, and reduced quality of life.

Some adaptation options were suggested that would assist in monitoring and intervening with pressures from the rising water table and decrease in unsaturated zones. North Carolina floodplain mapping efforts, building codes, erosion rates, and first floor elevation databases could be combined with GIS analysis of water table "hot spots" to produce better information on risk. Additionally, standards for separation of ground water and septic drain fields could be enhanced. Reinstating the NCSU onsite clean water protection conference would provide a good forum for sharing new ideas. The coastal hazard revolving loan fund and other means for assisting homeowners with retrofits could be beneficial.

Septic system failures could eventually lead to condemnation of homes by the town, so homeowner attention to repair and replacement is vital to prevent this. Each group produced numerous suggestions for adaptations that either maintain or expand policies currently in place in Nags Head to help property owners intervene in septic system malfunctions before septic failure occurs. In particular, the Septic Health Initiative was discussed in some form by each group as a resilient practice that could be expanded; one group even suggested making it mandatory rather than voluntary for homeowners to ensure that assistance is provided for regular maintenance and retrofitting when necessary. Realtors and property managers could also take a role in educating to prevent over-occupancy at rental homes. If homeowners install more water efficient fixtures, less water will travel through septic treatment, reducing strain on these systems. Groups noted that in the future it may become necessary to consider on-site wastewater strategies not currently permitted. For example, small neighborhoods could cluster septic systems, or other advanced on-site wastewater treatment could be encouraged. Group L noted that some homeowners have tried to install alternative systems (peat media, low pressure pipe, Advantex) but high costs for installation and service are leading some to abandon such systems and revert to original septic technologies. Groundwater lowering systems deployed elsewhere for reducing surface water flooding due to water table height may also be a possibility for lowering groundwater table height and reduce pressure on septic systems, but

can be expensive and require a discharge point. One group did note that at some point centralized wastewater could be considered if necessary. However, it is important to note that the desire to avoid centralized wastewater to avoid pressures to develop more densely was a strong guiding value expressed in the large group visioning exercise and remained a core group value at the conclusion of the meetings.

Many of the suggestions noted for sound side shoreline management and runoff reduction that focus on ecosystem restoration – living shorelines, marsh restoration, stormwater best management practices, and other water quality protections – were also noted to mitigate degraded fishery nursery habitat. This further highlights these strategies as "no regrets" actions which will assist in reducing negative consequences for many undesired outcomes of erosion and increasing water table height.

E. Transportation and public safety

Transportation vulnerability was also discussed in groups B and C; however, the outcomes and consequences leading to road impacts emerged in two different ways between the groups. Group C discussed road impacts as a result of heavy rainfall and higher groundwater table impacts to stormwater runoff in combination with a higher sound and ocean levels from sea level rise to produce flooding on beachfront and sound side roads. However, Group B identified aging transportation infrastructure and increased population density leading to increased impervious surfaces as hazards in their own right. Degraded roads and flooded roads both have consequences for hurricane evacuation and emergency services, negatively affecting human welfare. Elongated recovery times due to road vulnerabilities may have impacts on utilities, public safety, property access, and eventually property value.

Continued state and federal level monitoring will be necessary to ensure transportation access that is sufficient to protect residents (including, as mentioned in the Hazards section above, indirect impacts to Nags Head from vulnerabilities to Highway 64 on the mainland). Dare County and the Town of Nags Head will need to continue their vigilance to provide emergency services as long-term conditions change. As flooding increases, roads may need to be raised, outfall capacity increased, and utilities relocated. Reducing impervious surfaces and low impact development again present "no regret" strategies for reducing hazards introduced by increasing population and redevelopment. Individual property owners also have a role in reducing stormwater runoff on their properties by also employing low impact development strategies and alternatives to impervious surfaces.

F. Summary of VCAPS meeting results

Without combining actions to remove duplications introduced by "no regrets" actions that intervene in multiple outcome chains, or aligning actions that may have been considered by one group to intervene in an outcome versus a consequence, the three groups presented a total 167 actions – 115 public sector actions, and 52 private sector or non-governmental organizations' actions. These actions encompass additional information that could be compiled to inform changes in climate-related hazards themselves, as well as the outcomes of climate hazards and consequences for beachfront and sound side shoreline management, water and wastewater management, and transportation and public safety.

The group completed the meeting by revisiting the Nags Head vision and values for resilience and by completing a summarizing exercise where participants were asked to create talking points that captured the essence of the meeting. Attendees stated that the Town of Nags Head has two choices to plan for sea level rise: to adapt or to let it happen. They felt these meetings signaled the town is collaborating to choose adaptation, because the natural environment is the lifeblood of the Town of Nags Head and its residents are obliged to protect, preserve, and adapt despite changes. The main themes of the meeting were to maintain clean water, to minimize marsh and sand loss to erosion, and to maintain quality of life. Participants noted the town has always adapted to change before and were amazed at the things the Town of Nags Head is doing already that will help it to prepare for sea level rise. The town's rich community knowledge is an excellent resource, but the town must continue to be proactive to face future challenges.

After reviewing this initial meeting summary to ensure completeness and accuracy, the project team will meet with the Town of Nags Head and a steering committee to determine next steps for refining these actions into strategic plans for addressing sea level rise. Some steps, including creating educational programs, supporting further studies, and establishing or expanding shoreline committee plans, could be taken independent of the status of a full sea level rise plan. Other steps that were not raised during the VCAPS exercise, but arose in other communities' planning processes, could also be considered.

APPENDIX 2:

FOCUS Nags Head Comprehensive Plan Goals

The VCAPS Implementation Table contains overall strategies (e.g., OM-1) that often address many of the goals listed in the town's comprehensive plan, FOCUS Nags Head. In the table, the goals are referenced by number and are listed below. This demonstrates the overlap and interconnectedness between planning efforts.

GOALS

1. Preserve our community's distinctive heritage and unique lifestyle

a. A relaxed-paced, family beach community comprised primarily of low-density development and open spaces.

b. A healthy, well-maintained oceanfront beach that is visually and physically accessible and usable; not blocked by large structures.

c. An environment that reflects the heritage of "Old Nags Head" with unique and eclectic architectural styles, scenic views, and coastal landscapes.

2. Protect our critical natural resources and coastal ecosystem

a. Build and promote a sustainable economy that supports residents and visitors.

b. A natural environment typified by clean water and a coastal barrier landscape with noninvasive, salt tolerant vegetation.

c. Ocean and estuarine shorelines that are carefully managed to preserve the natural and beneficial functions of the environment while balancing the need to respect private property rights and public access.

d. Plan for the future impacts of sea level rise; ensuring proper policies, plans, and practices for stormwater and wastewater management are in place to sustain the natural environment and maintain a viable family, tourism-based economy.

3. Build and promote a sustainable economy that supports residents and visitors

a. A diverse supply of housing, including single-family homes and multi-family dwelling units, that meet the needs of residents in all phases of life and for varying income levels.

b. A diverse supply of visitor accommodations, including single-family homes, hotels, cottage courts, and multi-family dwelling units for visitors who desire both short-term and long-term stays.

c. A thriving local business community that offers a wide range of goods and services available to residents and visitors.

d. A premier family beach destination on the Outer Banks, providing an enjoyable and memorable experience.

4. Plan for orderly and sustainable growth and redevelopment

a. A well-organized and compatible pattern of land development and redevelopment through proactive land use and transportation policies.

b. Development that is designed to reduce private property damage and loss of life from major storm events and natural hazards.

c. Safe connectivity and accessibility between neighborhoods, businesses, and recreational opportunities for a variety of travel modes, lessening traffic congestion, and enabling an active and healthy lifestyle for residents and visitors.

d. A place with active and passive recreational opportunities that serve all ages and abilities, creating opportunities for community interaction and healthy living.

e. Preservation and maintenance of legacy commercial businesses.

5. Maintain a well-run and efficient government that provides high quality and cost-effective services

a. Develop, fund, and prioritize the Capital Improvement Plan annually to provide for the infrastructure, equipment, and facility needs of the community.

b. Provide the highest quality public safety services possible, and routinely review the public safety needs of the community to ensure that resources are available to meet these needs.

c. Provide friendly and accommodating customer service.

d. Communicate town information to residents and visitors through a variety of media that demonstrates the results of measurable goals and objectives.

e. Advocate for the provision of high quality, responsive services, legislation, resources, and policies from government partners and other organizations that further the vision of the Town of Nags Head.

APPENDIX 3:

Prioritized Actions by Category

Table 1: Ocean Management

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
OM-1	Establish a beach nourishment coalition to synchronize towns' needs and plans without sacrificing control.		12	20
OM-2	Study additional engineering, financial tools to use to mitigate against beach loss.		12	10
OM-3	Wait on local bills and court rulings to determine how much authority local municipalities have in dealing with structures on the public trust beach.	Teardown or rebuild setting home further back on lot.	10	
OM-4	Develop a beach cleanup and public engagement program during high season.		7	
OM-5	Develop partnerships to improve media coverage.		5	

Table 2: Estuarine Shoreline Management

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
ES-1	Develop an estuarine shoreline management plan that establishes policies, procedures, and overall management strategies for the town's estuarine shoreline. This plan will work to develop specific projects and strategies to		17	20

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
	prevent estuarine flooding in the future. The plan should research, identify and map marsh loss, "soft" stabilization methods that are appropriate for Nags Head's estuarine shoreline, potential opportunities for land acquisition, and potentially restorable wetlands. Additionally, it should develop incentives that can be utilized for the protection of natural shorelines.			
ES-2	Partner and assist property owners with permitting guidance for living shorelines.	Develop guidance on loss of estuarine shoreline, implementing living shorelines, and permitting guidance.	9	6
ES-3		Acquire land along estuarine shorelines for natural preservation or acquire estuarine shoreline properties that can be retrofitted with living shorelines. (private, NGO)	7	4
ES-4	Develop partnerships to assist the town with installation of living shoreline demonstration projects on town or county owned property.	Develop partnerships to assist the town with installation of living shoreline demonstration projects on town owned property.	4	
ES-5	Develop a comprehensive education and outreach strategy on green building techniques, living shorelines, the permitting process, and available incentives.	Encourage green building techniques and living shorelines by builders and contractors.	4	
ES-6		Educate visitors about estuarine shoreline erosion.	2	
ES-7		Assist with installation and	1	

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
		maintenance costs (NGOs) of living shorelines.		
ES-8		Seek grants for conservation easements along estuarine shorelines.	1	
ES-9		Bulkheading and backfilling by private homeowners.	1	

Table 3: Stormwater Management

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
SW-1	Address stormwater at the source through best management practices (e.g. low impact development, decrease the amount of impervious surfaces).	Address stormwater at its source through best management practices (e.g. low impact development, decrease the amount of impervious surfaces).	11	13
SW-2	Decrease the amount of impervious surfaces in the future. Examine regulations for road and parking lot requirements and explore ways to reduce impervious coverage associated with development.		7	11
SW-3	Develop a plan for dealing with vulnerable transportation corridors. This plan should identify vulnerable		7	

	transportation corridors and ways to close and/or reroute traffic. Additionally, this plan should develop policies that support the town's position managing these corridors.			
SW-4	Continue to fund established stormwater programs and projects.		6	7
SW-5	Develop long-range plans for progressively improving the town's stormwater drainage infrastructure. This plan includes documentation of the type, size, and location of existing drainage features within the town, including rights-of-ways and outfalls. Additionally, the plan should document existing nuisance and problem areas that experience frequent flooding.		5	
SW-6	Maintain open space.		4	
SW-7	Develop a public information committee for the Community Rating System (CRS) program that address flooding and stormwater.		3	
SW-8	Relocate utilities (e.g. water, power).		3	
SW-9	Relocate utilities (e.g. groundwater manipulation).		3	
SW-10	Explore the use of a coastal hazard revolving loan fund.		2	

Table 4: Ground and Surface Water Management

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
WM-1	Maintain and expand the Septic Health Initiative by providing government assistance for septic retrofits, assisting homeowners in maintaining their septic systems, conducting more groundwater sampling, securing additional wells for sampling, developing partnerships to assist with the peer review of existing data, transitioning to a mandatory septic inspection program with incentives, and mapping of groundwater.		17	30
WM-2	Develop higher standards/regulations in permitting for separation of groundwater and mean high water below a septic drainfield.		8	9
WM-3	Utilize offsite septic and/or shared/clustered septic systems for small neighborhoods.	Use neighborhood scale septic system designs to increase the cost efficiency of treatment.	8	2
WM-4	Continue to monitor water quality near beach and sound access points.		7	
WM-5	Incorporate education on sea level rise and high water tables into the Septic Health Initiative.	Educate property owners on septic over occupancy/use (realtors).	4	
WM-6	Conduct a GIS "hotspot" analysis to determine high risk areas where there could be septic system failure or septic system repairs needed.		2	
WM-7	Utilize a groundwater lowering system.		1	
WM-8		Raise the elevation of infrastructure.	1	

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
WM-9	Develop regulations for improving onsite septic systems in need of repair.		1	
WM-10	Continue to maintain and enforce rigorous environmental health standards for onsite wastewater systems (Environmental Health Department).			3

Table 5: All Groups (or Both Diagrams)

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
AG-1	Develop a long-term shoreline management plan that considers the environmental, legal, financial, physical, and regulatory issues and constraints that will need to be addressed to conduct ocean shoreline management over a 30-year time horizon. The plan should consider the following: • Multiple strategies including nourishment, structure relocation, sand fencing, dune vegetation, alternative shoreline stabilization techniques, and the potential for structure acquisition in limited circumstances. This includes agreement from the public and elected leaders on a target beach condition which becomes the town's goal to achieve through consecutive nourishment cycles. • A streamlined and programmatic approach to permitting that allows for a shorter window for		13	14

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
	construction projects. • Best practices for dune management including minimum disturbance by property owners (i.e. cutting away dunes to enhance views or significant dune removal to clear structures), regular sand fencing and dune vegetation planting, and proper siting and construction of structures. • An improved design utilizing dune vegetation, sand fencing, and adjustments to the beach and dune nourishment profile to limit impacts to oceanfront property owners from migrating sand. • Appropriate trigger points for maintenance cycles that address project goals. • A long-term funding strategy that provides consistent revenue for the town and reasonable and predictable tax rates for oceanfront and non-oceanfront property owners. • A coordinated approach with Dare County and other municipalities on a long-term funding approach to nourishment which provides a consistent and predictable source of revenue for maintenance and construction projects. • A coordinated approach with Dare County and other municipalities to determine if and how regional planning can improve project efficiencies and achieve cost savings. • A comprehensive communication strategy to educate town property owners and residents on the importance of the beach and the strategies the town is utilizing to maintain the beach and provide public			

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
	access.			
AG-2	Develop a plan for adaptation that includes a suite of SLR scenario/probability distributions (more up-to-date than CRC).		9	18
AG-3	Conduct ongoing monitoring of physical conditions/geography including erosion rates, wind transport of sand, and dune capacity as part of the long term ocean shoreline management strategy.		8	21
AG-4	Develop a comprehensive education and outreach program for K-12 and residents/property owners that includes the follow topics: SLR, storms, sound side & oceanfront erosion, beach nourishment, and CRS.	Develop a comprehensive education and outreach strategy for SLR, storms, sound side/oceanfront erosion, beach nourishment, and CRS that can be implemented by real estate agents and other private interests.	4	21
AG-5	Conduct mapping of impervious surfaces, lot coverage, and stormwater runoff to collect base data in order to develop adaptation strategies.		4	
AG-6	Install living shorelines.	Install living shorelines: demo projects by TNC and NC Coastal Federation.	2	1
AG-7	Conduct State level planning for evacuation planning and vulnerable infrastructure leading to OBX (roads, water) in light of SLR.		2	1
AG-8	Develop a plan for management of vulnerable structures.		2	
AG-9	Continued maintenance or expansion of open space and wetlands, wetland services (carbon)		1	
AG-10	Develop an increased understanding of what is different		1	

ID	Public Action	Private Action	Individual Category Score	Overall Score Value
	about Outer Banks vs. other communities.			
AG-11	Develop a regional planning approach to addressing connectedness and tourism.		1	
AG-12	Maintain local zoning ordinances for setback, erosion rates, and flood zones.		1	

Appendix 4: Overall Priority Actions

Original ID	Overall ID	Public Action	Private Action	Individual Category Score	Overall Score Value
WM-1	O-1	Maintain and expand the Septic Health Initiative by providing government assistance for septic retrofits, assisting homeowners in maintaining their septic systems, conducting more groundwater sampling, securing additional wells for sampling, developing partnerships to assist with the peer review of existing data, transitioning to a mandatory septic inspection program with incentives, and mapping of groundwater.		17	30
B-3	O-2	Conduct ongoing monitoring of physical conditions/geography including erosion rates, wind transport of sand, and dune capacity as part of the long term ocean shoreline management strategy.		8	21
B-4	O-3	Develop a comprehensive education and outreach program for K-12 and residents/property owners that includes the follow topics: SLR, storms, sound side & oceanfront erosion, beach nourishment, and CRS.	Develop a comprehensive education and outreach strategy for SLR, storms, sound side/oceanfront erosion, beach nourishment, and CRS that can be implemented by real estate agents and other private interests.	4	21
ES-1	O-4	Develop an estuarine shoreline management plan that establishes policies, procedures, and an overall management strategy for the town's estuarine shoreline. This plan will work to		17	20

Original ID	Overall ID	Public Action	Private Action	Individual Category Score	Overall Score Value
		develop projects and strategies to prevent estuarine flooding in the future. The plan should research, identify and map marsh loss, "soft" stabilization methods that are appropriate for Nags Head's estuarine shoreline, potential opportunities for land acquisition, and potentially restorable wetlands. Additionally, it should develop incentives that can be utilized for the protection of natural shorelines.			
OM-1	O-5	Establish a beach nourishment coalition to synchronize towns' needs and plans without sacrificing control.		12	20
B-2	O-6	Develop a plan for adaptation that includes a suite of SLR scenario/probability distributions (more up-to-date than CRC).		9	18
B-1	O-7	Develop a long-term shoreline management plan that considers the environmental, legal, financial, physical, and regulatory issues and constraints that will need to be addressed to conduct ocean shoreline management over a 30-year time horizon. The plan should consider the following: • Multiple strategies including nourishment, structure relocation, sand fencing, dune vegetation, alternative shoreline stabilization techniques, and the potential for structure acquisition in limited circumstances. This includes agreement from the public and elected leaders on a target beach condition		13	14

Original ID	Overall ID	Public Action	Private Action	Individual Category Score	Overall Score Value
		which becomes the town's goal to achieve through consecutive nourishment cycles. • A streamlined and programmatic approach to permitting that allows for a shorter window for construction projects. • Best practices for dune management including minimum disturbance by property owners (i.e. cutting away dunes to enhance views or significant dune removal to clear structures), regular sand fencing and dune vegetation planting, and proper siting and construction of structures. • An improved design utilizing dune vegetation, sand fencing, and adjustments to the beach and dune nourishment profile to limit impacts to oceanfront property owners from migrating sand. • Appropriate trigger points for maintenance cycles that address project goals. • A long-term funding strategy that provides consistent revenue for the town and reasonable and predictable tax rates for oceanfront and non-oceanfront property owners. • A coordinated approach with Dare County and other municipalities on a long-term funding approach to nourishment which provides a consistent and predictable source of revenue for maintenance and construction projects.			

Original ID	Overall ID	Public Action	Private Action	Individual Category Score	Overall Score Value
		• A coordinated approach with Dare County and other municipalities to determine if and how regional planning can improve project efficiencies and achieve cost savings. • A comprehensive communication strategy to educate town property owners and residents on the importance of the beach and the strategies the town is utilizing to maintain the beach and provide public access.			
SW-1	O-8	Address stormwater at its source through best management practices (e.g. low impact development, decrease the amount of impervious surfaces).	Address stormwater at its source through best management practices (e.g. low impact development, decrease the amount of impervious surfaces).	11	13
SW-2	O-9	Decrease the amount of impervious surfaces in the future. Examine regulations for road and parking lot requirements and explore ways to reduce impervious coverage associated with development.		7	11
OM-2	O-10	Study additional engineering, financial tools to use to mitigate against beach loss.		12	10
WM-2	O-11	Develop higher standards and regulations in permitting for separation of groundwater and mean high water below a septic drainfield.		8	9
SW-5	O-12	Develop long range plan for progressively improving the town's stormwater drainage infrastructure. This plan includes		5	7

Original ID	Overall ID	Public Action	Private Action	Individual Category Score	Overall Score Value
		documentation of the type, size, and location of existing drainage features within the town, including rights-of-ways and outfalls. Additionally, the plan should document existing nuisance and problem areas that experience frequent flooding.			
ES-2	O-13	Partner and assist property owners with permitting guidance for living shorelines.	Develop guidance on the loss of estuarine shoreline, implementing living shorelines, and permitting guidance.	9	6
ES-3	O-14		Acquire land along estuarine shorelines that can be naturally preserved or acquire land along estuarine shorelines that can be retrofitted with living shorelines. (private, NGO)	7	4
WM-10	O-15	Continue to maintain and enforce rigorous environmental health standards for onsite wastewater systems (Environmental Health Department).		0	3
WM-3	O-16	Utilize offsite septic and/or shared/cluster septic systems for small neighborhoods.	Use neighborhood scale septic system designs to increase the cost efficiency of treatment.	8	2
B-6	O-17	Install living shorelines.	Install living shorelines: demo projects by TNC and NC Coastal Federation.	2	1
B-7	O-18	Conduct State level planning for evacuations and vulnerable infrastructure leading to the Outer Banks (roads, water) in light of SLR.		2	1

Appendix 5:

Sea Level Rise and Climate Change Adaptation Planning In Other Jurisdictions

A. Overview

Various states and municipalities on the East Coast of the United States have incorporated policies about sea level rise and climate change into their respective land use plans or other planning documents. A majority of the plans reviewed have the stated goal of improving both community sustainability and resilience, but each municipality has a unique relationship to the potential effects of climate change. The most comprehensive plans analyze climate change as a short-term, local issue as well as a long-term, national issue.

This section reviews and summarizes counties and municipalities that are planning for a broad range of ideas to tackle the myriad issues climate change will bring to their communities. The jurisdictions included in this section are:

- Florida: Southeast Florida Regional Climate Compact, Matanzas Basin, Lee County, Broward County, City of Satellite Beach, and City of Punta Gorda;
- State of Massachusetts;
- Maine: Maquoit Bay and Town of York; and
- State of Rhode Island.

The summaries are not intended to be exhaustive of what each jurisdiction is doing to plan for climate change and sea level rise, but rather provide a snapshot of how planning is playing a role in adaptation. Where relevant, summaries include relevant policies included in climate change plans, land use plans, and comprehensive plans. Web links to relevant supporting information are included under "Resources", and we encourage the Town of Nags Head to review those resources for further details.

B. Current Climate Change Adaptation or Sea Level Rise Planning Efforts in Communities on the East Coast

FLORIDA

Home Rule State – Yes
Dillon's Rule State – Unclear (Conflicting statutes address Dillon's Rule)

i. State-Level Planning

The State of Florida does not have a state office dedicated to coordinating sea level rise adaption. While no direct statewide legislation could be found, there are references to planning for sea level rise embedded in state law. For example, in 2011, Florida passed the Community Planning Act, which made significant changes to the state's growth management laws. Among these changes was the addition of a comprehensive planning designation known as Adaptation Action Area. An Adaptation Action Area, as defined in Fla. Stat. 163.3164(1), is "a designation in the coastal management element of a local government's comprehensive plan which identifies one or more areas that experience coastal flooding due to extreme high tides and storm surge, and that are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure needs and adaptation planning". In 2012, The Florida Department of Economic Opportunity initiated a five-year project to integrate sea level rise adaptation into current planning mechanisms, including the local comprehensive plan and hazard mitigation plan, with a goal to provide statewide guidance on how to implement Adaptation Action Areas at the local level.

In May 2015, Governor Rick Scott signed Senate Bill 1094 into law. This bill modified Fla. Stat. 163.3178, which is Florida's comprehensive planning law, with respect to flooding. The modified law adds detail to the redevelopment component of local comprehensive planning in the state. For instance, the redevelopment component now must "include development and redevelopment principles, strategies, and engineering solutions that reduce the flood risk in coastal areas which results from high-tide events, storm surge, flash floods, stormwater runoff, and the *related impacts of sea-level rise*" (emphasis added). While Florida law does not formally call for planning for climate change and sea level rise, this law nevertheless now includes "sea-level rise" as a causes of flood risk that must be addressed within the context of redevelopment principles, strategies, and engineering solutions. It remains to be soon how state agencies and local governments interpret and implement this provision of the law. Below is a summary of regional, county, and municipal efforts to plan for sea level rise and climate change in Florida.

ii. Regional-Level Planning

The Southeast Florida Regional Climate Compact (SEFRCC) was formed in 2010 and includes as members Broward County, Miami-Dade County, Monroe County, and Palm Beach County. The SEFRCC was formed following a 2009 summit on regional climate change leadership. The main objectives of the SEFRCC are to:

1. Develop annual legislative programs and jointly advocate for state and federal policies and funding;

2. Dedicate staff time and resources to create a Southeast Florida Regional Climate Action Plan to include mitigation and adaptation strategies; and
3. Meet annually in regional climate summits to evaluate progress and identify emerging issues.

The major purpose of the SEFRCC is to coordinate mitigation and adaptation activities across the four counties. Activities of the Compact are informed by a steering committee, which includes representatives from each member county, the 109 cities in the region, and ex officio representation from regional groups such as the South Florida Water Management District and South Florida Regional Planning Council. In 2011, the SERFCC released a draft regional climate plan. The plan was finalized in 2012 and includes stakeholder input. The plan was formally adopted by all counties in the Compact in 2014. The plan includes 110 action items to adapt to climate change and to reduce greenhouse gas emissions over a five-year period. The action items focus on the areas of sustainable communities and transportation planning, water supply, management and infrastructure, natural systems and agricultural resources, energy and fuel, risk reduction and emergency management, and outreach and public policy. The action plan also sets forth policy recommendations that will be implemented through:

- Existing legal structures, planning, and decision-making processes;
- The development of new policy documents by local and regional planning bodies;
- The development of consistent goals and progress indicators through the governments in the region;
- A coordinated multi-disciplinary outreach and education program; and
- Processes for focused and prioritized investments.

In addition, the Compact supports the adoption of an Adaption Action Area (AAA) comprehensive plan designation for areas uniquely vulnerable to climate impacts, including sea level rise. The Compact has released numerous planning and guidance documents since its formation and has influenced policy and legislation at the state, regional, and local levels. Examples of its influence is the adoption of AAA into Florida law, its support of adaptation planning efforts in the members communities of Broward County and City of Fort Lauderdale.

Matanzas Basin

A project led by the University of Florida and the Guana Tolomato Matanzas National Estuarine Research Reserve, this three-year effort resulted in a technical report that identifies sea level rise vulnerability and trends for the Matanzas Basin area to sea level rise and potential adaptation strategies. While this effort was not led by a local government (however, the project area included the Matanzas River/Estuary and watershed and communities in St. Johns and Flagler Counties) and has not yet resulted in implementation even within the national estuarine

research reserve, the interdisciplinary project team nevertheless considered the local governance context to be critical in adaptive capacity. This means the data and other information in the technical report has the potential to be utilized by communities within the Matanzas Basin in their individual planning efforts. Another notable element of this project is the inclusion of stakeholder input (i.e., from residents of neighboring communities) through public workshops. This effort is included in this report as an example of how a federal government program that manages coastal property is planning for sea level rise and considered the local government context when considering adaptation options. Given Nags Head's proximity to Cape Hatters National Seashore, which is currently assessing its own vulnerability to sea level rise, this particular project can serve as an example of how federal property managers, local governments, and local residents can join forces in assessing regional vulnerability to sea level rise.

The project team developed an adaptation framework and toolbox. General adaptation strategies recommended in the technical report focused more on providing local governments with guidance on how to solve problems than specifying what local governments should do in order to plan for sea level rise:

- Determine and address causes of change;
- Decide what to protect and what to let go;
- Value and conserve the ecosystem and the services it provides;
- Explore new places for resources; and
- Guide future development patterns and coordinate with environment conservation.

The framework the project team developed focuses on vulnerability type (high vs. low vulnerability, high vs. low natural value) and associated responses (avoidance, land conservation, accommodation, protection, relocation, and smart growth/low impact development). For a local government in the region that would like to engage in sea level rise planning, the framework provides structure on how to approach planning and decision-making. More information on the framework and toolbox begins on page 240 of the technical report. The Governance Adaptive Capacity section, which includes planning and policy analysis of current local planning in the project area, also may be of interest and begins on page 268. A link to this report is in the Resources section.

iii. <u>County-Level Planning</u>

Lee County

In 2010, Lee County partnered with the Southwest Florida Regional Planning Council to develop the Lee County Climate Change Resiliency Strategy that can be used to develop a full

adaptation plan. The CCRS is a toolbox that contains a full suite of ideas and opportunities for the departments and divisions in Lee County to utilize climate change planning, energy savings, and cost savings. The report includes a description of specific implementation actions, a summary of considerations used to set priorities and select action items, communication with stakeholders and decision-makers, and monitoring and evaluation of results. In the report, resiliency strategies are organized according to vulnerability, and strategies are not prioritized. Coastal erosion and sea level rise are identified as vulnerabilities in the report. The report identified many strategies and actions Lee County government can do to increase resilience against coastal erosion and sea level rise. This list begins on page 71 of the report, but below is a snapshot of potential actions the County can take:

- Adopt soft strategies, such as aquatic vegetation beds, using natural or artificial breakwaters, and beach nourishment, where appropriate;
- Allow coastal wetlands to migrate inland in any area explicitly indicated;
- Allow shoreline hardening, where appropriate;
- Change the placement and design of infrastructure
- Conserve land in coastal areas by removing or limiting development potential through acquisition, conservation easements, and the purchase and transfer of development rights;
- Consider sea level rise in infrastructure planning and site design; and
- Constrain locations for certain high-risk infrastructure.

Broward County

In 2015, Broward County, a member of the SEFRCC, released a Climate Change Action Plan (CCAP). The goal of the CCAP is to build stronger communities and infrastructure, protect critical sectors and natural resources, and using sound science to understand climate impacts. Broward County's CCAP recognizes that policies and regulations will play a role on the rate of climate change, and that the county has a responsibility to adopt policies to address climate change locally. The CCAP focuses on the following focus areas: natural resources, water supply, energy resources, built environment, and community outreach (to increase public awareness and mobilize action on climate change). The two main goals of the CCAP are to: (1) mitigate the effects of climate change by reducing GHG emissions by 2% per year by 2020 and (2) increase the resilience of their community to the effects of climate change. High priority actions include, but are not limited to:

- Analyzing sea level rise, drainage, and hurricane impacts;
- Develop habitat buffer zones;
- Increase the number of miles of living shorelines and dunes;

- Develop alternative water supply strategies;
- Develop adaptive management strategies'; and
- Apply models to develop resilient design standards.

The CCAP also recommends a suite of policy strategies to implement all high priority actions. For example, the plan recommends continuing its climate change task force, adopt adaptation standards that consider sea level rise and climate change, address adaptation and mitigation in their land use plan, and limit development in vulnerable areas. Adaptation planning is another critical element in the CCAP, and the plan recognizes the need to improve local inundation mapping capabilities, develop new 100-year storm maps, incorporate sea level rise and storm surge impacts into maps of hazard areas, and support research on the vulnerability of the built environment.

Broward County's comprehensive plan does incorporate climate change and sea level rise into policies. For example, Policy 10.2.6 states:

> Broward County shall, in coordination with its local municipalities, designate Adaptation Action Areas (AAA), per Florida State Law, in order to:
>
> a. Identify areas that are vulnerable to the impacts of rising sea level;
> b. Identify and implement adaptation policies to increase community resilience;
> c. Enhance the funding potential of infrastructure adaptation projects.
>
> The Broward County Commission, the Broward County Planning Council or a municipality may apply for Adaptation Action Area of Regional Significance designation, if the problem(s) and proposed solution(s) of the proposed area demonstrate regional significance, and conform with one or more of the criteria listed in Section 4.D.13. of the Broward County Land Use Plan. Areas designated by the County as Adaptation Action Areas of Regional Significance will be added to the Priority Planning Areas for Sea Level Rise Map as part of the Broward County Land Use Plan.

The Coastal Management Element also includes objectives and policies related to shoreline resilience (e.g., beach nourishment, living shorelines, and protection and enhancement of dune systems and biological communities). Other elements of the comprehensive plan also require consideration of climate change, sea level rise, and coastal flooding. For example, the Sanitary Sewer Element calls for sewage system design to take these impacts into account. See Policy 5.2.5 as an example:

> Design for additional capacity shall be in accordance with Section 62-600.405, FAC and consider within the Capacity Analysis Report, the impacts of increased

coastal flooding, sea level rise, saltwater intrusion, and other potential future climate change impacts, and plan for infrastructure replacement and relocation as needed.

Climate change and sea level rise are included in other elements of the county's comprehensive plan, and link to the plan is available under Resources.

iv. Municipal Level Planning

City of Fort Lauderdale

In 2010, the City of Satellite Beach released a technical report that assessed the city's vulnerability to sea level rise and initiated steps to plan for changes to the natural and built environments. This report was prepared by RW Parkinson Consulting, Inc. and submitted directly to the City of Satellite Beach Comprehensive Planning Advisory Board. The report specifically addresses sea level rise. Not only did the consulting company model local vulnerability to sea level rise, it also facilitated a public outreach and education campaign during the one-year project period. This campaign included convening a stakeholder group and a sea level rise subcommittee. The purpose of this subcommittee was to effectively transfer technical information to the City's decision-makers. The subcommittee met monthly during the project period to report on project results and discuss recommendations to the City. In addition, the campaign included public forums, which were designed to provide information on climate change and sea level rise. Forums presented scientific information, potential impacts of climate change and sea level rise to the City, and results and recommendations included in the report. The assessment of the City's vulnerability to sea level rise was accomplished in three steps:

1. Development of a three-dimensional base map of the City;
2. Compilation and mapping of critical infrastructure and assets; and
3. Quantification of the extent to which the City and its critical assets would be inundated by sea level rise.

The technical report recommended planning for sea level rise, and the sea level rise subcommittee recommended proposing amendments to the City's current comprehensive plan that would expand some existing policies to include sea level rise and to add a new section addressing adaptive management. The subcommittee's recommendations were in the form of a sample ordinance, a link to which is included in the Resources section. The Comprehensive Planning Advisory Board subsequently reviewed, amended, and adopted the subcommittee's recommendations unanimously to City Council in July 2010.

As a follow-up to the 2010 technical report, the City has partnered with the East Central

Florida Planning Council, the Florida Coastal Management Program, and others on a public outreach project on "Creating a Resilient Community". This public outreach project was conducted through a survey of residents of which vulnerabilities were of most concern, strategies for these vulnerabilities they would and would not support, and opportunities residents would like the City to investigate further. This project results were summarized in a report that was released in 2015.

City of Punta Gorda

In 2009, the City of Punta Gorda, in partnership with the Southwest Florida Regional Planning Council and Charlotte Harbor National Estuary Program, released a climate change adaptation plan, and the city's comprehensive plan addresses sea level rise and the need for strategies and actions to adapt to projected impacts. Objectives such as green building and infrastructure improvements flooding improvements, particularly downtown Punta Gorda, feature prominently in the action plan. The development of the action plan included public workshops to determine acceptable and unacceptable adaptation options and prioritization of acceptable options. Acceptable adaptation options fell under these general categories:

- Seagrass protection and restoration;
- Xeriscaping and native plant landscaping;
- Explicitly indicating in the comprehensive plan which areas will retain natural shorelines;
- Constraining locations for certain high-risk infrastructure;
- Restrict fertilizer use;
- Promote green building alternatives through education, taxing incentives, and green lending; and
- Drought preparedness planning.

In the Conservation and Coastal Management Element of the city's comprehensive plan, mitigating risk, maximizing economic value, and conserving coastal ecosystems are the overarching goals. Under the hazard mitigation goal, the comprehensive plan states as under Objective 2.4.2: "Address the impact of sea level rise, and seek strategies to combat its effects on the shoreline of the City". To support this objective, the comprehensive plan includes the following policy:

> Policy 2.4.2.1: The City will work with the Southwest Florida Regional Planning Council to determine the potential sea level rise impacts on the Coastal Planning Area.

> Measurement: Completion and implementation of developed coastal studies or development of model scenarios.

The comprehensive plan's Future Land Use Elements includes several policies related to land use and hurricane vulnerability. While climate change and sea level rise are not specifically mentioned, the policies addressing said vulnerability are noteworthy. Under Objective 1.1.8 of the city's comprehensive plan, "Punta Gorda will continue to eliminate, reduce, or mitigate conditions that are inconsistent with any interagency hazard mitigation report recommendations that it deems to be appropriate, and which are inconsistent with the comprehensive plan". The policy developed in response is as follows:

> Policy 1.1.8.1: In response to the Interagency Hazard Mitigation City of Punta Gorda Comprehensive Plan 2025 1-119 Report recommendation pursuant to the 1992 unnamed storm, designated FEM-952-DR-FL, the City of Punta Gorda will continue to participate in the Community Rating System (CRS) program, provide public education on flood hazards, have development and building regulations that mitigate flood hazard, maintain and/or improve stormwater drainage, train Community Development Department staff in flood issues, and control the siting of mobile homes.
>
> Measurement: Continued participation in the CRS program.

Under Objective 1.1.7, the City of Punta Gorda "will mitigate the coastal population hurricane vulnerability by maintaining or reducing the overall residential density relative to that contemplated in the Comprehensive Plan as adopted in 1988". The policies developed in response are as follows:

> Policy 1.1.7.1: Development of all vacant unplatted lands within the City of Punta Gorda as of July 1, 2008 which are in a coastal high hazard area will not exceed 5.0 units per gross acre for residential development when density can be reallocated from the downtown district to other areas within the CHHA's that satisfy Chapter 163.3178(9) Florida Statutes. Measurement: Proportion of such unplatted lands developed annually at a gross density greater than 5.0 units per acre for residential development.
>
> Policy 1.1.7.2: Construction of public facilities in coastal high hazard areas will be in furtherance of one or more of the following: downtown revitalization, efficiencies in the provision of service, or service to existing populations.
>
> Measurement: For public facilities construction proposed in coastal high hazard

areas, a written determination of how such facilities will contribute to downtown revitalization, efficiencies in provision of service or service to existing populations. Such determination is to be made part of the annual capital improvements program.

Policy 1.1.7.3: In coastal high hazard areas outside the City limits where property is served by existing water transmission lines, no connections for new residential development will be allowed in excess of the 1988 FLUM density for the subject property. (For the purposes of this Objective, reference the adopted map "Representation of Punta Gorda Future Land Use Map" from the 1988 Plan and the adopted "Coastal High Hazard Area Map.")

Measurement: Record of development density for each new water connection in such areas for each year, and comparison to density requirements of the 1988 FLUM. Proportion of connections meeting the density requirement.

MASSACHUSETTS

Home Rule State – Yes
Dillon's Rule State – No

i. State Level Planning

Massachusetts has been planning for climate change since 2004, when it completed a Climate Action Plan in 2004 to address climate mitigation. The 2004 plan provided the state with its first overview of how climate change will affects Massachusetts, the impacts of this change, vulnerabilities of multiple sectors ranging from natural resources, infrastructure, public health, and the economy. Then, in 2008, Governor Deval Patrick directed the Secretary of Energy and Environmental Affairs to convene an Adaptation Advisory Committee to specifically focus on developing strategies for adapting to predicted changes in climate and their impacts on Massachusetts. This committee included experts across sectors and disciplines to analyze impacts to multiple focus areas. Focus areas include transportation and built infrastructure, commercial, industrial and manufacturing activities, low-income consumers, energy generation and distribution, land conservation, water supply and quality, recreation, ecosystem dynamics, coastal zone and ocean, rivers and wetlands, and local government. The committee released the Massachusetts Climate Change Adaptation Report in 2011. The report provides an overview of climate change impacts to Massachusetts, vulnerabilities in multiple sectors, and climate adaptation goals.

In addition, the State released a Clean Energy and Climate Plan for 2020 in 2010, pursuant to the Global Warming Solutions Act of 2008. This plan, while not sea level rise-related, places a statewide limit on greenhouse gas emissions (GHG) with a target of 25% below 1990 GHG levels by 2020. The plan provides a rationale for this target and describes how Massachusetts will meet this goal.

ii. County Level Planning

Counties are held to the standards required by Massachusetts' climate law detailed below.

iii. Municipal Level Planning

Massachusetts' regulations require that new buildings within a flood zone intended for human occupancy and not intended for water-dependent uses be designed and built to incorporate projected sea-level rise during the buildings' design life, in a manner consistent with projected sea-level rise. Such projections must be based on historical rates of sea level increase in New England coastal areas (310 CMR 9.37(2)(b)(2)).

RHODE ISLAND

Home Rule State – Yes
Dillon's Rule State – Yes

In 2010, Rhode Island passed the Climate Change Risk and Reduction Act, R.I. Gen. Laws 23-84-2, in which the legislature formally recognized that climate change and sea level rise are impacting the state. In addition, the Rhode Island Comprehensive Planning and Land Use Act, R.I. Gen. Laws 45-22.2-6, requires plans to include "an identification of areas that could be vulnerable to the effects of sea-level rise, flooding, storm damage, drought, or other natural hazards". The law also requires that "goals, policies, and implementation techniques must be identified that would help to avoid or minimize the effects that natural hazards pose to lives, infrastructure, and property".

i. State Level Planning

Rhode Island has a statewide planning division. Along with Massachusetts, Rhode Island has a state law that requires policymakers or planners to consider sea level rise when creating policy for land use planning or development.

On April 13, 2006, Rhode Island adopted "Land Use 2025: Rhode Island State Land Use Policies and Plan". The plan focuses on conservation and development and articulates Rhode Island's goals, objectives, and strategies to guide and coordinate the land-use plans and regulations of municipalities and state agencies, as well as strategic projects at both state and municipal levels. According to this plan, development in coastal areas must balance the need and desirability of a coastal location with the inherent hazards of shoreline erosion and exposure to periodic flooding and storm surges. The plan recognizes that climate change and sea level rise introduce the potential for more frequent and/or severe storm events, adding to the threat to improperly sited or constructed coastal area structures. Flood mitigation strategies should include acquiring particularly vulnerable areas for conservation uses to preclude construction there. Where development is permitted, "best practice" standards need to be followed that address structural design and construction, setbacks and buffer areas, limits on shoreline Land Use 2025: Rhode Island State Land Use Policies and Plan (April 2006) 3-21 modifications, the capacity of floodplains to store or convey floodwaters, and the extent of damage after a storm."

The second relevant plan is the Shoreline Change Special Area Management Plan, which is known as the Beach SAMP. The Beach SAMP focuses on helping protect Rhode Island communities from the coastal impacts of climate change by improving the understanding of where and why erosion is occurring and what areas and infrastructure are at risk of flooding during storms or from future sea level rise. The Beach SAMP process began in 2013 to serve as a state platform for gathering the new science and data needed to accurately characterize

Rhode Island's complicated and changing coastline. The Beach SAMP also is providing a means for the state and local communities to identify together the issues that municipalities are facing. In 2015, the Beach SAMP process enabled the state and communities to start working with the science by testing tools and engaging in activities focused on policies and solutions for long-term adaptation planning.

Currently, the SAMP is on the verge of entering the public comment process. The table of contents has been released http://www.beachsamp.org/wp-content/uploads/2015/06/beachsamp_toc_6.8.pdf. Will contain sections on "Sea Level Rise," "Erosion/Shoreline Change," and "Storm Surge & Flooding."

ii. County Level Planning

State agencies handle the planning for county level climate change adaption.

iii. Municipal Level Planning

State agencies handle the planning for county level climate change adaption.

MAINE

Home Rule State – Yes
Dillon's Rule State – Yes

i. State Level Planning

None.

ii. Regional Level Planning

Maquoit Bay

Maquoit Bay is providing guidance for handling climate change issues is the Maquoit Bay region. The Bay area includes a great deal of preserved land as well as the cities of Brunswick and Freeport. Maquoit Bay has a number of issues that are unique to the area and cannot be easily applied to other coastal areas. However, the area does contain significant wildlife habitat areas for migratory birds and waterfowl, fish, invertebrates and other wildlife, including commercially important fish and shellfish. There are a number of coastal areas/cities that will need to incorporate policies that protect local fauna/flora in a similar way.

Maquoit Bay's Climate Change Adaption Plan explicitly states tangible effects that residents have witnessed over the past decade or so. This is a step farther than any of the other examined plans went. An example of the Maquoit Bay Plan: "Local residents are beginning to see evidence of a changing climate. The Town of Brunswick's Marine Warden stated that coastal water temperatures are the highest since the 1950's, and notes species shifts possibly related to the warmer water. There is a higher prevalence of quahogs and invasive green crab, while native soft shell clams seem to be struggling." The Maquoit Bay Climate Change Adaption Plan covers a watershed and not a specific municipality. However, the policies implemented in the Bay Plan are surely applicable to other coastal areas that have the goal of flora/fauna protection.

The Maquoit Bay Climate Change Adaptation Plan provides adaptation recommendations by Ecosystem Service Category.

In order to preserve opportunities for shoreline movement and marsh migration the plan specifically recommends:

- Ordinance changes to limit new structures and infrastructure within the at-risk areas (areas subject to future flooding and areas proximate to future bluff erosion)
- Limitation on hard (riprap, seal walls) approaches to addressing bank erosion, emphasizing soft alternatives (planting, geotextiles, re-contouring, living shore lines);

- Identification and purchase of easements to help landowners realize some financial gain for avoiding the increased risk areas.

To maximize Stream Connectivity, the plan recommends updating culverts and other structures that severely impede steam habitat connectivity. The plan suggests that this will both improve stream connectivity and reduce the potential for flooding. The plan also recommends adopting low impact development approaches that minimize new impervious surface area and maximize on-site infiltration of runoff to help maintain the health of the bay.

iii. Municipal Level Planning

Town of York

In 2013, the Town of York adopted the Adaptation to Sea Level Rise Chapter into the town's comprehensive plan. This Chapter was prepared by the Planning Board of York, the Southern Maine Regional Planning Commission, and a Marine Geologist with the Maine Geological Survey. The information contained in the Chapter was based on local and global data collected from a number of sources including four regional efforts in Maine that addressed coastal resilience. The data examined a range of factors including, existing tidal elevations, historic tide levels, radiocarbon dating marsh areas showing sea level change, global sea level rises, and ocean thermal expansion rates.

The Adaptation to Sea Level Rise Chapter can be broken down into three subtopics: (1) Introduction to Sea Level Rise; (2) Vulnerability Assessment; and (3) Tidal Surge and Freshwater Contributions. The Introduction to Sea Level Rise acknowledges that sea level change has occurred and that expert projections indicate that sea levels are expected to continue to rise. Under the Vulnerability Assessment, the chapter demonstrates how buildings, roads, and public infrastructure are potentially impacted by sea level rise. The Chapter includes tables indicating the number of potential buildings and roads impacted based on sea level rises of 1,2,3.3, and 6 ft. increments. The Vulnerability Assessment also highlights Sewage Treatment Facilities as a public facility susceptible to impact given that they are historically located near the shore and at the lowest point in a community. Lastly under the Tidal Surge and Freshwater Contributions, the Chapter points out that towns that take action to prepare for long-term sea level rise will also protect themselves against tidal surges that occur in the short term.

In addition to the Adaptation on Sea Level Rise Chapter, the Town of York Comprehensive Plan outlines 17 strategies regarding how the Town will address the State Goal to "Recognize

that Sea Level Rise is occurring, and that storms are happening more frequently, with higher intensities and water levels." These strategies include, but are not limited to:

- Review floodplain management ordinances and enact amendment to protect existing properties and direct owners over time to modify their structures so that they are more resilient to sea level rise;
- Review Shoreland zoning with the objective of providing increased coastal buffer areas between developed areas and shoreline;
- Perform ongoing vulnerability assessments;
- Consider use of beach nourishment programs;
- Incorporate sea level rise into decision-making and design of transportation improvements; and
- Develop ordinance amendments that require new construction, redevelopment, additions, retrofits or medication of property to incorporate porous materials, reduce total impervious area, and employee other techniques to reduce or slow run-off, capture and reuse rain water.

The Town of York still needs to appropriate funds to conduct a more detailed vulnerability assessment to include a depth damage analysis of the impacts on buildings from sea level rise and storm surge as well as, analyze the cost benefits for the type of adaptation measures to be implemented. However, as of 2016, the town has voted to delay this new assessment until next year.

C. Resources

Florida

Southeast Florida Regional Climate Compact: http://www.southeastfloridaclimatecompact.org/.

Definition of Adaptation Action Area in Fla. Stat. 163.3178: http://www.leg.state.fl.us/statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0100-0199/0163/Sections/0163.3178.html.

Adaptation Action Areas: A Planning Guidebook for Florida's Local Governments: http://www.floridajobs.org/docs/default-source/2015-community-development/community-planning/crdp/aaaguidebook2015.pdf?sfvrsn=2.

Southeast Florida Regional Climate Compact Regional Climate Action Plan: http://www.southeastfloridaclimatecompact.org//wp-content/uploads/2014/09/regional-climate-action-plan-final-ada-compliant.pdf.

Planning for Sea Level Rise in the Matanzas Basin: Opportunities for Adaptation: https://planningmatanzas.files.wordpress.com/2012/06/planning-for-sea-level-rise-in-the-matanzas-basin1.pdf.

Lee County Climate Change Resiliency Strategy: http://research.fit.edu/sealevelriselibrary/documents/doc_mgr/447/Beever%20et%20al.%202010.%20Lee%20County%20CC%20Resiliency%20Strategy.pdf.

Broward County Climate Action Plan: http://www.broward.org/NaturalResources/ClimateChange/Documents/BrowardCAPReport2015.pdf.

Broward County Comprehensive Plan: http://www.broward.org/PlanningAndRedevelopment/ComprehensivePlanning/Pages/CompPlan.aspx.

Broward County Comprehensive Plan Coastal Management Element: http://www.broward.org/PlanningAndRedevelopment/ComprehensivePlanning/Documents/CoastalManagementElement.pdf.

Planning for Sea Level Rise in the Matanzas Basin: https://planningmatanzas.files.wordpress.com/2012/06/planning-for-sea-level-rise-in-the-matanzas-basin1.pdf.

Municipal Adaptation to Sea Level Rise: City of Satellite Beach: http://www.satellitebeachfl.org/Documents/Sea%20Level%20Rise%20-%20CRE%20Report%2007-18-10.pdf.

City of Satellite Beach Sample Ordinance: http://www.satellitebeachfl.org/Documents/Sea%20Level%20Rise%20-%20Recommendation%20from%20CPAB%20to%20be%20considered%20by%20Council.pdf.

Creating a Resilient Community Public Input Analysis for City of Satellite Beach: http://www.satellitebeachfl.org/Documents/CC%2005-20-15%20SB%20Creating%20Resiliency%20Community%20-%20Public%20Input%20Analysis.pdf.

City of Punta Gorda Adaptation Plan: http://www.ci.punta-gorda.fl.us/userdata/growthmgmt/PuntaGordaAdapatationPlan8-14-09.pdf.

Massachusetts

Massachusetts Climate Protection Plan (2004): https://www.documentcloud.org/documents/499572-romney-massachusetts-climate-action-plan-2004.html.

Massachusetts Climate Change Adaptation Report (2011): http://www.mass.gov/eea/waste-mgnt-recycling/air-quality/climate-change-adaptation/climate-change-adaptation-report.html.

Massachusetts Clean Energy and Climate Plan for 2020, http://www.mass.gov/eea/waste-mgnt-recycling/air-quality/climate-change-adaptation/mass-clean-energy-and-climate-plan.html.

Maine

Town of York Comprehensive Plan, http://www.yorkmaine.org/Departments/CodeEnforcement/ComprehensivePlan.aspx.

Maquoit Bay Climate Change Action Plan: https://www.manomet.org/sites/default/files/publications_and_tools/Maquoit_Bay%205-13.pdf.

Rhode Island

Rhode Island Land Use 2025: http://www.planning.ri.gov/statewideplanning/land/landuse.php.

Rhode Island Shoreline Change Special Area Management Plan: http://www.beachsamp.org/.