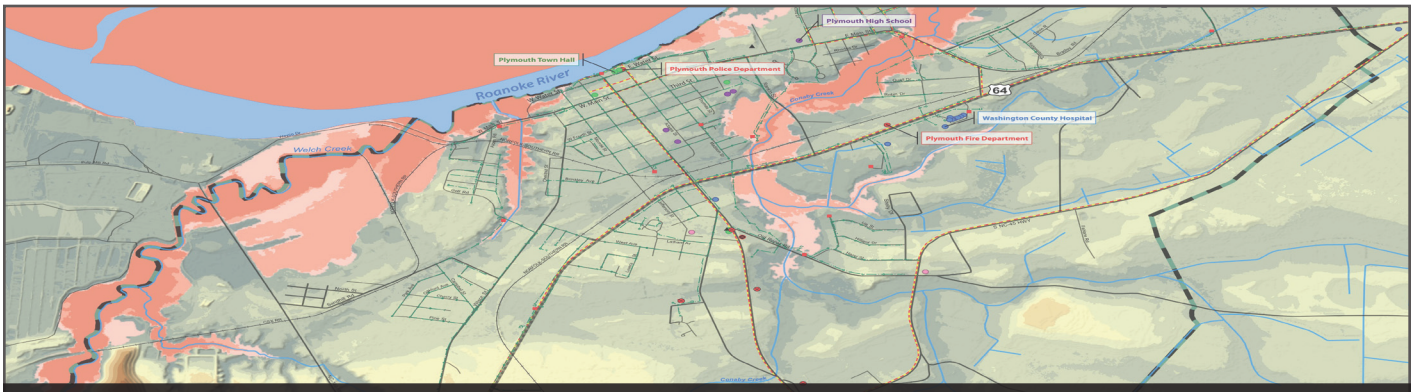

Facing the Future in Plymouth, NC: Preparing for Increased Flood Risks

Sea Grant
North Carolina

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Cover art includes a portion of an Inundation Map created by East Carolina University's Renaissance Computing Institute, Regional Engagement Center, showing projected inundation for Plymouth, N.C. (This map is provided only for assessing potential vulnerabilities and general risk awareness. It is not intended for site-level insurance and flood-risk analysis.) Full map and a detailed explanation of how it was created are included in the back-pocket pull-out.

Cover photo of the Roanoke River provided as a courtesy of the Town of Plymouth. Report photos provided by North Carolina Sea Grant and the Town of Plymouth.

Facing the Future in Plymouth, NC:
Preparing for Increased Flood Risks

Executive Summary

This report presents the results of recent efforts in the town of Plymouth, North Carolina, focused on identifying and clarifying local leaders' understanding of the challenges that changing environmental conditions could pose to their community in the future. In 2010, leaders were interviewed to identify their concerns, and maps of future potential flood areas were created. In 2011, leaders worked with a research team to further explore their concerns and identify strategies to address the impact localized flooding could have on the town's stormwater and wastewater collection and treatment systems. The National Oceanic and Atmospheric Administration National Sea Grant office funded the project, and North Carolina Sea Grant coordinated the plan of work in conjunction with the town manager, mayor, and individuals from East Carolina University's Renaissance Computing Institute (RENCI) and the Social and Environmental Research Institute.

During individual interviews, local leaders identified changes in the natural and built environment for the following 10 categories: erosion, localized flooding/stormwater management/drainage systems, saltwater intrusion to the river, drought, sea level rise, weather patterns, groundwater, river flow, wetland/marshes, and infrastructure (water and wastewater systems, stormwater ditches and roads). Primary issues of concern centered on: how to address current and future challenges associated with the wastewater treatment plant collection system; localized flooding; improving the local economy; protecting and utilizing the natural resources; and providing amenities for and retaining youth within the community.

Local flooding was a major issue identified and leaders mentioned causes as rainfall, stormwater management, rising river levels, hurricanes/storm surge, wind tides, dams, and road construction. Impacts from flooding included erosion on the waterfront, wetlands, and ditches; impassable roads; and overloading of the wastewater collection and treatment system. To examine stormwater management and impacts to wastewater infrastructure further, a Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS) process was used. VCAPS allows a group to think about a management issue with the help of a facilitator to guide them through the creation of a diagram that reflects their collective thoughts on the causes and impacts of the concern, and possible solutions. Essentially, VCAPS provides structured discussion so a group can pool their knowledge of an issue in a time efficient manner and document it visually. Through the VCAPS process, Plymouth leaders were able to identify many of the outcomes of the town's increased flooding risks and some general strategies to address them.

Background

Like many rural municipalities in coastal North Carolina, Plymouth faces the potential for increased flooding in years to come. Its location near the mouth of the Roanoke River where it meets the Albemarle Sound could make it particularly susceptible to the possibility of rising sea level and increased rainfall intensity. The town's aging water and wastewater treatment infrastructure is already plagued by impacts from heavy precipitation, making it a matter of concern. In particular, pump stations are located along waterways that are periodically flooded and pipes throughout the town get overwhelmed with inflow and infiltration. This in turn causes discharges from the wastewater treatment facilities to exceed state permitted limits, resulting in decreased water quality downstream in the river and violation notices and fines for the town.

Considering these problems could be exacerbated by future environmental changes and additional negative impacts might develop, leaders in the town worked with a research team to further explore their concerns and began identifying strategies to address them. The project was funded by NOAA's National Sea Grant College Program. North Carolina Sea Grant coordinated the plan of work in conjunction with the town manager, mayor, and individuals from East Carolina University's Renaissance Computing Institute (RENCI) Regional Engagement Center and the Social and Environmental Research Institute.

This report presents results of these efforts including interviews conducted in 2010, mapping of future potential flood areas, and meetings in 2011 which focused on clarifying local leaders' understanding about future challenges they may face concerning the town's stormwater management and wastewater collection and treatment systems.

Interview Process

Between Aug. 20 and Sept. 10, 2010, staff from NC Sea Grant and ECU interviewed 18 local leaders to understand their thinking about the environment and environmental changes in their town. Interview candidates were selected in such a way as to ensure a broad representation across socioeconomic, racial and geographic distribution. They all worked or lived in the Town of Plymouth or in Washington County. More specifically, 11 of the interviewees were residents of the town, six lived in Washington County and two lived in other counties. The leaders served various roles in the community including: town and county staff, local (town and county) governing boards, civic, religious, nonprofit organizations, and town business leaders. A majority of the town residents had been there for more than 40 years. Interview questions

Windley-Ausbon House in Downtown Plymouth

were worded in a broad and open-ended style to attempt to capture initial thoughts and avoid influencing responses. Leaders were asked general questions about observed environmental change and then targeted questions about problems specific to their geographic area, such as frequent flooding and impacts to infrastructure. During the interviews, which lasted 1 to 3 hours, leaders were also asked to identify areas in the town known to experience flooding.

Each interview was transcribed and subsequently reviewed and analyzed using computer software. This allowed researchers to readily identify the common themes expressed by the leaders, as well as the breadth of issues and ideas related to the project's focus.

The following is a summary of the primary concerns identified by the interview process. These results, along with additional information about potential sea level rise and other climate change-induced impacts,

were presented to the Plymouth Town Council on June 13, 2011. At that meeting, the council voted in favor of staff continuing to work with partners to further identify vulnerabilities in the community and discuss potential mitigation strategies. A full report of the interview results is available upon request from North Carolina Sea Grant (see contact information on inside cover).

Selected Interview Results

Very prominent in the Plymouth interviewees' responses was a degree of pride in their community and a desire to see it thrive. Many of the people interviewed, whether residents or not, saw a great deal of potential for the town. The same people expressed concern about its future, given the current economy, the extent of poverty in both the town and county, and recent drops in population and industry.

When asked what came to mind about living in Plymouth, especially as it relates to the environment, many talked about natural resources, including how the Roanoke River and wildlife are valued and used by citizens. Others focused on the developed, social, or economic conditions in the community. Specific comments included the following (not in any order):

"*Not even making any reference to the ecotourism opportunities . . . just the geology and biology of the region is extraordinary.*"

"*I look at it [Plymouth] as a diamond in the rough, but in terms of environmentally, I would say improving. I've lived here long enough that I can remember the paper mill odor and you could see the fumes being emitted and in the spring time the herring would run up the river and you could go out here with the drift net and catch herring, and part of that experience was smelling the paper mill, and they've cleaned all that up*."

"*I'd say the people, jobs – the lack of jobs… nature…. recreation…things that could be done to beautify the town to make it more interesting….parks... things for the youth – that's the main thing education and ways to affect the youth.*"

"*. . . the availability of housing. There are some glorious restored edifices . . . and there is not a lot of affordable housing that is decent and available....*"

Environmental Changes

When asked about changes they had seen in the natural and built environment, respondents identified many topics, but most were water-related and fell into the following categories:

- shoreline erosion,
- localized flooding,
- stormwater management,
- drainage systems,
- saltwater intrusion to the river,
- drought,
- sea level rise,
- weather patterns,
- groundwater quantity and quality,
- river flow,
- wetland/marshes, and
- roads/buildings/water/sewer facilities.

Flooding Issues

Those who spoke of flooding in the community mentioned intense rainfall, rising river levels, hurricanes, and wind tides as contributors. They frequently mentioned that road construction and an aging network of drainage ditches also contribute to local flooding. One respondent mentioned that as sea level rises, large drainage ditches could serve as

Roanoke Avenue Wastewater Pump Station - Hurricane Irene, August 2011

conduits for water to move from the sound onto land during hurricanes or strong storms. There also were concerns about impacts to the wastewater treatment and collection system, including issues with access to the treatment plant and operation of pumping stations. A few respondents expressed the need to protect floodplains and wetlands in order to minimize impacts that increased flooding could cause in the future.

In addition to the issues mentioned above, respondents

also noted the following when specifically asked about flooding: it produces erosion-related issues for the waterfront, wetlands, and ditches; local creeks and ditches are limited in their capacity to convey stormwater; and ditches need to be regularly maintained, although their location relative to private property can make this difficult. It also was mentioned that drought poses its own problems. For example, when freshwater flow from upstream declines, salt water can move up the river from the sound and threaten industry and wildlife.

Flood Mapping

To better understand potential future flooding conditions in Plymouth that could result from storm surges or increased sea level, RENCI created an inundation map of the town. This map depicts the land that would be covered with 1.5 feet, 3 feet, and 4.5 feet of inundation (see folded map insert). As noted by RENCI, the map is provided only for assessing potential vulnerabilities and general risk awareness. It is not intended for site-level insurance and flood-risk analysis. See the folded insert for detailed information concerning the methods used to construct the map.

The Inundation Map (folded insert) shows a depiction of the Town of Plymouth with varying levels of flooding from the river. High water levels could result from significant loading to the river from upstream sources or from downstream storm surge created by wind-blown water from the Albemarle Sound during an extreme tropical storm event, such as a hurricane. This type of flooding would likely be temporary, though it may result in permanent changes to the shoreline or landscape due to erosion. If the higher water level originated from a permanent rise in the river level, as could happen with sea level rise, the flooding and loss of land would be permanent. The different shades of orange represent the land areas that would be flooded as follows, with the darker shades flooding first:

Dark orange	0 - 1.5 feet inundation
Medium orange	1.5 - 3.0 feet inundation
Light orange	3.0 - 4.5 feet of inundation

As the map shows, the large swamp forest to the north of the town and across the river would flood first, as would the low-lying areas adjacent to the river to the south. In addition, the creek drainage systems would also be inundated early. Some important town infrastructure components would be impacted in this first level of flooding, including the area surrounding the wastewater treatment plant, several stormwater lift stations and some primary town roads.

The individuals interviewed in 2010 also were asked to locate areas on a town map where flooding regularly occurs. The causes of this flooding were not specific but could be one or a combination of factors such as heavy local rainfall, upriver flooding or storm surge. Appendix 1 on page 10 shows the sites that respondents circled on the map to indicate the flood-prone areas. In general, areas they identified corresponded well with the areas that would be inundated with 1.5 feet of water level rise, namely the low-lying areas adjacent to the river and local streams. However, they also identified many flood-prone areas not adjacent to these two geographic characteristics. Many of these areas are located between two roads or between a road and the elevated railroad bed that runs through the southern part of town. It is possible that these man-made structures function as dams and cause water to pool behind them.

Making Improvements

Almost every person interviewed thought it was very important for the community to address the environmental issues discussed but identified barriers to taking action. In general, these obstacles were related to insufficient funding and staff; lack of awareness of the issues and apathy at all levels; more pressing issues in the community; the political community's lack of interest in environmental or hazard management; politics; and minimal community involvement. Several people noted that the town, including its citizens, government staff, and elected officials had a responsibility to understand the issues and put both short- and long-term implementation strategies in place to address them. How projects got funded, one person said, was a separate issue. Two leaders noted that as problems get larger, it was up to higher levels of government to tackle them. Other sentiments expressed were that the government couldn't be all things to all people, and that property owners also have some responsibility for action. In summary, what interviewees felt that Plymouth needs to respond included:

- Greater awareness of environmental hazards, consequences
- More funding, better economic climate

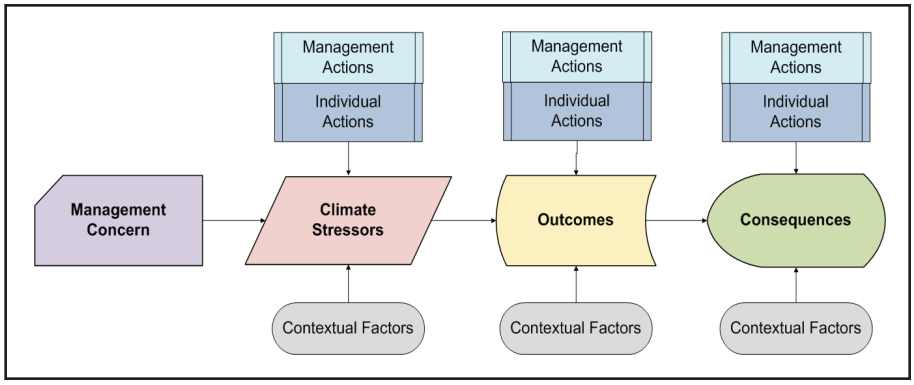
- Higher community involvement
- Willingness to think of future when fixing current problems

VCAPS Process: Examining Stormwater Management & Wastewater Infrastructure

The Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS) process combines structured discussion with an interactive computer-based diagramming program to help local officials and departmental staff develop scenarios that depict potential impacts of climate hazards on their communities and suggest ways to prevent or mitigate undesirable consequences. The VCAPS process was used in Plymouth to examine stormwater management and wastewater infrastructure issues and vulnerabilities. VCAPS was developed by the Social and Environmental Research Institute, the University of South Carolina and the South Carolina Sea Grant Consortium (for more information, go online to *www.seri-us.org/content/coastal-adpatation-planning*). The VCAPS process promotes structure and efficient dialogue among a diverse group of individuals. The computer diagramming tool enables a facilitator to summarize discussions visually, in real time.

On Oct. 4 and 5, 2011, seven community leaders and managers met for a total of five hours during two meetings to go through a VCAPS process. Those invited to participate in the meeting had some degree of decision-making responsibility in the town related to the issues and included the mayor, town board members, the utility director, the county emergency management director, the town engineer (consultant), the police chief, the county soil and water conservation district manager, and a representative from a local water association.

As shown in the right-hand column, a VCAPS diagram starts with a single management concern. This focuses and defines the boundaries of the discussion, ensuring that the VCAPS diagram is relevant to decision makers. Examples of specific concerns are stormwater management, wastewater management, beach and waterfront management, public health management, or emergency management. In Plymouth's case, each of these management systems is susceptible to a variety of "climate stressors," including heavy rainfall and sea level rise. When a "stressor" affects the town, it produces an "outcome," which is an event or process that occurs only because of the stressor. Using this process, thinking of an outcome is like asking, "what happens because of this stressor?" For example, stormwater runoff is an outcome of heavy rainfall. "Consequences" are impacts to entities (people, groups, towns, businesses, etc.) that managers seek



Building Blocks of a Vulnerability Diagram

to avoid. Consequences are the equivalent of asking, "why do we care if this outcome happens?" For example, runoff may ultimately result in the outcome of a wastewater treatment plant that cannot handle the volume, which leads to discharge that does not meet regulatory standards. A consequence of this discharge would then be that the town has to pay a fine for exceeding water quality standards. Throughout the discussions, participants are encouraged to identify preventive or responsive actions that can be taken by local, county, state, or federal government agencies or by private parties, such as businesses and homeowners.

To begin the discussion, Dr. Jessica Whitehead of North Carolina Sea Grant provided scientific input on observed and projected climate conditions and how they might impact flooding and water levels along the Roanoke River. Then, she asked the Plymouth participants what concerned them about environmental hazards and how they might be affected by possible future changes in water level. Although the group originally envisioned doing separate diagrams for stormwater and wastewater infrastructure, further discussion revealed that grouping both of these issues under the "stormwater" management umbrella

was logical, as they are tied together by the many causes of flooding in Plymouth. Together, the Plymouth participants identified potential outcomes and consequences of continued drainage system deterioration combined with water level rise. These outcomes and consequences were represented in a diagram (VCAPS Diagram, folded insert). Discussions also centered on possible responses by the town and individual residents, including "no regret" strategies, which offer immediate benefits whether or not projected changes in water levels occur, and "low regret" strategies, which present tradeoffs between greater future security and some limited current costs and benefits. The group considered possible consequences associated with various management approaches.

Causes of flooding in Plymouth

Plymouth participants identified several climate stressors that contribute to the ultimately relevant hazard of water level rise in the town. Two of these stressors are related to storm events in the Town of Plymouth: heavy rainfall events from local storms and heavy rainfall associated with landfalling tropical storms and hurricanes. Heavy rainfall that occurs upstream and inland from Plymouth also can raise the level of the Roanoke in the town.

The group decided that at this point, the cause of the water level rise does not matter to their management options; once water level rise leads to the outcome of flooding, the town must deal with the consequences whether it is caused by a short-term localized flooding event or long-term changes along the river. Flooding has occurred because of storm surges, water levels rising upstream (which lead to the need for releases from upstream dams), runoff in the town that raises the level of Conaby Creek, or raised groundwater table heights. The water level along the Roanoke rises in response to any of these, which can lead to the river overflowing its banks and subsequent flooding of the town streets, wastewater treatment plant access roads, wastewater pumping stations, and low-lying swampy areas in and around the Town of Plymouth. In the longer term, chronic relative sea level rise may raise the level of the Roanoke permanently.

Environmental and economic impacts of flooding

Flooding can lead to many environmental risks that threaten public safety and human health. In response to street flooding, Plymouth officials may have to evacuate senior housing and/or lose emergency access to certain parts of the town. Flooding of swamps can flush out snakes and bears, which are nuisances to residents. When flooding lasts long enough to result in standing water, mosquitoes become a problem, leading to a public health threat from potential disease transmission. Whether the mosquito problem reaches this point of being a health hazard depends upon the town's available funding, equipment, and staff for spraying. Town officials can spray for mosquitoes and educate the public about minimizing standing water on their properties. Property owners also can help by eliminating standing water and by reporting problem areas to the town.

Pumping station adjacent to Roanoke River

Plymouth participants documented a specific example of economic damage occurring locally due to the recent flooding experienced during Hurricane Irene in August 2011. Flooding from the storm damaged town docks and boat access, which will impact the town budget. In the wake of the storm, drainage from the swamps released large amounts of nutrients in the water, leading to low oxygen levels (hypoxia) that resulted in a massive fish kill along the Roanoke River. Participants noted that the speed with which dams upriver release water can also affect nutrient levels in the river. In addition to flies and public health threats resulting from the dead fish, the town faces the cancellation of several of its fishing tournaments for up to three years. This combination of reduced dock access and lost revenue from tournaments has severe economic consequences for Plymouth's tourism

business, with lost revenues for restaurants, gas stations, and the grocery. Some hotels and businesses now plan to close in the off-season. The only actions participants identified as available to them were preventing fish kills by working to ensure controlled dam releases, or by working to get the river restocked with fish.

Inflow and infiltration to sewers

Participants noted a particular concern about sea level rise and its potential to permanently increase groundwater table heights. This would impact the rates of inflow and infiltration (I&I) into the wastewater treatment system because the higher water pressure would push water through cracks in wastewater pipes. The amount of I&I would depend upon several factors, including eventual groundwater table levels, the infrastructure age, as well as several factors that would affect preventive maintenance, like willingness to pay for upgrades and the availability of grants and loans. Increased I&I would have several direct consequences, including sewage flooding into houses and an inability to effectively flush toilets, leading to public health risks. It also could lead to subsidence and sink holes that could occur when pipes collapse, leading to road collapses, and outraged residents because of property damage.

The town has several options to reduce I&I into the system even if the rate of sea level rise does not accelerate. One lower cost adaptation would be to educate the public and businesses about reducing the disposal of fats and grease through the sewer system and the importance of using and maintaining grease traps. This type of individual behavior reduces wear and tear on the sewer lines. However, when the problem is the infrastructure age, at some point pipes must be repaired (either by targeting points for repair or examining the entire system) or replaced. This might require raising water and sewer rates, but this decision brings its own consequence that Plymouth may be liable for damages due to broken pipes if it assesses specific fees for sewer and stormwater services. Repeated point repairs would eventually impact the town's budget; Plymouth may be able to create a "rainy day fund" to increase its ability to eventually move beyond point repairs. Participants noted an important feedback in the system here – if the town continues to do only short-term fixes, ultimately it will only increase I&I.

The town also could create a comprehensive improvement/master plan for repairs, with the assistance of engineering firms to support the planning process and ensure that the plans allow for future development. One plan element might be to inspect infrastructure and commercial establishments more frequently. The participants noted, however, that it would be more effective to also replace water lines at the same time as sewer lines because water mains are located above sewer lines, meaning that repair crews must go around the water lines to conduct the sewer repairs. Water lines are frequently as old as the sewer lines, and can break during the sewer line repair process. Therefore, this type of adaptation also would depend upon the availability of grants to repair both sewer and water lines.

Portion of Plymouth's Wastewater Treatment Plant subject to flooding from the Roanoke River

Flooding effects on pumping stations and wastewater treatment

A large portion of the discussion focused on the impacts that flooding has on the operation of wastewater pumping stations and the wastewater treatment plant. Some of the pumping stations are located on the Roanoke River or in flood-prone areas, and during times of heavy rainfall or storm surges, these stations can be partially submerged. This leads to overloading and ultimately pumping station failure. The failure of pump stations also can lead to sewer overflow, and chemical pollution and debris can be flushed to the river. Depending on the amount and type of materials that get into rivers and creeks, this can lead to ecological impacts, including fish kills.

Part of the problem is that the station designs pose an occupational safety hazard during repairs. The pumping stations also may have to handle too much volume, either by pumping river water directly (when submerged) or by having additional volume in the system from I&I. Pumping river water short-circuits the waste treatment process, resulting in poorly treated water being discharged into the river and exceeding water quality standards. It can ultimately kill the bacteria used in the waste treatment process. Depending on Plymouth's relationships with state legislators, whether the event was a named storm, any mitigating causes, and the frequency of recurring violations, the town may be required to pay fines per event, per day. The town also must broadcast that a water contamination event occurred, which carries a stigma. As a result of repeated problems, the town may be placed under a special order by consent (the 80/90 rule), which means it cannot permit additional building until the problems are solved. This results in lost opportunities for economic development. Pumping additional volume results in over-using the equipment, which increases operating expenses through electricity costs, labor, and additional wear and tear. All of these issues negatively affect the town's budget.

Summary of Findings

Over the two years of this project, researchers and participants gained insights on which local concerns related to environmental change were priorities and how a community could start planning for them. Specific benefits the town accrued from the VCAPS process and the overall project are noted below. These are based on interviews with VCAPS participants, and informal conversations with community members and among the research team.

Benefits of VCAPS Sessions

1. The process allowed the group to learn about the issues together, providing stakeholders with a broader understanding of the complexity of problems.

2. The process allowed each stakeholder to gain a better understanding of where they fit in and their role in the overall management issue.

3. The process was quick and efficient – allowing a lot of information to be shared in a very short period of time.

4. The process showed how the issues are all linked and how important it is to try and think more comprehensively about managing a problem since any action to address one facet may impact something else.

5. The facilitated process enabled each person to share their ideas with the group.

6. The diagramming and discussion forced the group to think more deeply about the issues, both during and after the sessions.

7. The process generated a readily understandable diagram that explains the issues discussed.

Overall Project Benefits

The project enabled key leaders in the town to better understand, identify, and communicate the impacts they could face from increased flooding risks. By undertaking this work, they are now in a position to take the important next steps to address their priorities – based on their own criteria.

There was also an increase in the ability and willingness of town leaders to consider the potential implications of sea level rise. One person noted this was in part a result of having experts involved in the discussions.

When taking steps towards future risk planning and management, Plymouth could benefit by addressing the items below. These ideas were generated by the research team and reflect information relayed in interviews and personal experiences during the project.

1. A greater education/communication effort is needed on how public funds are used within the community, and what benefits accrue from these expenditures. This is needed because there are misconceptions about how the town spends money, including what it is spent on and why. This education effort is especially important for funds used in the downtown and waterfront areas, and will be important for any future water-related infrastructure investments.

2. The Inundation Map created for the town was very informative to town leaders and generated much discussion. It will be important to share this resource with all community members and make

sure they understand how it will (or will not) be used in future planning efforts by the town and county.

3. Since the VCAPS process was well received by local leaders, it could be used to generate additional solutions and refine next steps for addressing flooding issues. The process also could be used to expedite discussion and resolution on other management issues.

4. Plymouth participants were very good at outlining outcomes and consequences of flooding, but the town's situation made it challenging to think of decisions that the town or individuals could make to mitigate the impacts of negative consequences. A valuable next step would be to bring in outside consultants who can examine the VCAPS diagram and help town managers generate a range of possible solutions for some of these consequences. Such consultants could include members of the private sector (e.g., engineering firms), nonprofits, and state and federal agencies. Some of these organizations will also have knowledge of resources available for reducing flooding hazards in small towns with limited capacities for responding on their own.

5. If used again, the VCAPS process will be most successful if:

   - All local elected and appointed board members participate. This will ensure a broad spectrum of ideas are expressed and heard among those with decision-making power in the community.

   - Town leadership issues the invitation to participate.

   - An outside facilitator is used to lead the VCAPS or similar process. Most participants felt it was useful to have someone facilitate the discussions who was not vested in the outcome, or who knew a lot about the topic.

   - A skilled/experienced person is assigned to create the diagram. Participants noted, to their surprise, that the diagramming was not distracting, nor did it produce a delay in the conversation. However, they felt this might not be the case with someone who could not readily use the software or follow the logic built into the diagramming structure.

   - Individuals without direct decision-making authority participate in the process to help clarify misunderstandings and bring in perspectives not presented by others but that are important to the group. For example, after the VCAPS meeting in Plymouth, participants suggested it would have been useful to have had representation from local emergency responders, fish and wildlife experts, state stormwater and wastewater management agencies, and transportation agencies.

   - The VCAPS sessions are held on one day and focus on one topic. Based on feedback from participants, some momentum was lost by holding discussions on two different days and given the nature of local governments, it also posed unexpected conflicts with scheduling.

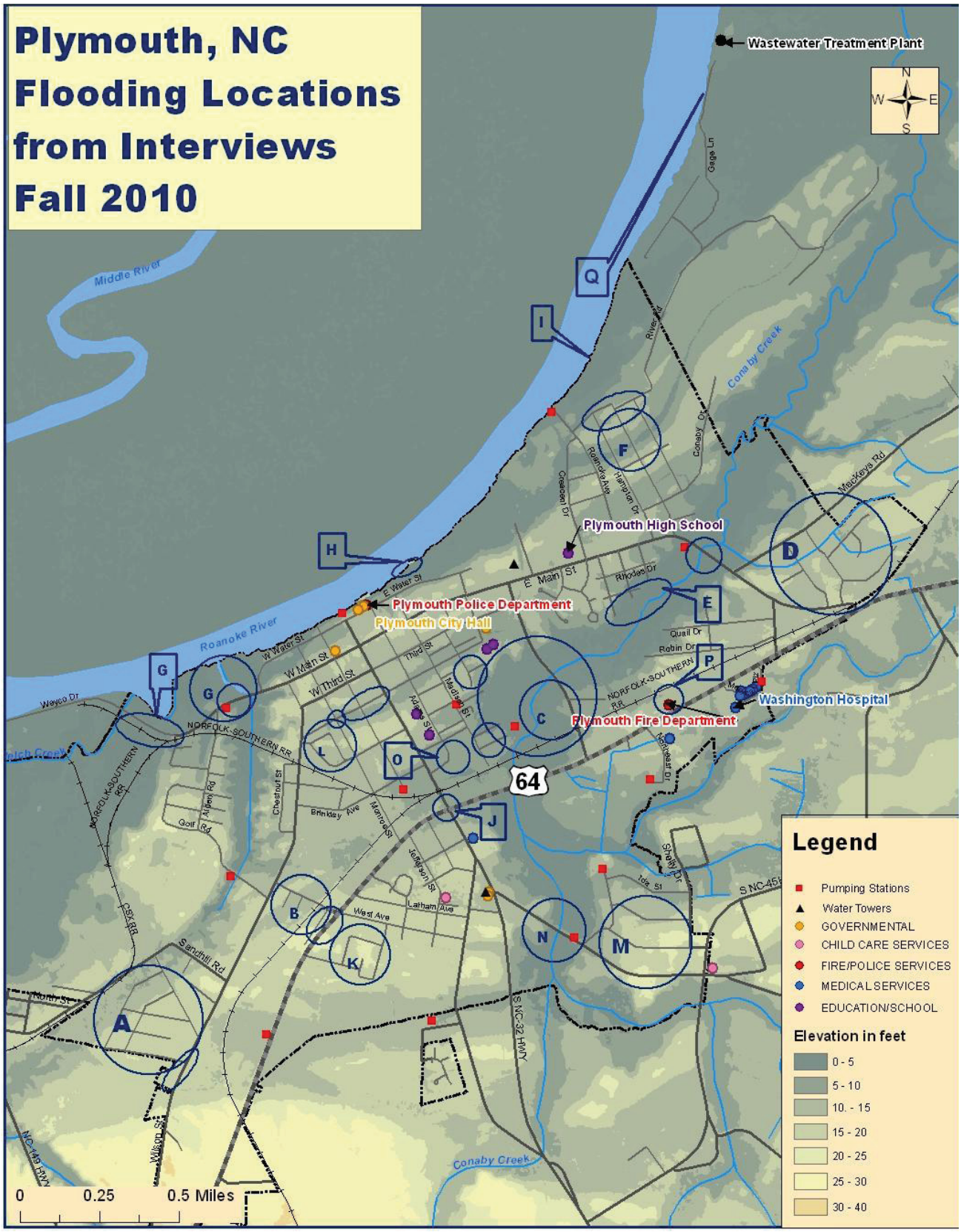
Similar to other communities all around the nation, Plymouth will likely integrate increased flooding risks and sea level rise into the town's short- and long-term planning efforts for specific management concerns rather than allocate a separate planning process just for these topics. This approach allows sea level rise to become an integral part of planning for risks and hazards management.

Before undertaking the approaches outlined in this report, communities should consider limitations that could prevent their success, including lack of relevant information, lack of perceived urgency, need for facilitation, and lack of political will.

Turn to Appendix 2 on Page 12 for a list of resources for communities seeking assistance and information on topics covered in this report.

This report was prepared by North Carolina Sea Grant and project partners including East Carolina University and the Social and Environmental Research Institute. The statements, findings and conclusions in this report do not necessarily reflect the views of the project partners, the Town of Plymouth, and its departments. These parties are not liable for the consequences of any actions taken on the basis of the information contained herein.

Appendix 1 - Interview Mapping Results



Appendix 1 - Interview Mapping Notes

Location	Streets	Comments
A	Pine St., Cranberry St, Cherry St., Oakford St., Park Ave., Campbell St.	Drainage Project 2, Smaller area at Pine and Wilson Street
B	Harvey St., Spencer St., West St., Truman Ave.	Drainage Project 3, Highway 64 and West Ave. Intersection
C	Rankin St. and Conaby Creek	Crowell and Thomas; Madison St. and Johnson Lane/Johnson Ct.
D	Mackeys, Woodlawn Ter, Jackson Heights, Ridgeway, Gavin, Bradley, Patton Ct.	Drainage Project 1
E	East Main St. and Conaby Creek	Also behind apartments and near high school
F	Riverside Dr., Kennedy Dr., Gen. Pettigrew, Matt Ransome, Hampton	Along Riverside Drive
G	West Main St.	Smaller area, Country Club, West Main St., and Welch Creek
H	Waterfront	Erosion and safety concerns
I	Waterfront	Storm surge area
J	Washington St. and 64	
K	Sterling Dr. , Anne St., Luvera St.	
L	Winnsett Circle, Monroe St, Fourth Street	Small area at Monroe and Fourth St., Fourth Street from Monroe to Washington
M	Old Roper Rd., Hazel St., Hillard St.	
N	Old Roper Rd and Conaby Creek	
O	Adams and Brinkley St.	
P	Around Fire station	
Q	Gage Lane to Wastewater Plant	
Off Map	Roanoke Shores	

Appendix 2 - Resources

North Carolina Sea Grant–Planning for Change: *www.ncseagrant.org/home/coastal-connections/living-on-the-coast/climate-and-weather*

North Carolina Climate Change Initiative: *www.climatechange.nc.gov*

State Climate Office of North Carolina: *www.nc-climate.ncsu.edu/climate/climate_change*

Southeast Regional Climate Center: *www.sercc.com*

N.C. Division of Coastal Management Sea Level Rise Information Page: *http://dcm2.enr.state.nc.us/Hazards/slr.html*

North Carolina Sea-Level Rise Risk Management Study: *www.ncsealevelrise.com*

Carolinas Integrated Sciences and Assessments (CISA): *www.cisa.sc.edu*

Albemarle-Pamlico National Estuary Program: *www.apnep.org*
This organization is currently developing the capacity to help local governments map vulnerable assets and conduct risk analyses for drinking water and wastewater infrastructure. To inquire about these services, visit their website or contact any member of their staff.

NOAA Coastal Services Center Digital Coast: *www.csc.noaa.gov/digitalcoast* and **Sea Level Rise and Coastal Flooding Impact Viewer**: *www.csc.noaa.gov/slr/viewer*

NOAA Office of Ocean and Coastal Management Climate Change Planning Guide for State Coastal Managers: *http://coastalmanagement.noaa.gov/climate/adaptation.html*

Georgetown Climate Adaptation Toolkit: *www.georgetownclimate.org/sites/default/files/Adaptation_Tool_Kit_SLR.pdf*

Coastal Climate Adaptation: *http://collaborate.csc.noaa.gov/climateadaptation*

U.S. Environmental Protection Agency Climate Change–Health and Environmental Effects in Coastal Zones: *http://epa.gov/climatechange/effects/coastal/index.html*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