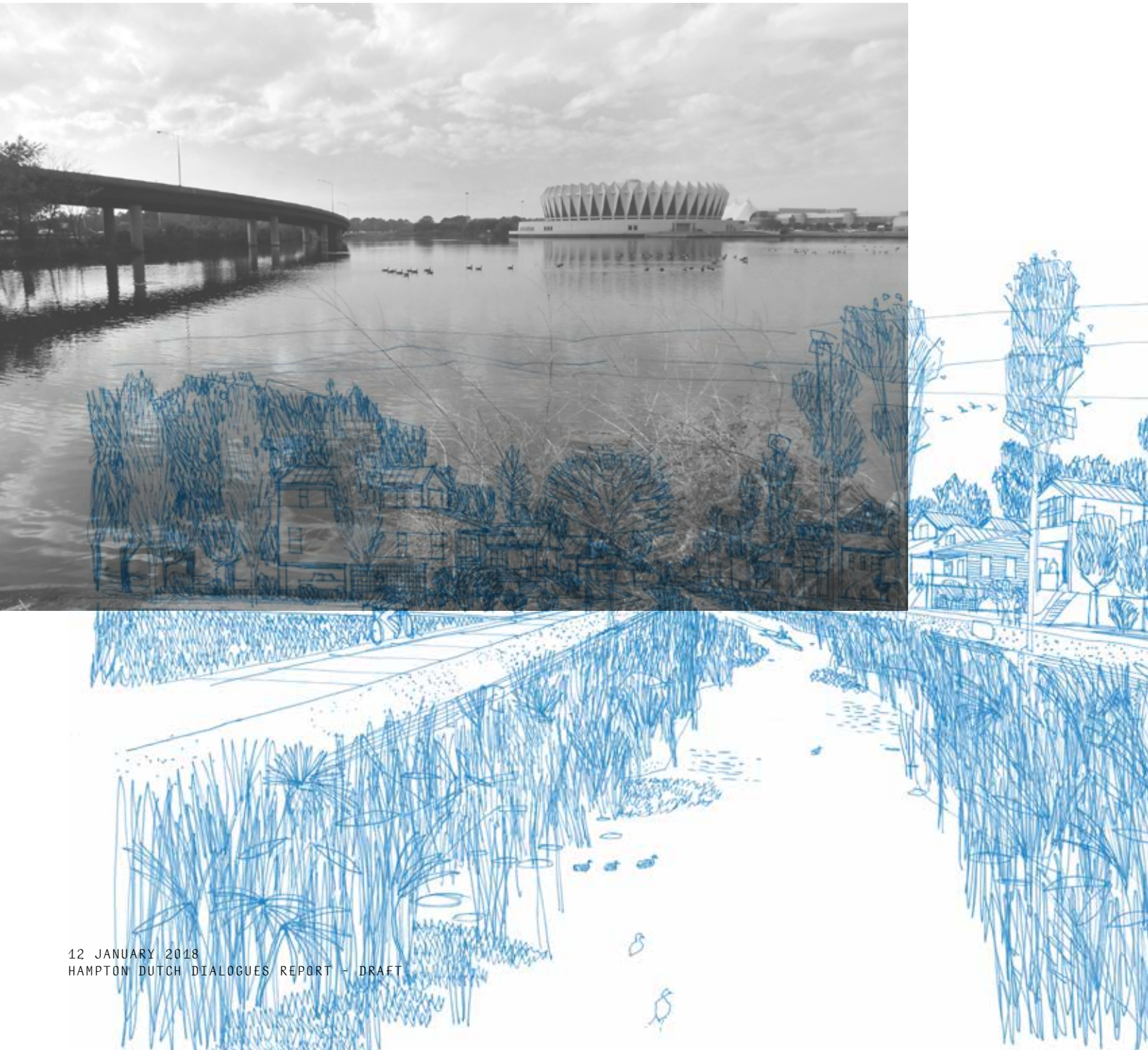
Living with Water Hampton: A Holistic Approach to Addressing Sea Level Rise and Resiliency



12 JANUARY 2018
HAMPTON DUTCH DIALOGUES REPORT - DRAFT

HAMPTON VA

December 13, 2017

Dear Fellow Hampton Citizens, Businesses and Community Organizations:

Hampton, Virginia is a very special place in part due to our geographic location at the confluence of the Chesapeake Bay with the James and York Rivers to form one of world's great harbors and natural environments. Our community is surrounded by water and the day-to-day life we enjoy is influenced in numerous ways by the water. We have thrived throughout history as a waterfront community due to our long standing understanding and co-existence with the various bodies of water that make our community such a unique place. Over the last several years, one of the most pressing issues we hear from our citizens is that of the ever increasing frequency and severity of flooding events. These "events" vary from being simple nuisances to everyday life to more severe events that may threaten lives, property and commerce. Many long time citizens often express that they have never experienced water related events to the degree they now do. Both anecdotal and empirical evidence tell us that our world is changing in a number of ways with respect to how we must adapt and live with the water that is so intrinsic to who we are and what we can be.

In response to these community's concerns, Hampton City Council formed the Hampton Comprehensive Waterways Management Steering Committee in 2010 in order to bring together concerned community stakeholders, City staff and consultants to develop a comprehensive plan to manage Hampton's waterways within an integrated and coordinated framework. While this effort was initially focused on navigable waterway management, the overall discussion evolved into a more comprehensive look at how our community addresses issues like tidal flooding, stormwater management, shoreline protection and waterway maintenance. The findings from this effort were presented to City Council in 2011 and served as the initial blueprint for establishing community priorities around these important water related issues.

In June of 2015, the City of Hampton participated in a unique and innovative process called ***Dutch Dialogues Virginia: Life at Sea Level***. The cities of Hampton and Norfolk were selected as "pilot" areas for the purposes of this intense five day exploration. This effort brought together some of the best consultants from the region as well as national and international resources including consultants from New Orleans and the Netherlands. The purpose of the Dutch Dialogues Virginia charrette was to begin exploring and identifying more holistic ways to "live with the water." The Dutch Dialogue concept emerged out of the post Katrina analysis and planning in the New Orleans region. The New Orleans experience clearly illuminated some of the flaws in our past ways of thinking with respect to water management. At the end of this five day process, the Mayors and City Manager's of both Hampton and Norfolk pledged to continue to move this effort forward and take a leadership position in Hampton Roads with respect to how their communities and the region adapt to the changes from sea level rise, land subsidence and climate change.

This report represents the first phase of Hampton's efforts to build on the Dutch Dialogues Virginia: Life at Sea Level learnings and momentum. In this report, we begin the process of understanding the

OFFICE OF THE CITY MANAGER
22 Lincoln Street | Hampton, Virginia 23669
P: (757) 727 - 6392 | F: (757) 727 - 3037

important forces that are working to cause the more frequent and severe flooding we are now experiencing. In addition, we engaged our citizens in dialogue to understand the key community values and philosophies that should guide our future work so we can respond to their concerns in a way that respects the unique tapestry of places to make up Hampton. We have also worked hard to engage our many regional partners who have helped us to broaden our understanding and meet our goal of using the best data possible in our work.

The work represented by this document is extremely important to the future of our community and we are committed to being successful. The very future of many of our neighborhoods, commercial districts and historic resources depend on our ability to successfully adapt. Clearly we will have to change the way we think and act as a community in relation to these types of challenges. As our Dutch partners have demonstrated, you can be challenged by the water and yet continue to thrive and succeed as a place people want to live and commerce thrives. Hampton and Hampton Roads possess assets of national importance that cannot be lost. This is not the first daunting challenge our community has faced and I am confident we are on the right path to succeed in establishing Hampton as a shining example of how a community can adapt and thrive in the face of serious challenges so we become an even more vibrant coastal community in the future.

Sincerely,

Mary B. Bunting
City Manager

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REPORT PREPARED BY:
WAGGONNER & BALL
ARCHITECTURE/ENVIRONMENT
2200 PRYTANIA STREET
NEW ORLEANS, LA 70130
+1 504 524 5308
WBAE.COM

Executive Summary

Introduction

The Hampton Roads region is one of the most vulnerable areas in the country for impacts from climate change, sea level rise, and recurring flooding. As members of a coastal community, Hampton's citizens have experienced these impacts, and are sensitive to the challenges they face. Increases in flood insurance rates, repetitive loss from flooding, and lack of safe routes to employment and critical services due to flooding and large storms are all concerns for this city.

Hampton has undertaken this effort to address ongoing stresses, such as nuisance flooding from higher tides, and prepare for future shocks from large weather events through a place- and asset-based approach to resiliency. Resilience is building on the strengths of a community to make it easier to recover from extreme events and relieve everyday stresses. This document details the work completed and progress made as part of Phase I of the Resilient Hampton initiative. This effort assesses the multiple forces of water, incorporates community principles and values, and recommends solutions driven by unique neighborhood characteristics.

Hampton is uniquely poised to tackle these issues, and lead the way to a resilient future. Hampton exists because of its proximity to water, and development of the early economy occurred in relationship to the water: the seafood industry requires water for fishing and crabbing, Langley Air Force Base originally required water to fly over and practice the earliest attempts at aerial bombing, and tourism is based in marinas and beaches. Hampton has a very close cultural connection of water, and a desire to work with the water, and not simply shut it out. Further, Hampton has a long history of education and innovation, with multiple organizations that are equipped to partner with the City to address these issues head-on and provide smart, cutting-edge research and data.

Improving resilience is critical to Hampton's future success, and the city is committed to doing so by treating water as an asset. This new way of thinking makes water something to work with, and not against. For example, the City should not think of water as a "backyard condition" to build away from, but as an amenity that can enhance aesthetics, property values, and quality of life. Clearly, there are economic opportunities in this way of thinking, as well. However, in order to improve resilience in the city, it is important to understand how water affects the City, and in what capacity.

Assessment

In Hampton, multiple forces of water affect the City. Those forces are:

- **Storm surge**, wave action, and high water levels associated with storms and low pressure weather systems;
- **Tidal action**, the fluctuation of water levels between low and high tide;
- **Stormwater**, water generated from rain and storms that can be difficult to infiltrate due to impervious surfaces, and can lead to runoff; and,
- **Groundwater**, the water that lies below the surface of ground, and which can impact the ability of the soil to infiltrate stormwater if the groundwater level is high.

Often, these forces are interacting with one another, creating a more complicated and intense water event. This can also make it difficult to determine the cause of the flooding, and thus harder to generate solutions.

These concerns are further exacerbated by climate change and relative sea level rise. Hampton has documented numerous storms over its history, but data show more intense storms occurring more frequently than in the past: eight of the eleven highest storm surges from the last 80 years have occurred in the past twenty. Relative sea level rise, the combination of rising sea levels and subsidence, also greatly impacts Hampton Roads and Hampton. Sewell's Point in Norfolk has documented one of the greatest changes in relative sea level in the world: 1.45 feet in the last 100 years. With an abundance of available information, it is important that Hampton determine a baseline to plan to going into the future.

How We Move Forward

In order to move Hampton forward in a resilient way, a set of guiding principles has been established to inform decision-making.

- Create Value-Driven Solutions
- Reinforce Assets
- Layer Public Benefits
- Strengthen Partnerships
- Use Good Data
- Share Knowledge and Resources

These principles define how the City will become a resilient Hampton. It is an asset- and place-based approach that recognizes the importance of building on assets, making investments based on the unique places and values in Hampton, establishing good communication, receiving community input and good data, and investing in such a way that many benefits are achieved at once.

Values

Through a community-driven process, eight values were established that reflect Hampton:

- **Safe**: Reducing risk during major events and creating safe, reliable systems.
- Equitable: Prioritizing strategies that create benefits for all, and strengthening marginalized sectors of the community.
- **Natural**: Repairing and protecting natural systems in order to sustain them for the future.
- **Heritage**: Appreciating the history and culture of local communities and supporting it into the future.

- **Integrated**: Connecting systems in strategic ways to yield multiple benefits.
- Sufficient: Leveraging public investment to support the local economy and jobs, and being fiscally responsible with city funds.
- **Nimble**: Being able to adapt in the face of changing environments, improved data, and new best practices.
- **Innovative**: Creating forward-thinking solutions.

These values are further described in the document and are the basis of a new evaluation tool. This tool is one of the most important products of this phase. In order to be a successful, resilient community, Hampton must begin evaluating its choices in the context of its community values and guiding principles. This evaluation tool is unique to Hampton, and is designed to assist decision makers in understanding how closely a project or investment aligns with the city's stated values. While this tool is not meant to decide whether or not a project should go forward, it can provide an important, clear analysis of the project in terms of resilience.

In addition to the guiding principles and values, the City has developed nine 9 goals that further illustrate the final outcomes Hampton hopes to achieve with our resilience work.

Place-Driven Analysis

In order to achieve wide input and understand the difference needs and interests of various neighborhoods, the project team held a number of public workshops and stakeholder meetings. Stakeholders included officials from both local and state governments, non-profits, research and educational institutions, the business community, and regional partners.

Hampton's neighborhoods were divided into six different areas that share common characteristics and concerns related to water: Newmarket Creek, Harbor-facing, Southwest Branch Back River, Hampton River, Bay Facing, and Low-lying. For example, neighborhoods in the Bay Facing section are likely to experience more issues around large events such as hurricanes and impacts from shoreline erosion, while those neighborhoods in the Hampton River area (which includes Phoebus and Downtown) are more frequently impacted by stormwater runoff and backflow through existing infrastructure. Each study area has major topics to address, as well as recommended strategies to focus on.

Broadly, proposed strategies for improving resilience fall into four categories: policy, education and communication, physical, and operations and maintenance. Some strategies apply widely across the city, such as enhanced education, and some are more applicable to specific locations. Each of these categories is explored in depth and suggested strategies are provided.

Based on the feedback and analysis the project team took from the various meetings and workshops, several potential focus areas are recommended for Phase II. Each represents a specific type of issue that Hampton faces, and includes Newmarket Creek to Langley Air

Force Base, Downtown Hampton, Fox Hill and Riverdale, and Buckroe Beach and the boardwalk. Along with moving on to Phase II, there are a number of next steps the city needs to undertake:

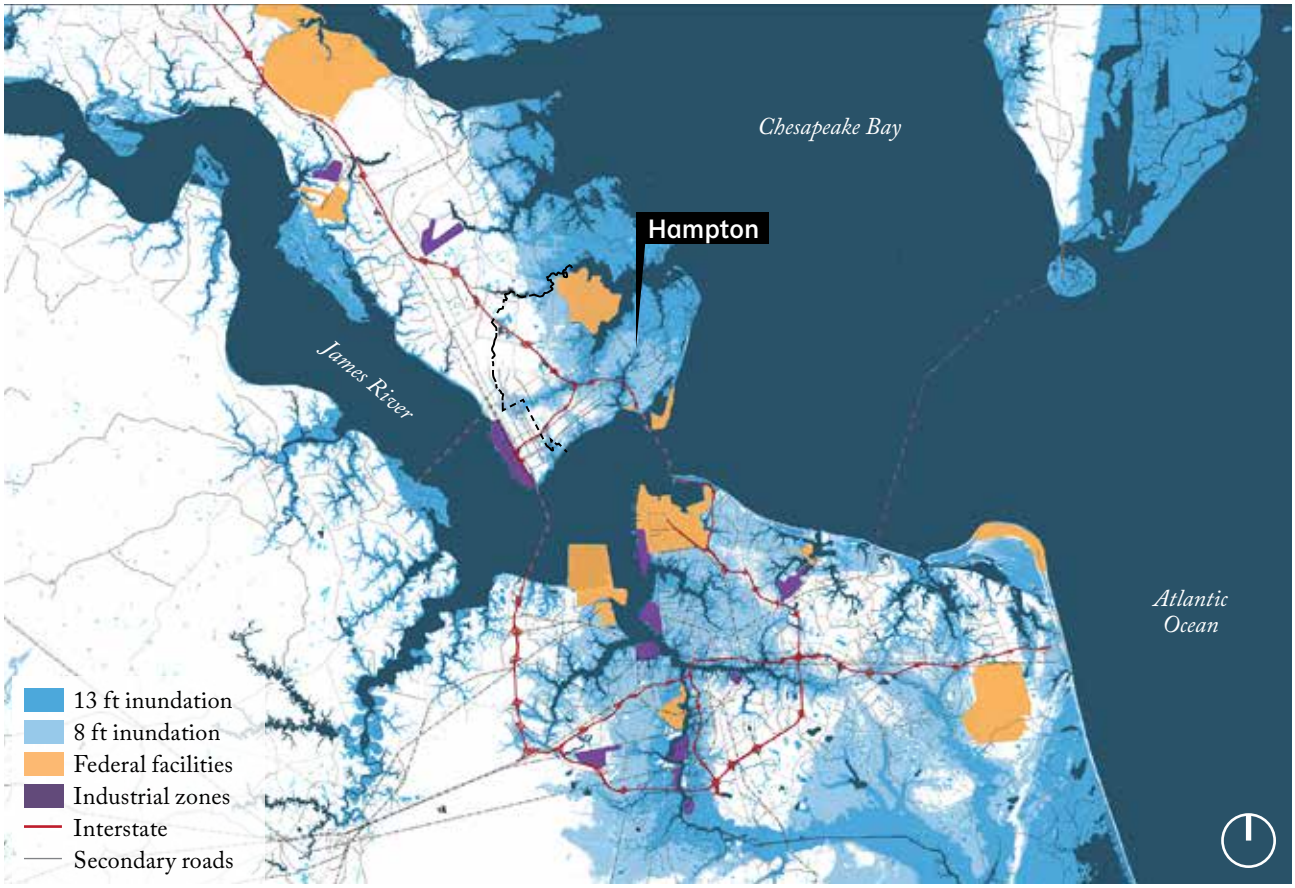
- Amend the Hampton Community Plan to reflect the work of this document and incorporate the recommendations.
- Undertake a comprehensive effort to review and amend City codes and ordinances to support the goals and objectives adopted into the Hampton Community Plan from this document.
- Refine the "evaluation tool" as necessary and institutionalize its use as an integral part of decision making for public projects.
- Pursue changes to legal frameworks at the State level, if necessary.
- Set "resiliency targets" for the community and establish a process to track and measure our progress.
- Identify one or two geographic "focus areas" which will be the subject of the Phase II work. Phase II work will take a more detailed look at the identified geographic "focus areas" to apply what we have learned in Phase I. The goal for these areas will be development of a holistic set of strategies that can be implemented.
- Continue to work with our partners so we continue to learn, share, innovate and advocate for regional progress on sea level rise and resiliency issues.
- Work with our partners to develop a community education program which raises awareness with regards to the value of being a resilient community. In addition, the education program will identify strategies and action items applicable to businesses, individual homeowners, institutions and other stakeholders.
- Continue to work with Langley Air Force Base to develop a resiliency component to the existing Joint Land Use Study.
- Establish and support a "Hampton Resilience Partnership" in order to create a formal structure to bring community, business, academic and regional partners together on a formal basis to assist in moving our resiliency goals forward.

The goals, guiding principles, values, and strategies outlined in this document form the foundation of the City's new perspective on what it means to be Resilient Hampton.

Introduction

Rich Edges
The edges of the Hampton River display a rich variety of city assets. From marinas for recreation and industry to educational assets such as museums and universities, Hampton's miles of waterfront touch every aspect of life and culture.

Elevation



Infrastructure at Risk

Purpose of Document

Resilience is the bolstering of a community's inherent strengths in order to alleviate chronic stresses and enable recovery from extreme events and shocks in ways that makes the community even stronger than before. Each place's unique natural features, built environment, and human capital should shape its strategy for resilience. The purpose of this document is to bring forward a set of community-driven values and attributes, criteria by which to measure how well proposed strategies adhere to Hampton's character and build upon its existing assets. This analysis identifies themes and issues which apply regionally and city-wide, but also captures the specific character of the city's diverse neighborhoods. The content of this document is not yet prescribing solutions for a resilient Hampton, but instead summarizes Hampton's strengths and assets as well as its current challenges.

Hampton faces a unique set of challenges based on multiple – and often combined – forces of water. Sea level rise and increased precipitation amplify storm surge, surface runoff, and tidal action, as well as fluctuations in groundwater levels, which can lead to subsidence. The complex forces causing the city's chronic flooding are sometimes unclear and may lead to a misunderstanding of the effectiveness of potential solutions. Without a strategy to address these challenges, the city's character and economy are under threat. Increasing flood insurance rates and repetitive loss threaten the character of Hampton's varied communities as long-standing residents are displaced. With 48 cents of every dollar in Hampton's economy associated with government work, securing existing military and government assets is critical in the short-term, as is long-term diversification of industries and economic opportunities.

However, in the face of these challenges, Hampton already has some of the best assets and resources for resilience and adaptation. Historically a city of innovation, Hampton has a progressive culture of creative problem-solving. From the NASA Langley Research Center to multiple university and not-for-profit institutes, many organizations are already documenting changing local conditions. This document is designed to support existing and ongoing local efforts by the City, region, and stakeholders. The evaluation tool developed through this document aims to provide a simple method for communicating a potential project's strengths and weaknesses relative to Hampton's values. It is a resource to aid and inform investment decisions. Additionally, continued community participation will be needed in planning and implementation efforts. Just as sea level rise projections will change over time, constant adaptation is necessary to contend with the environmental challenges of today.

Opposite, top:
The topography (elevation) of the Hampton Roads region has been formed from geological and climactic events dating back millions of years. The Chesapeake Bay was formed by the flooding of the Susquehanna River Valley at the end of the last ice age.[1] A bolide, or meteor, which struck the southern portion of the bay around 35 million years ago continues to influence the Hampton Roads region, with some speculation that subsidence in the area may be attributed to compaction of material in the impact crater.[2] Running parallel to the western rim of the crater, the Suffolk Scarp (depicted in red and gray tones on the map) is an elevated landform that marks the edge of the oceanfront during the warming period preceding the last ice age.

Opposite, bottom:
The Hampton Roads region is an important natural port and strategic area for national defense. Measures must be taken to protect important regional assets which are currently at risk.

First From the Sea, First to the Stars

The City of Hampton is a coastal community located in the southeast corner of the Commonwealth of Virginia, at the mouth of the Chesapeake Bay. The first inhabitants of present-day Hampton were Algonquian Native Americans, who established the Kecoughtan settlement in between the Hampton River and Chesapeake Bay. In 1610, English colonists seized this village and established their own town, calling it Hampton. Considered the oldest continuously occupied English settlement in the United States, the modern history of Hampton traces back to the earliest explorers who came to this country from England. Over the course of four centuries, this legacy carries national and international significance, including pivotal events in the creation and evolution of the country. Hampton has shaped the history of commerce and national defense, slavery and emancipation, the first free education in America, and human exploration and space flight.

Hampton is situated at the center of the Hampton Roads region, which is home to approximately 1.7 million residents. In the city, nearly 140,000 people live on just over 50 square miles. Hampton boasts **124 miles of navigable waterfront**, and is surrounded by water bodies on three sides: the Hampton Roads harbor to the south, Chesapeake Bay to the east, and the Back River/York River to the north. Located where the James, York, Nanesmond, and Elizabeth Rivers converge into the Chesapeake Bay, the Hampton Roads region is one of the world's largest natural harbors.

Below:
An 1861 view of the Chesapeake Bay during the Civil War illustrates Fort Monroe's strategic location at the mouth of the James River. (Image source: David Rumsey Historical Map Collection[3])

Culture of Water

Watermen and businessmen, soldiers and seamen, settlers and visitors – the Hampton Roads region was settled for its location on one of the largest, deepest natural harbors in the world. Many have been drawn to the shores of Hampton for its abundance and beauty at the mouth of the Chesapeake Bay since.

The earliest settlements in Hampton appeared along the water. Fish camps continue to dot the shoreline, as these waters have been busy with generations of watermen providing the nation's best blue crabs and oysters. Sunbathers have flocked to the wide, sandy beaches and marinas, and yacht clubs flourish still today. The Hampton Cup Regatta, an event that has run since the 1920s, draws vessels from all across the United States. Industry has valued Hampton's favorable location and sheltered waters, as has the Air Force, for flying out over the water. Even infamous pirate Blackbeard once roamed the waters around Hampton. The Grandview Lighthouse stood for 127 years as both a guide to those on the water and an important gathering place for the community. Although ultimately taken by erosion and a series of storms, it remains a symbol of a strong coastal community.

Storms and high tides are a part of coastal life. When developing solutions to address future conditions, it is essential to reflect on Hampton's culture and relationship with water, and to reconnect and strengthen this relationship.

Below, left:
Oyster pile at J.S. Darling & Co. Oyster Planters, c. 1900. (Image source: Hampton History Museum)

Below, right:
Mill Creek at sunrise, 2017. (Image source: Daily Press contributor Verycoolnin)

Bottom, left:
Lighthouse at the Back River (Grandview). (Image source: Hampton History Museum)

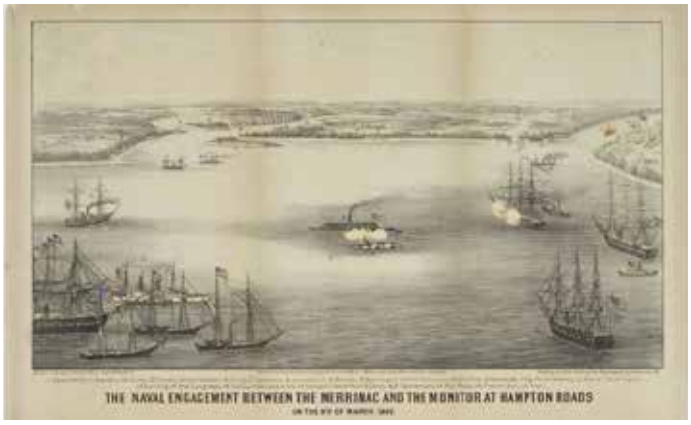
Bottom, right:
Bay Shore Park at Buckroe. (Image source: Hampton History Museum)

National Defense

Hampton has historically been, and remains today, a key site for national defense. In 1607, English explorers and settlers marked Point Comfort (commonly referred to as Old Point Comfort), the present-day site of Fort Monroe, as a key strategic defense point for the harbor. Completed in 1834 and named for President James Monroe, the fort's construction began with slave labor, then transitioned to use of military convicts. During the Civil War, the Union-controlled fort became a haven for emancipation after three enslaved men escaped the Confederate Army and fled to Fort Monroe. Declaring the men "contraband of war," General Benjamin Butler refused to return the slaves. By the end of the war, over 10,000 former slaves lived in tents outside of "Freedom's Fortress."

Until 2011, when the U.S. Army turned control of Fort Monroe over to the Commonwealth of Virginia, Old Point Comfort had served as a point of defense for nearly four centuries. Though no longer an active military base – today the site is Fort Monroe National Monument – the fort remains a key asset to Hampton and the surrounding region for its historical, educational, cultural, and architectural value. Operated through a partnership between the National Park Service, Fort Monroe Authority, and City of Hampton, Fort Monroe is a symbol of Hampton's history and military heritage.

The modern chapter of Hampton's role in national defense and research began in 1915, at the start of World War I, when Congress established the National Advisory Committee for Aeronautics (NACA). In 1916, the federal government selected a site along the Back River because of its relatively flat topography and proximity to the coast. Opened in 1917, Langley Air Force Base is one of the first military sites in the world specifically constructed for flight. A century later, Langley is now the oldest continually active air force base in the world, and is the oldest airfield in Virginia. In 2010, the base joined with Fort Eustis to form Joint Base Langley-Eustis. Entering its second century, Langley maintains its mission of fast global deployment and air superiority for the United States. For the past 100 years, Hampton's proud community has supported these world-class national defense installations. These critical assets must be protected from changing climates and rising seas.



Top:
The historic battle of the ironclads took place off Hampton's shores. (Image source: The New York Public Library Digital Collections[4])

Center:
The Atlantic Fleet amassed near Fort Monroe, circa 1900. (Image source: The New York Public Library Digital Collections[5])

Bottom:
A F-22A Raptor housed at Langley Air Force Base flies over Fort Monroe. (Image source: Air Combat Command[6])

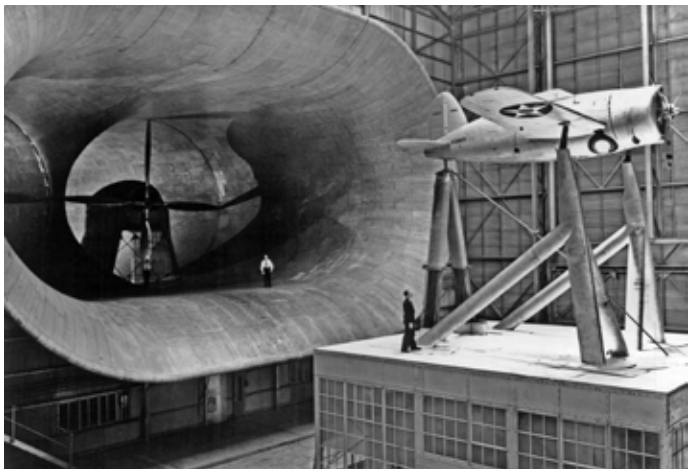
Education

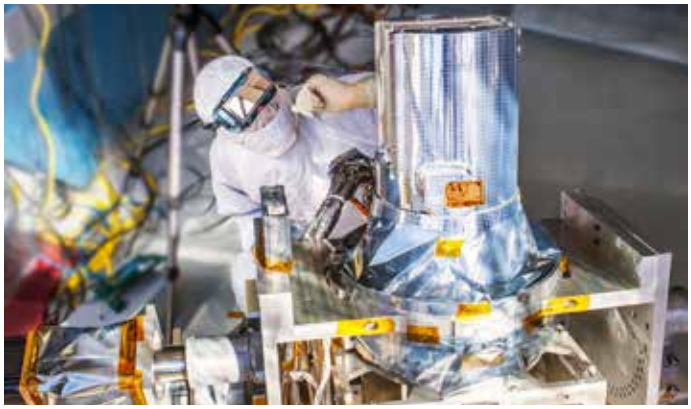
Hampton has a long history of innovation in education, research, and technological development, which should be applied to its current challenges from changing climates and rising seas. During and after the Civil War, Hampton became a national center of equitable education for freed slaves. In 1861, at the start of the Civil War, Fort Monroe enacted the 'Contraband of War' decision. As the number of freedmen who camped in the area grew well into the thousands, it became clear a school was needed. The first classroom for these 'contraband' students was under the shade of a young oak tree. This tree later served as the first site in the South for the reading of the Emancipation Proclamation. Named Emancipation Oak, the tree sits on the campus of present-day Hampton University, and stands as a lasting symbol of the promise of education for all.

Innovation

The end of another war also led Hampton to become an international leader in aeronautics research and technology, ushering in the space age. In 1917, a year before World War I ended, Langley Memorial Aeronautical Laboratory was established near the northeastern edge of Hampton along the Back River. Langley became the nation's first civilian facility dedicated to researching flight. After four decades of innovation and development, the program shifted to space research, becoming NASA, the National Aeronautics and Space Administration.

Today, NASA's Langley Research Center (LaRC) drives work related to study the planet's changing climate. With the Atmospheric Science Data Center, LaRC is responsible for processing, archiving, and distributing NASA earth science data about radiation, clouds, aerosols, and tropospheric compositions. This uniquely situates NASA Langley as a research partner for the City of Hampton, helping study climate data that could inform critical infrastructure decisions.



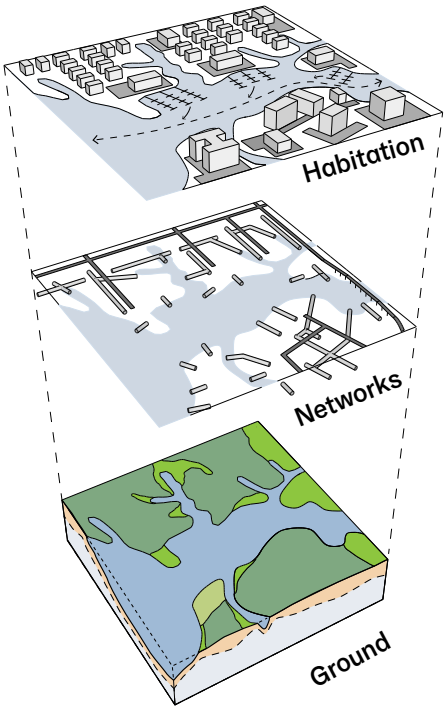


Top:
A mathematical geography class at Hampton Institute, now known as Hampton University. (Image source: Library of Congress[7])

Center:
NACA's Full Scale Tunnel at Langley Research Center in 1932. (Image source: Smithsonian National Air and Space Museum[8])

Bottom:
SAGE III, a climate monitoring instrument developed at NASA Langley, was launched to the International Space Station in 2017. (Image source: NASA[9])

Preparing for the Future



Layered Planning
A holistic new approach outlines principles for water management, regional planning, and urban design that are specific to Hampton, developed out of a process that considers local soils, water, and biodiversity, as well as infrastructure networks and land use.

Hampton is seeking solutions to anticipate future shocks from large events while addressing ongoing stresses, such as increasing nuisance flooding from higher tides and stronger rainfalls. Though Hampton has weathered a number of significant storms over the years – notably Hurricane Isabel in 2003 – the city has the advantage of approaching resilience planning from a post-disaster recovery lens before a disaster occurs, unlike cities such as New Orleans post-Katrina or New York City post-Sandy, who planned after the event. Addressing the complex threats facing the City of Hampton will require new ways of thinking, working, and learning. Solutions that only address one issue will no longer justify the investment made in them. Instead, resilient solutions will require a holistic approach which accounts for environmental, social, and financial inputs. To that end, this document is the first step in creating a strategy for a resilient city by identifying both threats and community values.

To begin the resilient design process, the cities of Hampton and Norfolk held a five-day workshop called **Dutch Dialogues Virginia: Life at Sea Level**. The Dutch Dialogue approach to "living with water" is an innovative method that first emerged in the aftermath of Hurricane Katrina in the New Orleans region. A partnership between Waggonner & Ball and the Royal Netherlands Embassy brought together a team of experts from the Netherlands with local professionals to assist in New Orleans' efforts to better prepare its community post-Katrina. In June 2015, the City of Norfolk, the City of Hampton, the Hampton Roads Planning District Commission, and various other partners brought the Dutch Dialogues approach to Hampton Roads. Hampton and Norfolk were chosen as the "pilot" cities around which the workshop was focused. At the conclusion of this five-day session, the Mayors and City Managers of Hampton and Norfolk pledged to continue the momentum and work together to lead the region toward a more resilient future.

Focusing on Newmarket Creek – a connective element spanning much of the city - the Dutch Dialogues work also organized around guiding concepts:

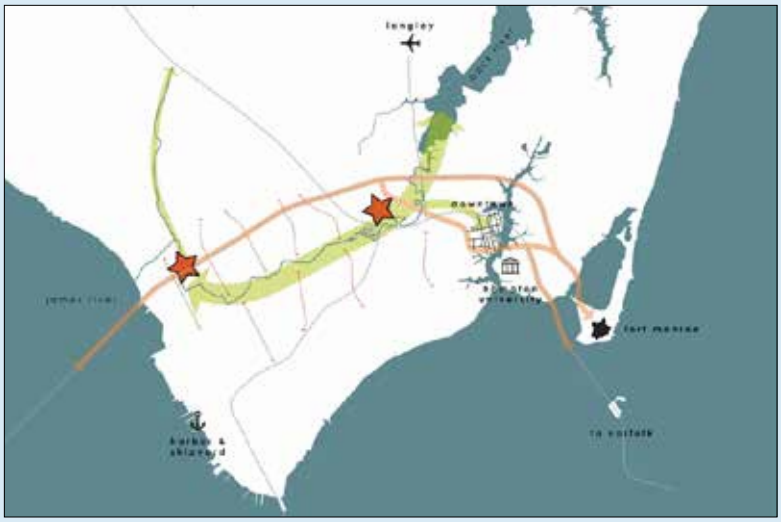
- Scale. Start from a larger perspective in scale as well as time. Connect long-term perspective with concrete, short-term measures.
- Innovate. Dare to think outside the box.
- Work with the system, not against it. Analyze the system; when you understand how it works, you can work along with it.
- Create multiple benefits. Don't accept solutions that only work. Strive for solutions that both work and add value.
- Value water. Manage and utilize water wisely. Retain, store, and drain.
- Draw. Use drawing as a communication tool between different disciplines and audiences.

Integrated resilience planning requires a deeper understanding of how different layered systems interact. Soils and water are the basis for planning and designing infrastructure networks, which in turn shape the urban fabric and human activity. Human intervention and policy change the shape of the land and the flow of water and nutrients across the landscape. These interactions create a delicate balance. Water has always been an integral part of Hampton's history, culture, and livelihood. Therefore, local water systems should not only be managed to reduce flood risk and provide basic utility, but should also continue to support economic development and enhance quality of life by supporting a broader range of human activities and uses as well as wildlife and habitats. Creating strong cities and landscapes requires increased coordination, knowledge sharing, and collaboration in the realms of planning, design and construction, and management.

Dutch Dialogues Virginia: Life at Sea Level

DUTCH DIALOGUES WORK FOCUSED ON UTILIZING NEWMARKET CREEK AS A CONNECTIVE ELEMENT THROUGHOUT HAMPTON. MERCURY BOULEVARD - WHICH LOOSELY PARALLELS NEWMARKET CREEK - CONTAINS MANY OF THE CITY'S ECONOMIC ASSETS. AT HINGE POINTS WHERE THE CREEK AND THE BOULEVARD INTERSECT (SHOWN AS STARS IN THE DRAWING TO THE RIGHT), THERE ARE OPPORTUNITIES FOR REDEVELOPMENT.

IN MANY AREAS OF THE CITY, NEWMARKET CREEK IS SEEN AS A BACKYARD CONDITION. THE TEAM ALSO LOOKED AT USING GREEN INFRASTRUCTURE INSERTED INTO NEIGHBORHOODS TO CREATE ACCESS POINTS FOR THE CREEK. AS AREAS AROUND THE CREEK ARE REDEVELOPED, NEW DEVELOPMENT COULD FACE THE CREEK, USING IT AS AN ASSET INSTEAD OF REGARDING IT AS A THREAT.



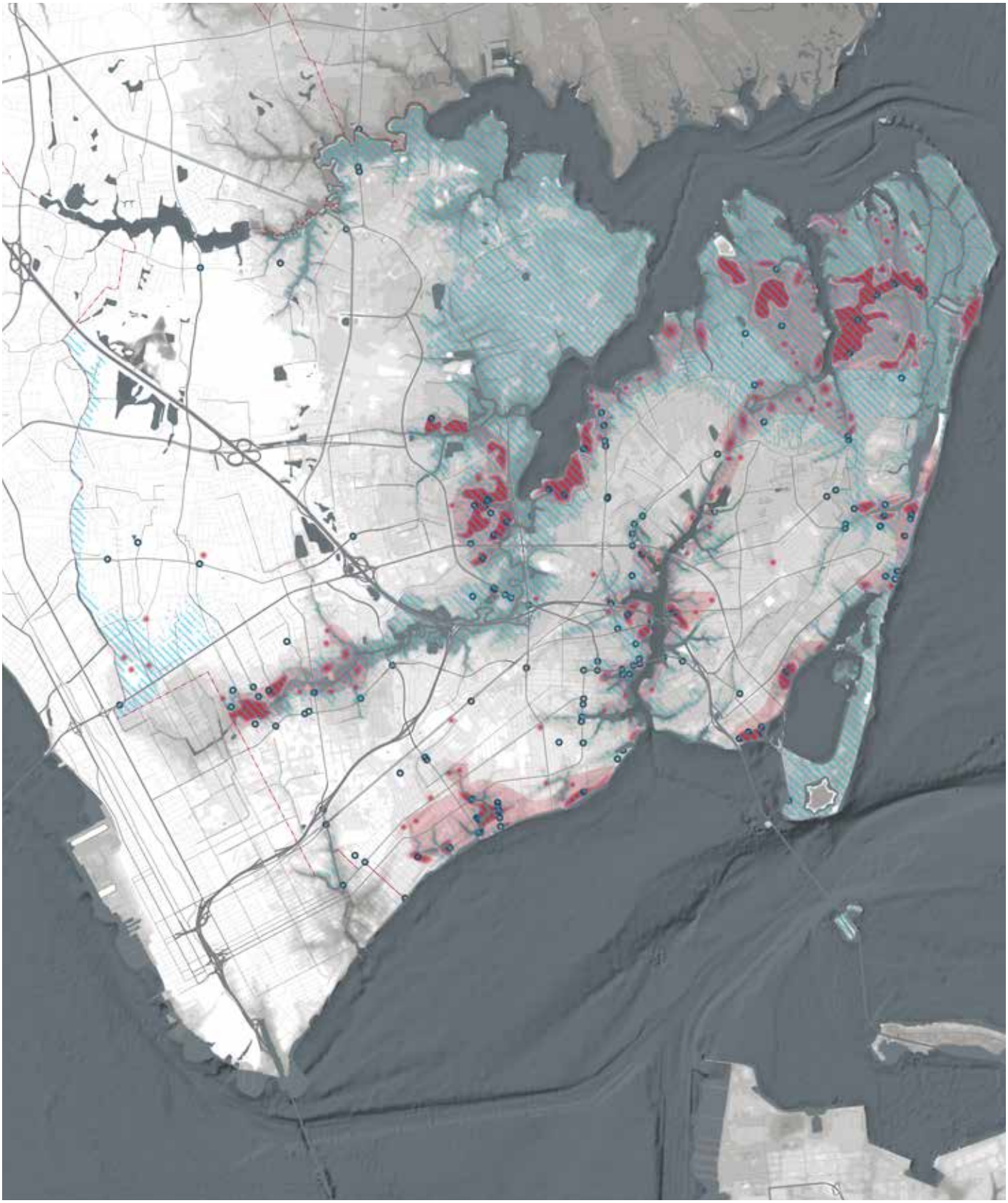
Improving resilience is critical to the future success of Hampton and its neighboring coastal communities. With changes in sea levels and climate already documented in the area, maintaining the status-quo in stormwater management will not sustain the city's long-term viability either physically or economically. However, the development of a resilience strategy will provide the City and its citizens with a path toward a more adaptable city, better able to respond to stresses and threats as they arise. To be successful, these resilience initiatives must also reflect the specific character of the diverse neighborhoods and areas of the city.

As a city that lives and works on the water, Hampton's citizenry is already sensitive to the challenges they face. Increased instances of tidal flooding, also known as "sunny day flooding," affect people's ability to access both employment and critical services. Larger and more frequent storm surge during extreme events such as hurricanes and nor'easters can cause extensive property damage; patterns of repetitive loss can already be observed in areas prone to damage from such events. Increases in flood insurance rates combined with decreasing property values are threats felt through the community at large. Compounding these threats is the need to secure the area's critical assets and industries, not the least of which is the area's national defense installations.

However, the presence of key national assets is precisely what makes Hampton a model community for adaptation and resilience. A proactive approach will prepare Hampton for the future, instead of working to maintain outmoded systems and technologies. This report, prepared through a series of community and stakeholder meetings, identifies community-driven values around which to build a resilience strategy. Furthermore, the report lays out the development of an evaluation tool with which the City can gauge the benefit of future investment. This tool will require further testing and development alongside continued community participation. Reinforcing the idea of resilience, adaptation of the strategy is also necessary to contend with environmental, economic, and social challenges in Hampton over time.

Below:
Hampton Coliseum as seen from Newmarket Creek.

Opposite:
Comparing observed street flooding, repetitive loss, and the 100-year floodplain can help illustrate the areas most susceptible to future risk.



Repetitive Loss & Flooded Intersections

Repetitive Loss Cluster

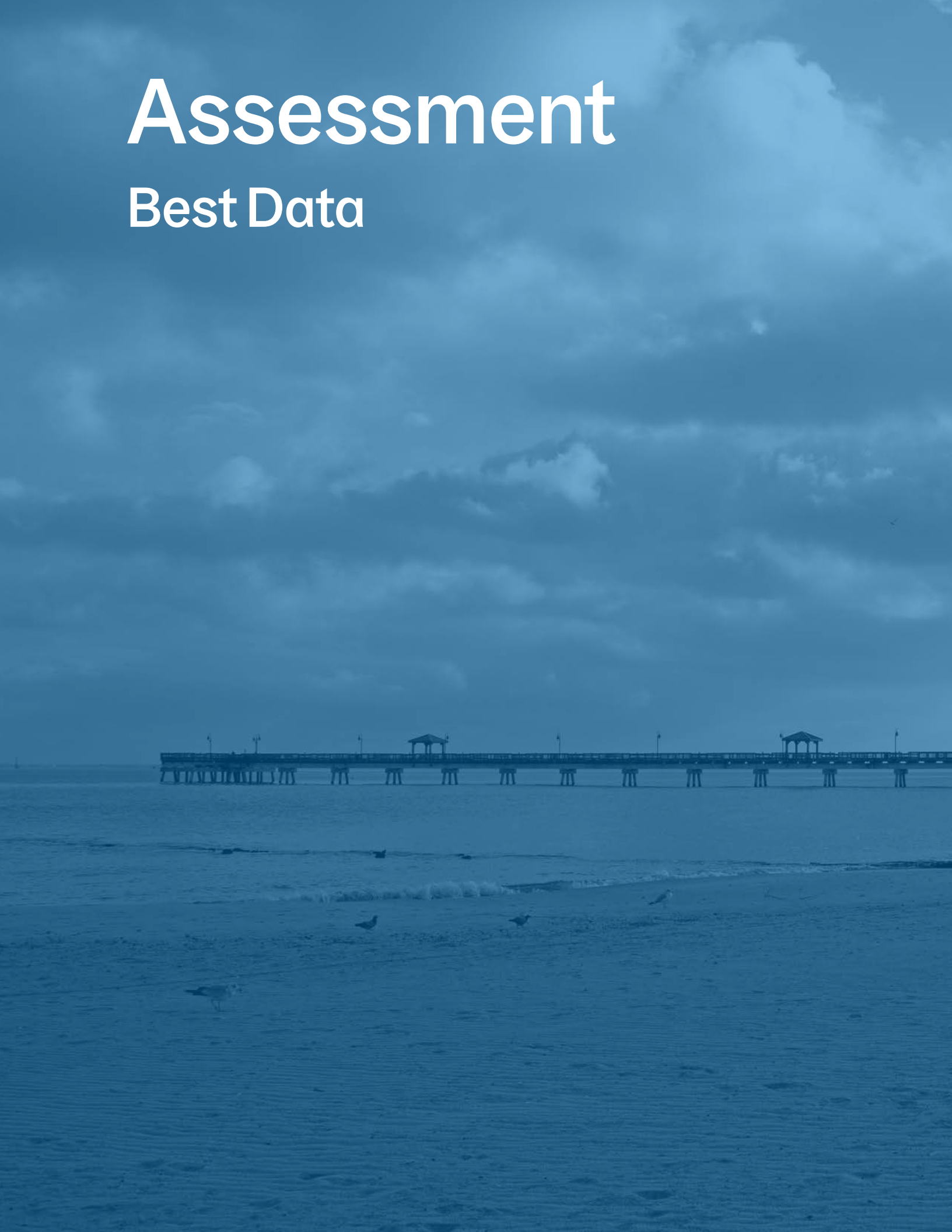
Repetitive Loss Zone

Recorded Flooding

100-Year Floodplain

Assessment

Best Data



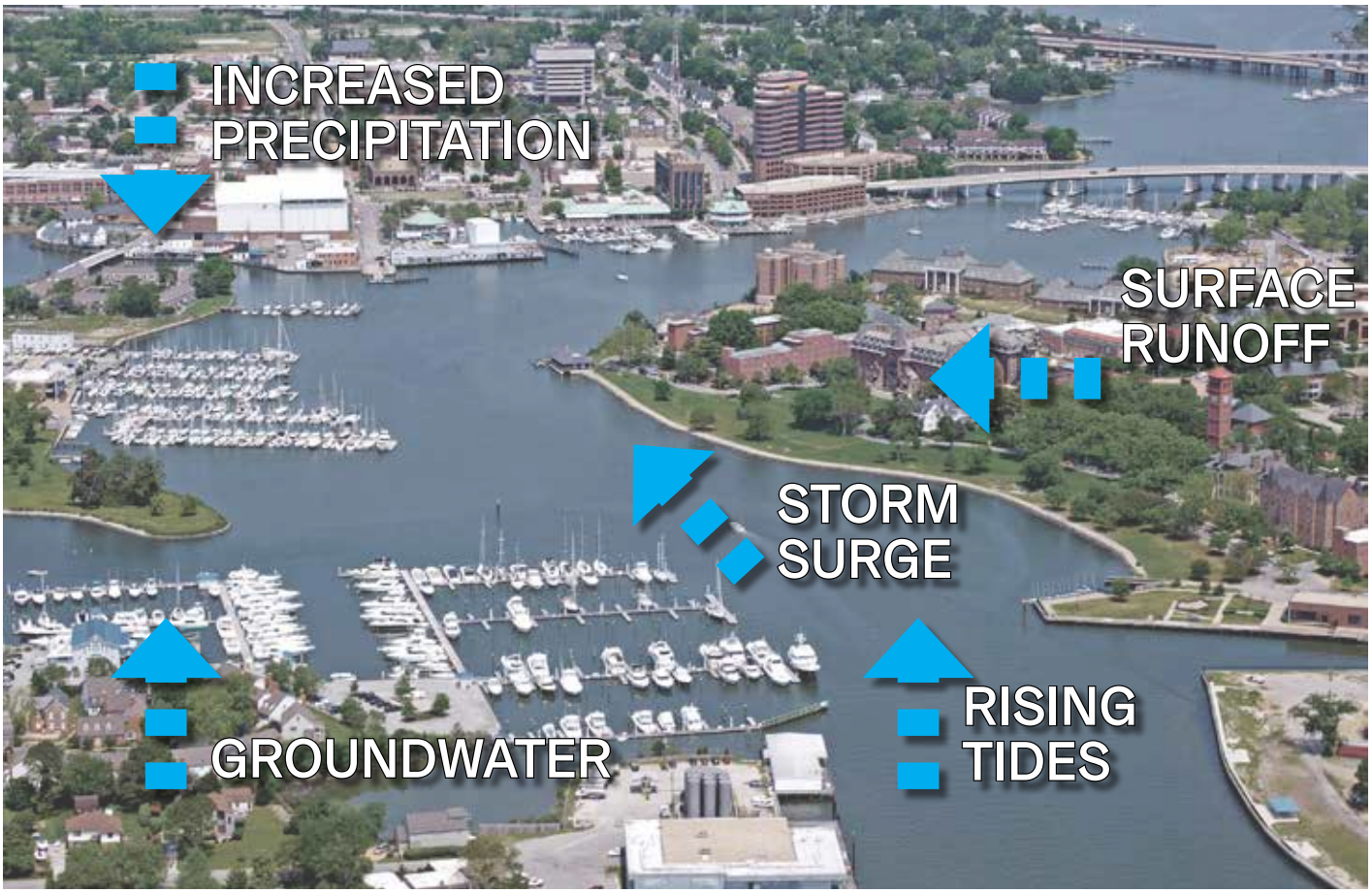
Working and Playing on the Water
Water is a driver of both income and recreation for Hampton. Buckroe Beach has been a recreation destination for over a century.

Challenges

The Hampton Roads region has been widely recognized as one of the most vulnerable areas of the country in terms of potential impacts from climate change, sea level rise, and recurring flood events. The frequency and severity of these events has become a significant threat to both the economy and quality of life in the region. Additionally, vital historical and national defense assets within the City of Hampton will be threatened over time.

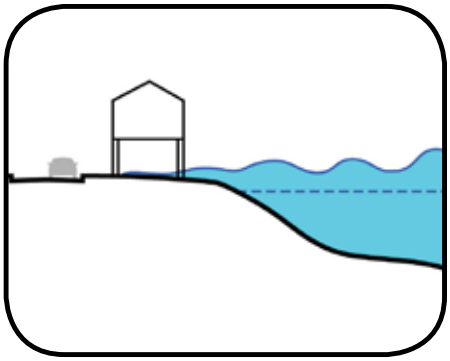
Situated at the mouth of the James River and Chesapeake Bay just before meeting the Atlantic Ocean, Hampton is surrounded by multiple forces of water: storm surge, tidal action (which also affects local rivers and creeks) , stormwater, and groundwater. Like other coastal areas, Hampton is exposed to hazards that include major storm events - such as hurricanes and nor'easters - with subsequent high winds, waves, and surges. High water levels can cause flooding as well as erosion, potentially leading to extensive damage and leaving areas more susceptible to threats from future events. Combinations of these forces of water have affected the city in different ways over time, but increasing frequency of flood events has raised concern about what should be considered the "new normal." When planning for resilience, it is critical to understand each force of water, as well as how they are interrelated.

Multiple Forces Of Water at Work in Hampton
Understanding how these complex and differing forces interact and compound is a crucial first step to addressing resiliency.



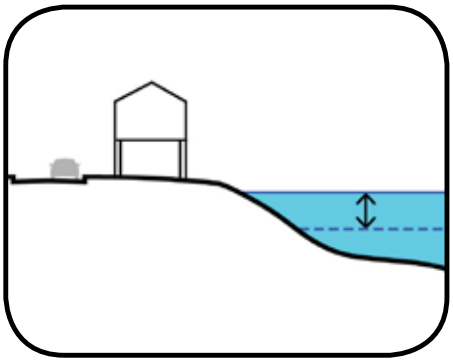
Forces of Water

Storm surge, with its accompanying wave action and high water levels, is destructive and sudden, and is different from other forces of water that threaten Hampton. As sea levels rise, higher water will bring higher waves and more flooding. Wave action against the shore will also cause greater erosion, further exacerbated by deeper waves from higher water. These higher waves and water levels will also spread inland, reaching properties that were previously above flood levels. Storms also bring high winds, which cause damage farther inland than flooding, and can affect a greater number of properties and infrastructure.



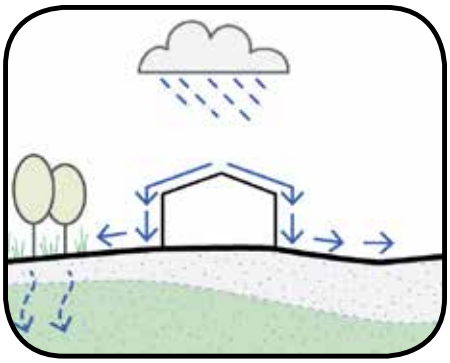
Storm Surge

Tidal action, the process of water levels fluctuating between low and high tides, is perhaps the most important influence on other forces of water. Storm surge or intense rainfall during low tide results in very different impacts compared to those events occurring when the tide is high. When storms hit during high tide, they are more intense; higher water levels bring higher waves, and water spreads farther inland. Stacking tides, or high tides that aggregate over several cycles, can occur during rainstorms or extreme events, and can cause more when stormwater has nowhere to drain. In Hampton, tidal action affects both coastal zones as well as inland areas situated close to the rivers, creeks, and inlets throughout the city. This impacts the drainage system as well. During high tide, water can backflow into drainage outfalls. In some areas of the city, this means that stormwater cannot flow out into waterways and becomes backed up. With nowhere to go, stormwater creates ponds at full catch basins, or backs up and out of manholes.



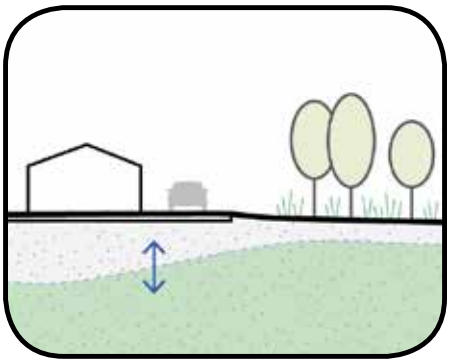
Tidal Action

Stormwater is a challenging force to manage in any city, and places stress on the existing drainage system. Some water from rainstorms is absorbed by the ground, but much of Hampton is developed or paved with surfaces that prevent water from infiltrating into the soil. This condition creates runoff, which flows across impervious surfaces such as roadways, parking lots, and roofs, and can easily overload parts of the drainage system. Even higher inland areas, while away from the coast, can face the threat of flooding if high tides prevent the discharge of stormwater into surrounding waterways.



Stormwater

Groundwater, an invisible force, impacts the subsurface foundation of the city. Much of Hampton has high, or shallow, groundwater levels, meaning the depth to the water table is only a few feet below the surface of the ground. The distance between groundwater and the ground surface is a determining factor for how much water soils can store. When seas rise, groundwater levels rise as well, creating areas that are regularly wet and cannot absorb stormwater. At the same time, impervious areas that do not allow water to infiltrate can cause subsidence, which is the gradual drying out, compaction, and sinking of hydric soils. Subsidence leads to increased flood risk as grounds continue to sink over time. Conversely, high groundwater levels, combined with poorly infiltrating soils, can prevent temporary water storage, exacerbating flooding.



Groundwater

Pollution can also result from any force of water. Stormwater runoff carries pollutants from impervious surfaces across the city, which eventually enters local waterways. Many waterways around Hampton are condemned (non-fishable), or have generally poor water quality. Furthermore, when the drainage system backs up, polluted water can enter city streets or homeowner's yards.

When flash flooding or extreme events occur, they can bring additional toxins into local water sources, such as oil and gas from flooded cars. Resilient systems - such as some green infrastructure - can help improve water quality by using plants to slow and filter stormwater runoff before it reaches waterways. This, in turn, can lead to improved conditions for water-based economies such as commercial fishing.

Effects of Forces of Water in Hampton

WAVE ACTION
STRONG WINDS DURING MAJOR EVENTS CAN RAISE THE SEA LEVEL AND CREATE STRONGER WAVE ACTION. STORM SURGE CAN OVERTOP WALLS AND ERODE SHORELINES. (IMAGE SOURCE: DAILY PRESS[10])

STORMWATER RUNOFF
JUST AS WATER FLOWS OFF THE PLASTIC SURFACE OF AN UMBRELLA, SO TOO IT FLOWS OFF OF IMPERVIOUS SURFACES SUCH AS ROOFS AND PAVED STREETS. THE MORE IMPERVIOUS SURFACE, THE MORE STORMWATER RUNOFF NEEDS TO BE MANAGED. (IMAGE SOURCE: DAILY PRESS[11])

BACKFLOW THROUGH INFRASTRUCTURE
HIGH TIDES OR COMBINATIONS OF HIGH TIDES WITH RAIN EVENTS CAN LEAD TO WATER FLOWING THE OPPOSITE DIRECTION THROUGH DRAINAGE PIPES. (IMAGE SOURCE: DAILY PRESS[10])

STANDING WATER
IN AREAS WITH HYDRIC SOILS OR WHERE THE GROUNDWATER IS CLOSE TO THE SURFACE, SATURATED SOILS DO NOT ALLOW FOR INFILTRATION OF RAINWATER. THIS CAN RESULT IN STANDING SURFACE WATER, EVEN IN PERVIOUS AREAS.

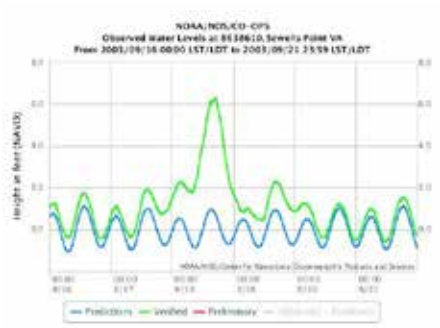
Climate Change and Relative Sea Level Rise

With climate change, sea levels are expected to rise in the ocean, bay, and rivers that encompass Hampton. Recently, storms that have affected the city have also increased in frequency and intensity. Eight of the city's eleven highest storm surges over the past 80 years have occurred during the last twenty years. Even a moderate tropical storm or nor'easter can become a major threat. Nor'easters can also last multiple tide cycles, which vastly increases the amount of high water levels, as described earlier in the stacking tides effect. Greater flooding farther inland will result.

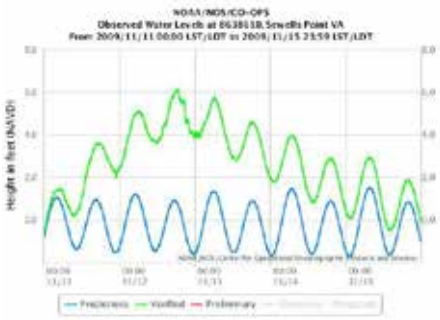
Relative sea level rise, which is rising waters combined with subsidence, poses a double threat to Hampton. Increasing water levels bring higher high tides, and subsidence results in sinking land. This accelerated risk means that flooding will reach higher elevations at a faster rate. A local example from the other side of the James River is Sewell's Point in Norfolk: this area had a relative sea level rise of 1.45 feet over the past 100 years, one of the largest documented changes in the world.

Intense rain has also occurred more frequently than in the past. Hampton has been experiencing fairly frequent 100-year flooding events, or those with a 1% chance of occurring each year. In 2016, Hurricane Matthew caused 1,000-year flooding locally, which has a 0.1% annual chance. What was once a "100-year" might, in reality, now occur once every decade. Crucial to resilient adaptation is helping the community shift to prepare for more regular and intense rain events. Hampton's citizens have been conditioned to prepare for major storm events as a fact of life for their coastal community. However, "nuisance" flooding from high tides or rain events (or a combination of the two), and the increased frequency of these events, has been more difficult for residents to adapt to and accept.

Rising seas and increasing storms will also impact ecosystems. Hampton has a range of different zones, from aquatic, to coastal edge and shoreline, as well as upland, and urban or developed. Over time, this could mean the loss of native species that provide valuable ecosystem services.

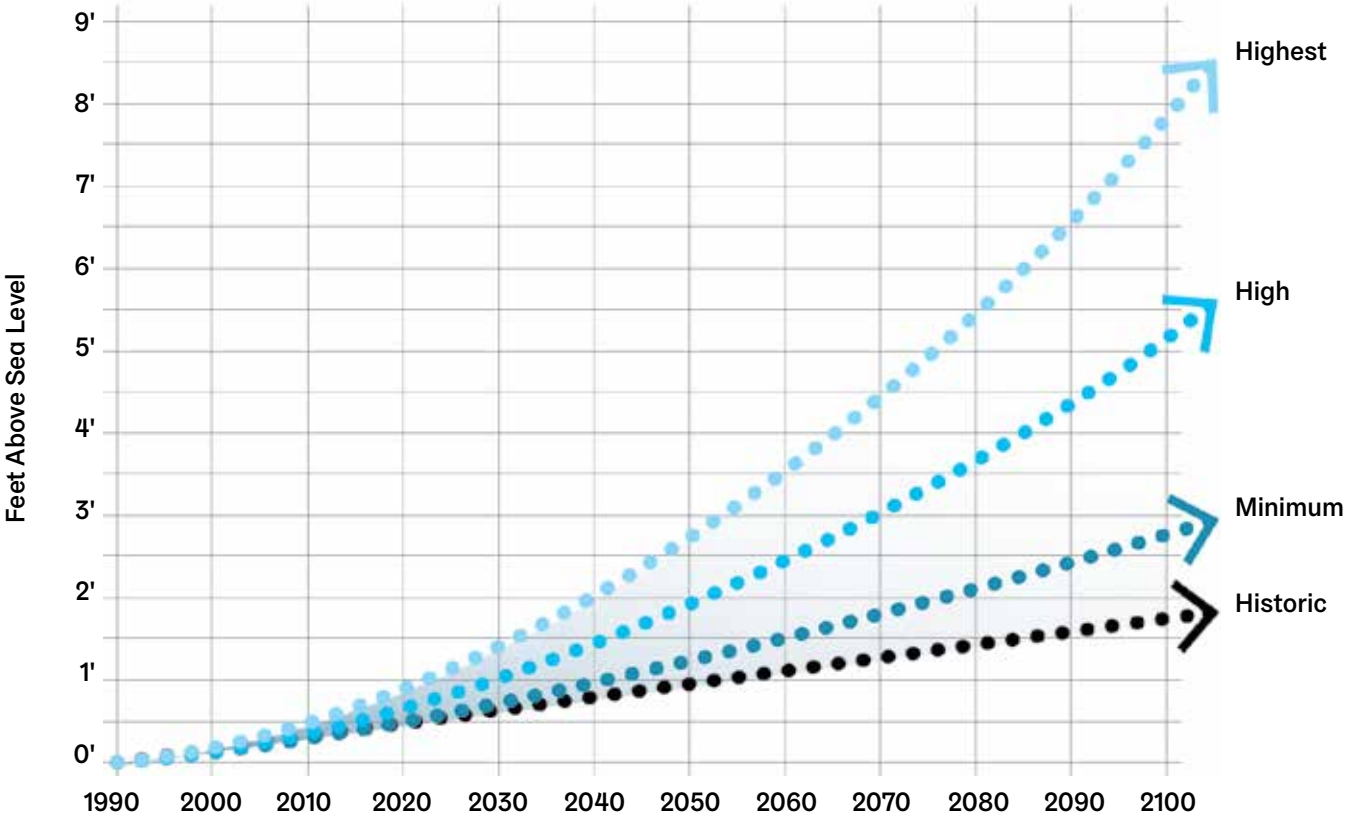


Hurricane Isabel Surge



Stacking Nor'easter Tide

Stacking tides
Comparing the data between a hurricane and a nor'reaster, one can see that the duration of a nor'easter can be much longer than the duration of a hurricane. Instead of a spike in surge - as seen during Hurricane Isabel - nor'easters last more tide cycles, with high tides building over several tide cycles. (Source: NOAA Sewell's Point Tide Gauge Norfolk)

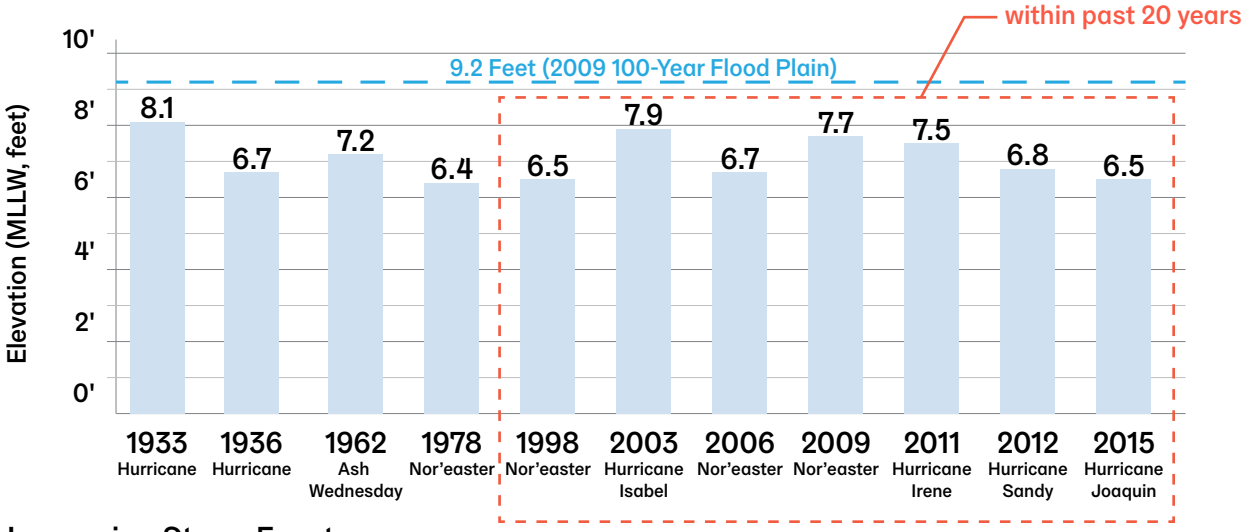


Projecting Sea Level Rise

The Virginia Institute of Marine Science has developed four scenarios of sea-level rise that also account for projected land subsidence in southeastern Virginia. The scenarios represent trajectories based on a combination of factors:

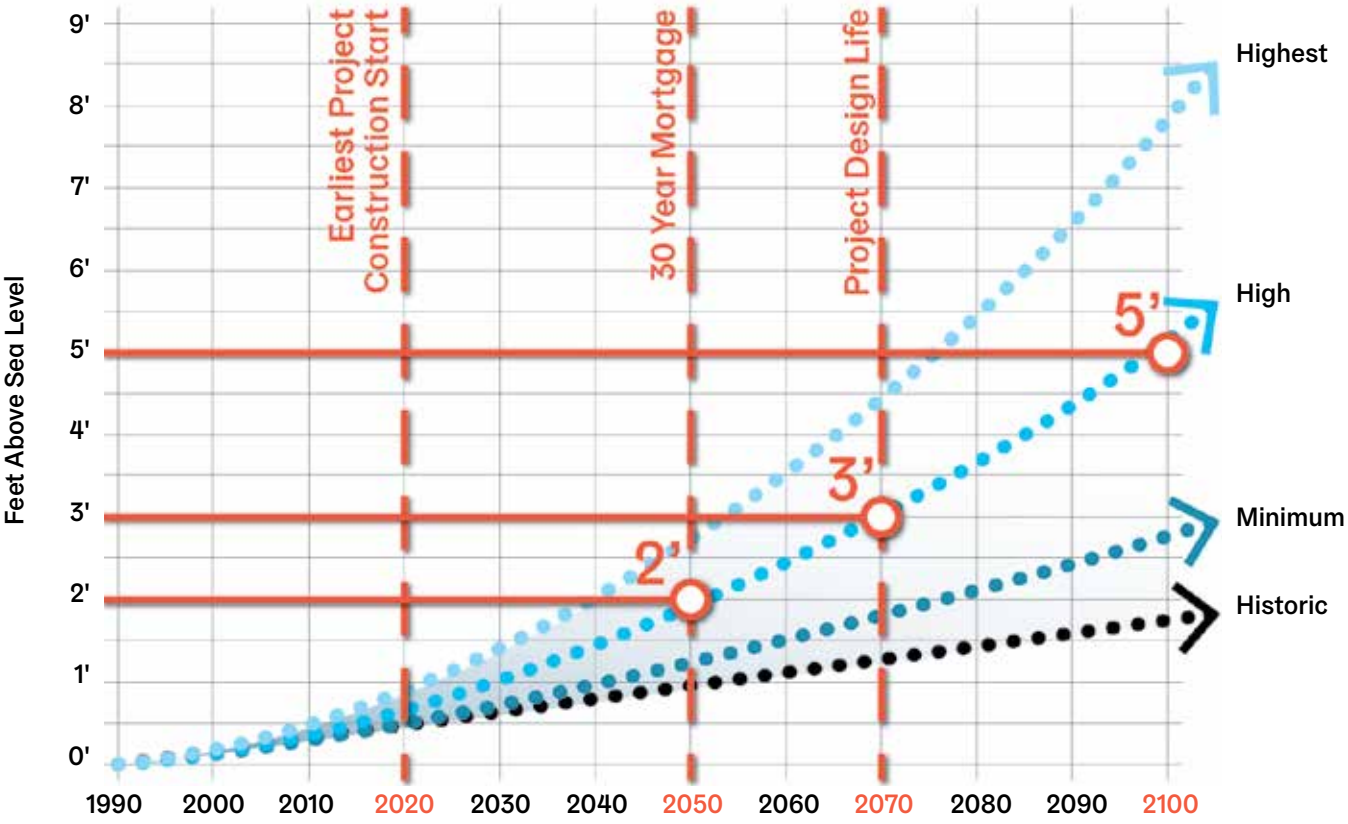
- **Historic:** Based on long-term (100 years or more) rates of sea level rise and not incorporating acceleration.
- **Low:** Based on Intergovernmental Panel on Climate Change (IPCC) model with conservative estimates of future greenhouse gas emissions.
- **High:** Based on upper-end sea level rise projections using relationships between sea level observations and air temperature.
- **Highest:** Based on maximum possible glacial melting and ice-sheet loss combined with estimated consequences of global warming.

(Source: VIMS Relative Sea Level Rise Projection for Southeast Virginia[12])



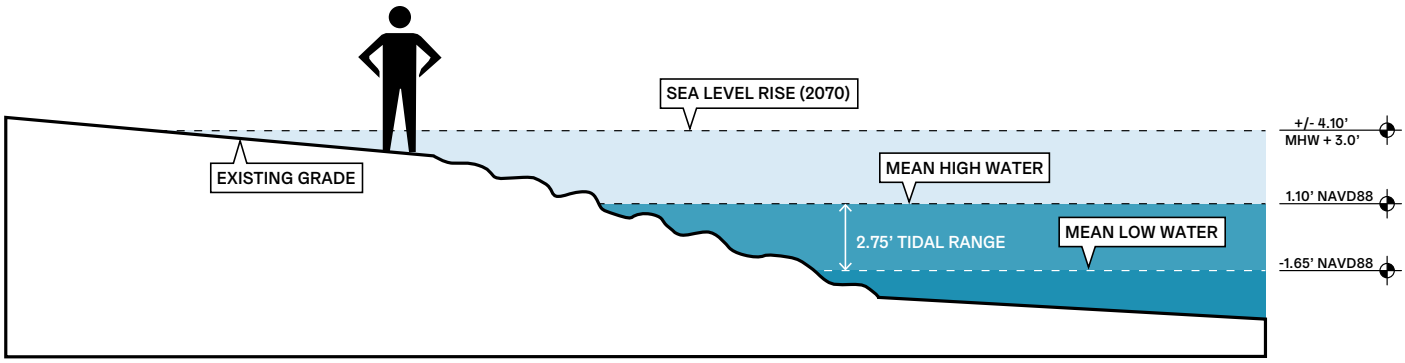
Increasing Storm Events

The graph above tracks the storm surge during major area events. Eight of the eleven highest storm surges have occurred in the last twenty years. (Source: NOAA Sewell's Point Tide Gauge Norfolk)



Planning for Sea Level Rise

While sea level rise projections have some level of variability over time, looking at the life span of a potential project relative to sea level rise can help determine the return on investment for the project. Data in this report references the "high" scenario, which accounts for upper-end sea level rise projections combined projected subsidence. (Source: VIMS Relative Sea Level Rise Projection for Southeast Virginia[12])



Designing for Future Water Levels

The diagram above illustrates the water level (Mean High Water) in 2070 with 3' of relative sea level rise, the "high" curve in the top graphs.

Design Considerations

With dynamic water systems, it is important to establish baseline data from which to project future conditions. Much of this base data is collected through monitoring of local tidal conditions. To collect data, both the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS) have installed monitoring stations in the area. NOAA maintains a station that records water levels and meteorology at Sewell's Point, just across the James River in Norfolk. NASA uses Sewell's Point data for their Flood Impact Analysis Tool, as it is the closest and most comparable coastal tide gauge for Hampton. Additionally, the USGS has tide gauges in Hampton River, Newmarket Creek, and Brick Kiln Creek to study tidal conditions farther inland. Tidal data is used to establish the tidal range, which includes an average of low and high tides.

With a range of predictions for sea level rise, many municipalities also work with consultants and researchers to establish a baseline for sea level rise. In Hampton, the "high" curve on the VIMS sea level rise projections estimates three feet of sea level rise by 2070. The diagram at the bottom of the previous page depicts how three feet of sea level rise compares to today's mean high water level.

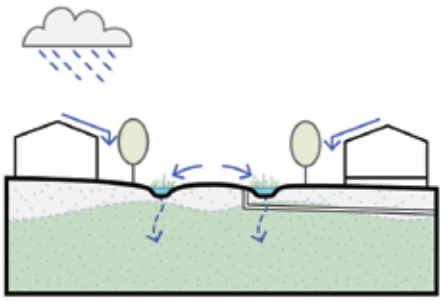
Facing the future risk of sea level rise, some areas may need to plan for permanent inundation, while others areas - which may not currently experience flooding - may become periodically inundated. By designating some zones for permanent inundation and designing others for periodic inundation, it may be possible to reduce risk to other areas in the city where even periodic inundation is unacceptable, such as Hampton.

Permanent inundation refers to areas that will be frequently flooded, with the expectation that these areas can and will stay wet most of the time. An example would be the creation of a detention pond, which could be designed with sufficient storage capacity to hold additional water during a storm.

Periodic inundation refers to areas designated or designed for occasional flooding. Designing for periodic inundation — where water would be temporarily stored in the landscape until the storm passes — requires an understanding of how the water will infiltrate into the soil, making the site dry again. In this approach, water is stored, or detained, temporarily; most of the time the site will be dry. For example, a large rain garden would hold rainfall and let it slowly infiltrate into the ground instead of going into the storm drain. Within one or two days, depending on the amount of rainfall, the water would have drained into the soil, and the site would be dry again. Then it would look like a lush landscape rather than a permanent pond. With this type of project, water must either be drained or infiltrate into the ground within 72 hours, ideally 48, to prevent mosquitoes from breeding.

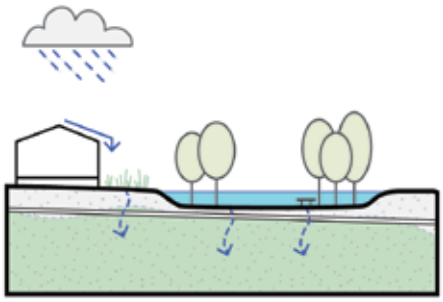
Buildings can also be designed to weather periodic inundation through either wet or dry floodproofing techniques. Wet floodproofing strategically allows water to enter the building in an area below the base flood elevation (BFE). Dry floodproofing, by contrast, includes protective measures which prevent water from entering the building. Floodproofing requirements and measures frequently tie to FEMA flood insurance rate maps which, in turn, can tie into local building codes.

Resilience strategies require a shift in the approach to water management. The current strategy of piping and draining stormwater will become less effective as sea levels rise. Methods for slowing, storing, and - when possible - discharging water can create a living water system with greater capacity for adaptation and stress absorption.



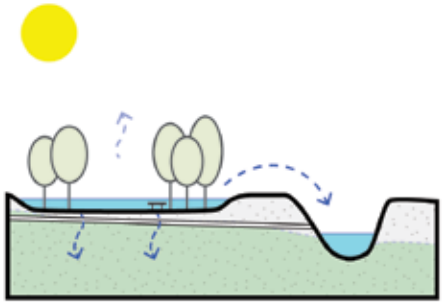
Slow

Rooftops, driveways, streets, and sidewalks can be redesigned to catch rain where it falls, and to allow some of that water to soak into the ground. A healthy urban tree canopy also slows the flow of water and improves environmental quality. Passing water slowly through plant materials (such as in bioswales) can also help clean water and improve water quality.



Store

Large-scale detention and retention features integrated into the landscape and public spaces provides additional storage capacity for both runoff and high tides. These spaces can be designed for periodic inundation and, when dry, can serve as spaces for recreation. Stored water can also be used or reused for purposes such as irrigation.

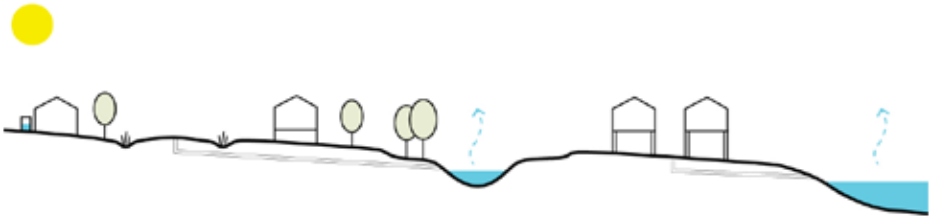


Discharge (when possible)

When rain and high tide events coincide, draining of water may not be possible because the outfall height of current pipes is below the water level. By creating places to store water, it can be safely and efficiently drained during dry weather and/or low tides.

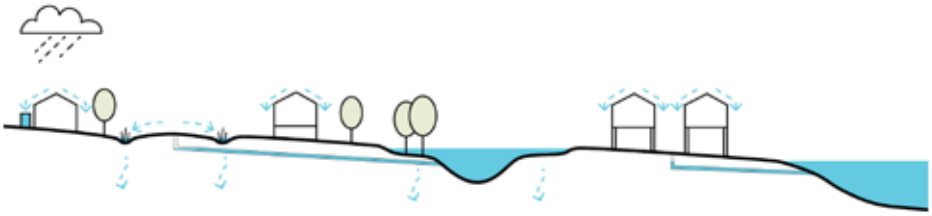
Minimum
Dry Weather, Low Tide

Dry weather and low tides allow water which was stored during storm events to discharge into local water bodies. Stored water can also be used for irrigation or to recharge groundwater during dry stretches.



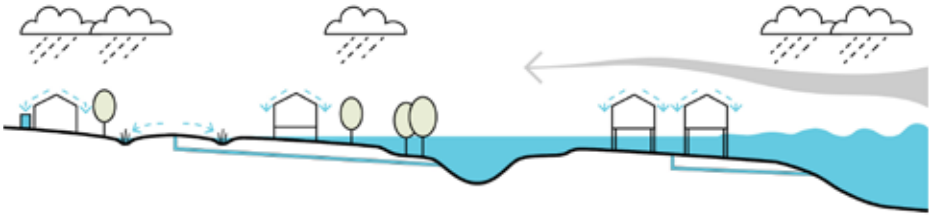
Maximum
Wet Weather, High Tide

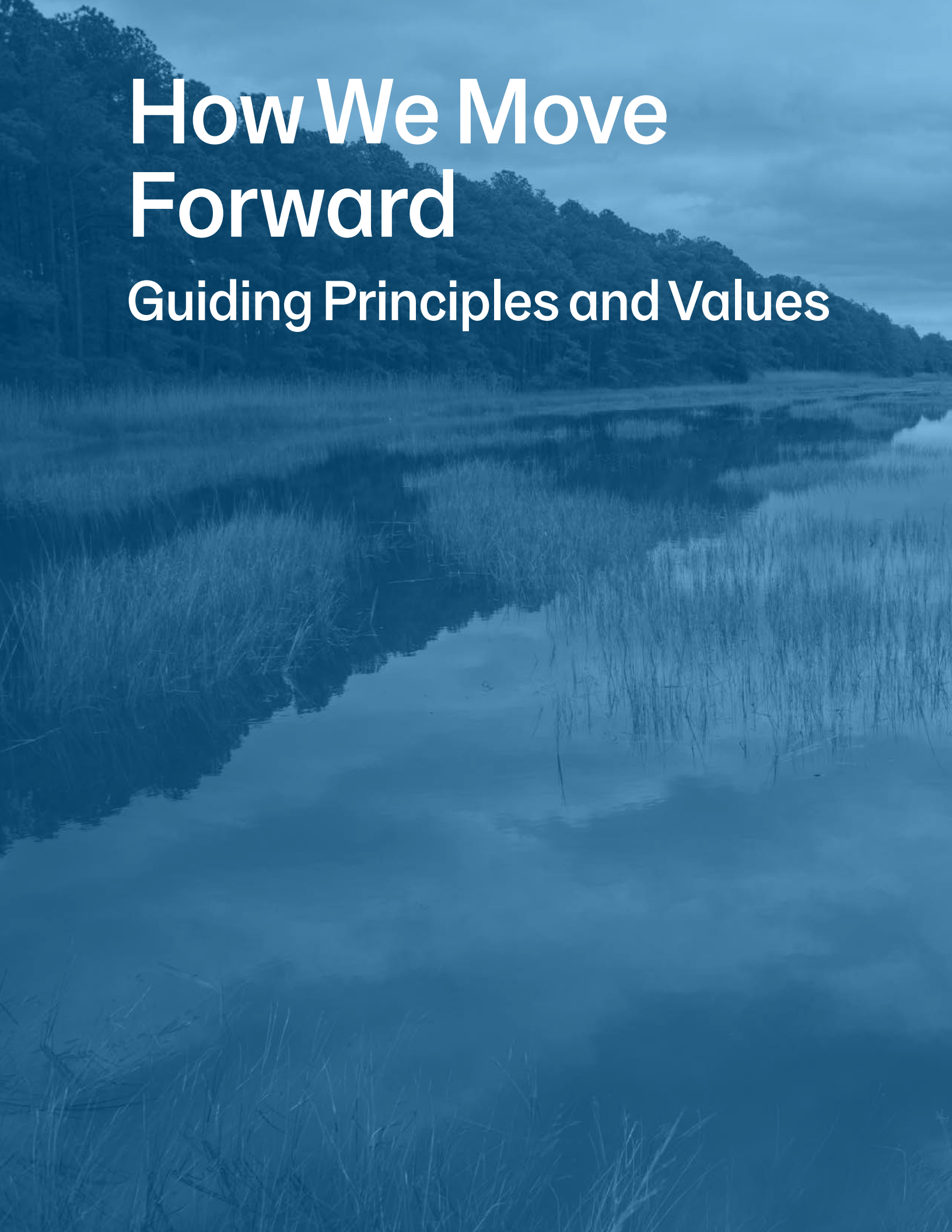
Though water may not drain during combination events, designating storage spaces for water helps put water in logical places and lessens flood damage to houses and other financial assets.



Extreme
Major Event, Storm Surge

Providing water storage areas and implementing architectural adaptations can lessen damages during large storm events. Areas that are not normally wet are allowed to flood during extreme events.





How We Move Forward

Guiding Principles and Values

Multifunctional Systems
In Foxhill, as with other low-lying areas in Hampton, marshes protect shorelines from erosion, provide habitat for wildlife, and create nature-rich environments appreciated by the area's residents.

Guiding Principles

Hampton's place-based approach is to analyze history, existing systems, and cultural influences; develop a resilience strategy using both good data and broad community inputs; illustrate a vision for a resilient Hampton; and provide a framework for implementation with short-, medium-, and long-term goals. This report is the culmination of the first phase of this work: developing city-wide goals and criteria. It provides a broad overview of the challenges facing the city and captures the values of the city's citizens and leadership. Through this initial analysis, guiding principles have been established for improving city resilience:

Create Value-Driven Solutions

Resilient solutions fit their place. Hampton is not seeking one-size-fits-all solutions, but instead solutions that reinforce the specific values of the community. Through this process and driven by input from the Hampton community and stakeholders, we have established eight primary values:

1. Safe
2. Equitable
3. Natural
4. Heritage
5. Integrated
6. Sufficient
7. Nimble
8. Innovative

The following section "Values" explains these in more detail. An evaluation tool based on these eight values, discussed in a separate document, provides a means for assessing how well potential projects respond to these criteria. The evaluation tool is intended to help analyze projects that are in the planning phase, and to determine if they would be a good fit. Once a project has been implemented, it is possible to replicate that project, or principles of that project, at other locations in Hampton — and eventually, throughout the region. However, each project should be assessed on an individual basis to ensure it is a smart fit with each specific location.

Reinforce Assets

A city of historical, educational, and military significance, Hampton has a number of existing assets. Efforts to strengthen the city's resiliency should build upon these assets, facilitating their continued operation and growth. Networks connecting people to these assets are also of prime importance. A pattern of connecting arteries and nodes of activity can be visibly read throughout Hampton's development and continues to underpin the area's urban structure. These connecting corridors and commercial centers are natural paths of travel and areas of congregation already recognized by the community and should be the basis for a resilient network.

Layered on top of these paths and centers are additional assets of economic, historic, and/or cultural value. These are the resources which bring people to the area for work, education, community, and/or recreation. The City of Hampton has defined the following urban development areas: Buckroe, Coliseum Central, Downtown, Fort Monroe, Kecoughtan Road Corridor, North King Street Corridor, and Phoebus. Fort Monroe, once an Army base, is now an asset for culture and recreation, as are Hampton Coliseum and Hampton Convention Center. Prime assets for economy and jobs include the following major employers:[13]

Alcoa Howmet, *castings, gas turbine & engine parts*
Craft Machine Works, Inc., *construction machinery*
Hampton University, *higher education*
Langley Air Force Base, *federal government*
NASA Langley Research Center, *federal government*
Measurement Specialists, Inc., *sensors*
National Institute of Aerospace, *research & development, education*
Riverside Regional Medical Centers, *medical facilities*
Science Systems and Applications, Inc., *aerospace, modeling, & simulation*
Sentara Healthcare, *medical facilities*
Hampton VA Medical Center, *medical facilities*
Sprint, *telecommunications*
Thomas Nelson Community College, *higher education*
Verizon Communications, *telecommunications*

In addition to these named assets are Hampton's network of public schools, community centers, and public safety facilities.

Layer Public Benefits

Smart investments are those which answer a number of needs and provide a good return for the investor. Projects which utilize taxpayer money need to provide a good return on investment for the Hampton community by not only reducing risk but also enhancing quality of life. Strategies should consider financial, social, and environmental factors collectively to maximize project benefits.

Strengthen Partnerships

The challenges facing Hampton are also regional challenges. As water does not know political bounds, it is imperative that adjoining municipalities work together to address systems in a holistic manner. Due to their proximity, Newport News, Poquoson, and York County are particularly critical to Hampton's future success. In 2015, at the conclusion of the Dutch Dialogues Virginia workshop, the cities of Hampton and Norfolk pledged to lead the Hampton Roads region forward toward creating vibrant and resilient places through innovative integration of flood risk mitigation, economic opportunity, planning, urban design, engineering, environmental stewardship, and quality of

life. In addition to fellow municipalities, partnerships spanning a range of key area stakeholders, universities, business community leaders, and transportation entities will be critical to the success of an integrated resilience strategy. During this work phase, the following stakeholders were identified and should be engaged as next steps in creating a resilient Hampton:

Government - State/Federal
Department of Defense
Joint Base Langley-Eustis
NASA Langley Research Center (NASA LaRC)
US Army Corps of Engineers, Norfolk District
Veterans Affairs Medical Center (VAMC)
Virginia Silver Jackets

Government - County / Municipality
Chesapeake
Gloucester County
Isle of Wight County
James City County
Mathews County
Newport News
Norfolk
Poquoson
Portsmouth
Suffolk
Williamsburg
Virginia Beach
York County

Regional Partners
Hampton Roads Planning District Commission (HRPDC)
Hampton Roads Sanitation District
Hampton Roads Transit (HRT)
Virginia Department of Transportation (VDOT)
Virginia Port Authority

Institution / Education / NGO
The College of William & Mary
Commonwealth Center for Recurrent Flooding Resiliency
Hampton University
Old Dominion University
Thomas Nelson Community College
Virginia Coastal Policy Center
Virginia Tech
Virginia Institute of Marine Science (VIMS)
Wetlands Watch

Business Community
Coliseum Central Business Improvement District
Downtown Hampton Development Partnership (DHDP)
Partnership for a New Phoebus
Peninsula Housing and Builders Association
Virginia Peninsula Association of Realtors
Virginia Peninsula Chamber of Commerce

Use Best Data

With an abundance of local universities, water-focused institutes and not-for-profits, and governmental resources like NASA Langley Research Center, Hampton has access to some of the country's most cutting-edge geological, flooding, and climate data. Data collection is an iterative process, updated and revised as new inputs are collected and analyzed. Strategies should be informed by the best and most current data available. Each project should be better than the last, building upon newer data as well as monitoring and analysis of how similar projects and systems have performed over time. Where possible, projects should integrate means of data collection and monitoring – such as tide gauges, groundwater monitoring, or testing of water quality - to enhance the pool of available resources. With many monitoring systems already in place or under development, Hampton has the advantage of a solid foundation on which to continue to build good data.

Post-disaster data collection methods and findings could be revisited with a particular focus on presidentially declared disasters; for example, reevaluating data collected by a damage assessment team after Hurricane Matthew. Methods should be modified to position the City to pass data-driven thresholds associated with HUD's CDBG-DR resilience grant competitions.

For a list of relevant data sources, including projects, studies, and organizations in Hampton and throughout coastal Virginia, see the "Additional Resources" section in the Appendix.

Share Knowledge and Resources

The City of Hampton is committed to leading the Hampton Roads region's efforts to improve resilience and create stronger, more vibrant places to live, work, and recreate. Networks of water, transportation, industry, and people create an interdependency between the cities in Hampton Roads, making the region only as strong as its weakest link. Further, adaptations on an infrastructure scale would require the buy-in of adjoining cities and regional commissions. Therefore, the sharing of knowledge and resources between stakeholders and municipalities is essential for advancing the region together. A collaborative feedback loop between municipalities could continue to build better knowledge and resources for future projects and also share solutions that may be replicable on a regional scale.

Values

The eight values enumerated below are the fundamental beliefs that guide this effort. They have been established by a community-driven process and, while certain criteria are applicable to a broader area, they are specific to the City of Hampton. Several attributes help further describe and define each value. These values and attributes are the basis of the evaluation tool described later in this document. Below is a summary of each value:

1. Safe

Reducing risk during major events and creating safe, reliable systems.

The City of Hampton needs to demonstrate current and prospective residents, industries, and employers that it has a strategy for addressing climate challenges. A safe community with reduced risk is the primary value for Hampton's future. The process of becoming a safer, more resilient place with lowered risk depends on a range of factors. Major elements – or attributes – of safety and risk reduction include options for creating egress routes; reliable utility systems such as power, energy, and water supply; better protection of critical infrastructure; resilient adaptation in the floodplain; and making structures storm-resistant. However, reduced risk is only one facet of resilience. Improved safety must be balanced with quality of life for both humans and the environment.

2. Equitable

Prioritizing strategies that create benefits for all, and strengthening marginalized sectors of the community.

Related to safety, the value of equity prioritizes strategies that create benefits for all. The intent of resilience planning is to provide benefits for as many people as possible, and specifically strengthen marginalized sectors of the community. In Hampton, as in cities across the world, certain communities disproportionately face more challenges than others, whether through environmental risks such as flooding or pollution, or through socioeconomic factors such as lack of services or investment. Attributes to improve equity include being a good, responsible neighbor; encouraging citizen involvement; creating wider access to project benefits; and improving social justice.

3. Natural

Repairing and protecting natural systems in order to sustain them for the future.

Hampton has both been shaped by and helped shape natural systems. The city is strategically located in a natural harbor to take advantage of both coastal proximity and inland connections. This location provided historic access to aquaculture and water-based transportation while being protected by coastal edges that served as storm buffers. However, over time, some of these assets have been degraded, depleted, or polluted. The valuing of nature aims to help repair and renew natural systems in order to both sustain them for the future and to restore the protection they once offered. Attributes to enhance nature

include promoting nature-based solutions over conventional engineering; reducing stormwater runoff; improving water quality; reducing greenhouse gas emissions; creating ecological benefits through native vegetation and landscape types; and restoring natural systems.

4. Heritage

Appreciating the history and culture of local communities and supporting it into the future.

In Hampton, valuing heritage means appreciating the history and traditions that have developed over time as a result of the local landscape, waterways, and people. The city was built around and on the water. That connection, though adapted through time, remains today. Physical examples of unique local heritage and culture should also be preserved and supported into the future. Attributes include prioritizing historic and cultural resources; building upon Hampton's legacy; respecting the social and cultural character of neighborhoods; and reinforcing the local culture of water.

5. Integrated

Connecting systems in strategic ways to yield multiple benefits.

Integration and connection of different systems, benefits, and participants leads to a more holistic result that addresses a range of values and creates strategies with multiple benefits. With 124 miles of waterfront property, including several major rivers and creeks crossing through the city, water is already an integral part of Hampton's character. This value reinforces the idea of connecting systems in effective and strategic ways to yield the greatest amount of benefits. Attributes include achieving benefits beyond the main purpose of the project; collaborating across disciplines and sectors; and creating well-informed strategies by using the best data and information available.

6. Sufficient

Leveraging public investment to support the local economy and jobs, and being fiscally responsible with city funds.

Similar in some ways to equity, the value of sufficiency aims to leverage public investment to improve the financial health of residents while using funding in the most effective and beneficial manner. Resilience projects are an opportunity to create a greater return on investment by securing livelihoods while also developing new industries, creating jobs, and strengthening the local economy. Attributes to achieve better economic sufficiency include supporting livelihoods of residents by creating access to existing employment and creating new job opportunities; improving property values through reduced risk; influencing a rise in median income through higher paying job opportunities; implementing fiscally responsible strategies; and being more sustainable by reducing resource consumption.

7. Nimble

Being able to adapt in the face of changing environments, improved data, and new best practices.

The value of nimbleness - or flexibility and adaptability - is central to developing strategies that can accommodate changing conditions in Hampton. Over time, critical factors – including physical, social, and/or environmental aspects – may change, and prediction tools and models will constantly adapt with updated data. To be successful, strategies must be able to accommodate adjustment over time. Attributes include the ability to be implemented; adaptability to adjust purpose or use; consideration of all scales; development through an iterative process that accommodates multiple and varied inputs; and the ability to be replicated at a range of scales and conditions.

8. Innovative

Creating forward-thinking solutions.

Hampton has long been a place of innovation, from Hampton University to NASA and Langley Air Force Base. This forward-thinking attitude and creativity should also be applied to the climate-based challenges the city faces. To innovate is to think broadly about possibilities and to create new models. Hampton should become a model city for its regional neighbors in Virginia and along the coast, as well as for itself. Attributes include exceeding standards and – in turn – raising them; thinking of project life cycle in terms of maintenance, operations, and adaptability; and addressing specific local needs.

These values should shape Hampton's resilience strategies to create local solutions to place-specific challenges. These strategies could take the form of built projects, but they may also be changes in policy, education, communication, and/or operations and maintenance of existing assets.

Big Ideas

Goals

Space for Water
Wider sections of Newmarket Creek allow for increased water storage during storm events and also provide wildlife habitat through rich, marshy areas filled with native vegetation.

Goal Statements

RH1. Hampton will address the challenge of sea level rise and resiliency in a holistic manner founded upon the best science and data available, our own set of community values, and an appreciation for the uniqueness of each place.

The environment which surrounds us and influences our everyday lives is changing at a rapid pace in very significant ways. These changes and the pace of change are now our "new normal." Hampton is committed to understanding and addressing the implications of threats such as sea level rise and climate change through a broad, holistic approach. Key elements of this approach include good data and science as well as being firmly grounded in who we are as a community of people. This "human element" necessitates an understanding of what we value and what makes Hampton a special place with a compelling and unique national story. Our approach must be multi-dimensional in order to generate solutions that create multiple public benefits which result in enhancements to our economic and environmental vitality and overall quality of life.

RH2. Hampton will embrace the belief that a successful resiliency initiative will enhance quality of life for our citizens and create a more robust and vibrant economy and environment.

The Netherlands has been dealing with water issues for centuries and has proven that smart, effective, and sustained actions can lead to success. The pessimistic outlook often captured by the media should not be viewed as a fait accompli. Hampton and the region can become an even more vibrant and desirable coastal community with a superior quality of life and a bustling economy by demonstrating that resilient and environmentally smart decisions can be a stimulus for economic growth and prosperity.

RH3. Hampton's resiliency initiatives shall be "nimble," "adaptive," and accountable.

Upon City Council's approval of our overall resiliency goals, we will adopt targeted benchmarks so we are able to have clear short-term, measurable objectives. These shorter term objectives will allow us to clearly identify successes as well as areas in which we may have fallen short. This regular "evaluation" also encourages us to review and reassess the effectiveness of our strategies at regular intervals. This process should allow us to adjust quickly as conditions change so that we achieve the best results for our community. Hampton will also encourage the region to adopt similar targets that apply to regional objectives and strategies to help reinforce the importance of broader regional approaches to these challenges.

RH4. Hampton will adopt higher "resiliency standards" with respect to new public projects. Adaptation of existing infrastructure will be designed and implemented to improve resiliency rather than replicate the status quo.

Moving forward, Hampton will prioritize designing and constructing a wide range of public improvements that are resilient and adaptive to future conditions such as sea level rise and other risks. Public improvements will be evaluated using the "evaluation tool" and will be designed using parameters and projections based upon the useful life of the improvement. Adaptation of existing infrastructure and/or public facilities will be designed and implemented to improve resiliency rather than replicate the status quo. For example, if a road critical for safe egress is to be constructed or improved, it must be designed to account for sea level rise over the anticipated life span of that improvement rather than being designed based upon current minimum design standards.

RH5. Enhancing our response to sea level rise and resiliency shall be addressed at multiple scales: regional, city-wide, neighborhood, and individual parcel.

One of the messages we heard repeatedly during our community outreach sessions was to not just focus on the big, expensive projects that might take years to implement. We also heard a clear preference for "action." As a result, our efforts should focus on many scales of strategies and actions ranging from the large, multi-million dollar projects that may take years to implement actions that can occur quickly and may best be described as the "cumulative effect of many small, coordinated actions." This goal also implies that the City of Hampton cannot accomplish its objectives alone. The City will need the assistance of a wide range of partners at the state, federal, regional, and individual citizen levels in order to be successful. Each of these important partners must embrace their own role and responsibility.

RH6. All elements of our community (local government, business, citizens, not-for-profits, faith-based, educational institutions etc.) will become keenly aware and highly educated with respect to the challenges we face and the contributions they can make to address sea level rise and other related risks.

In order for our community partners to be active and effective in reaching our goals, Hampton must take the lead in providing an effective outreach and education program. This effort should provide timely and accurate information with respect to the science behind sea level rise, climate change and how this data translates to everyday experiences and threats. In addition, outreach and education should focus on what our partners can do to contribute toward reaching our goals as well as how they can become more resilient partners in our community. This effort need not be exclusively a local government initiative. Hampton should seek out local and regional partners to undertake and execute this goal.

RH7. In order to reach our goal of becoming a resilient city, Hampton must embrace a new way of doing business – an approach which adopts the guiding principles articulated in this document.

Living effectively with water will require a paradigm shift in terms of how we do business. In order to guide this transformation, six guiding principles are outlined as being foundations for our success. The six guiding principles are: (1) Create solutions driven by our values ; (2) Reinforce assets; (3) Layer public benefits; (4) Strengthen partnerships; (5) Use good data; and (6) Share our knowledge and resources. For example, an important function of local government is the regulatory role which serves to protect the health, safety, and welfare of the public through a broad array of regulations. Adapting more effectively to long-term sea level rise and other threats made more severe by climate change will require a comprehensive review of many existing codes and ordinances. Specifically, those codes and ordinances that regulate land use, building codes as well as other city and private operations should be reviewed through this new lens. One objective of this review should be to advocate to both local and state policy makers the adoption of codes, ordinance, and authorities that recognize and support reasonable regulatory actions which promote risk reduction, sustainability, and resiliency.

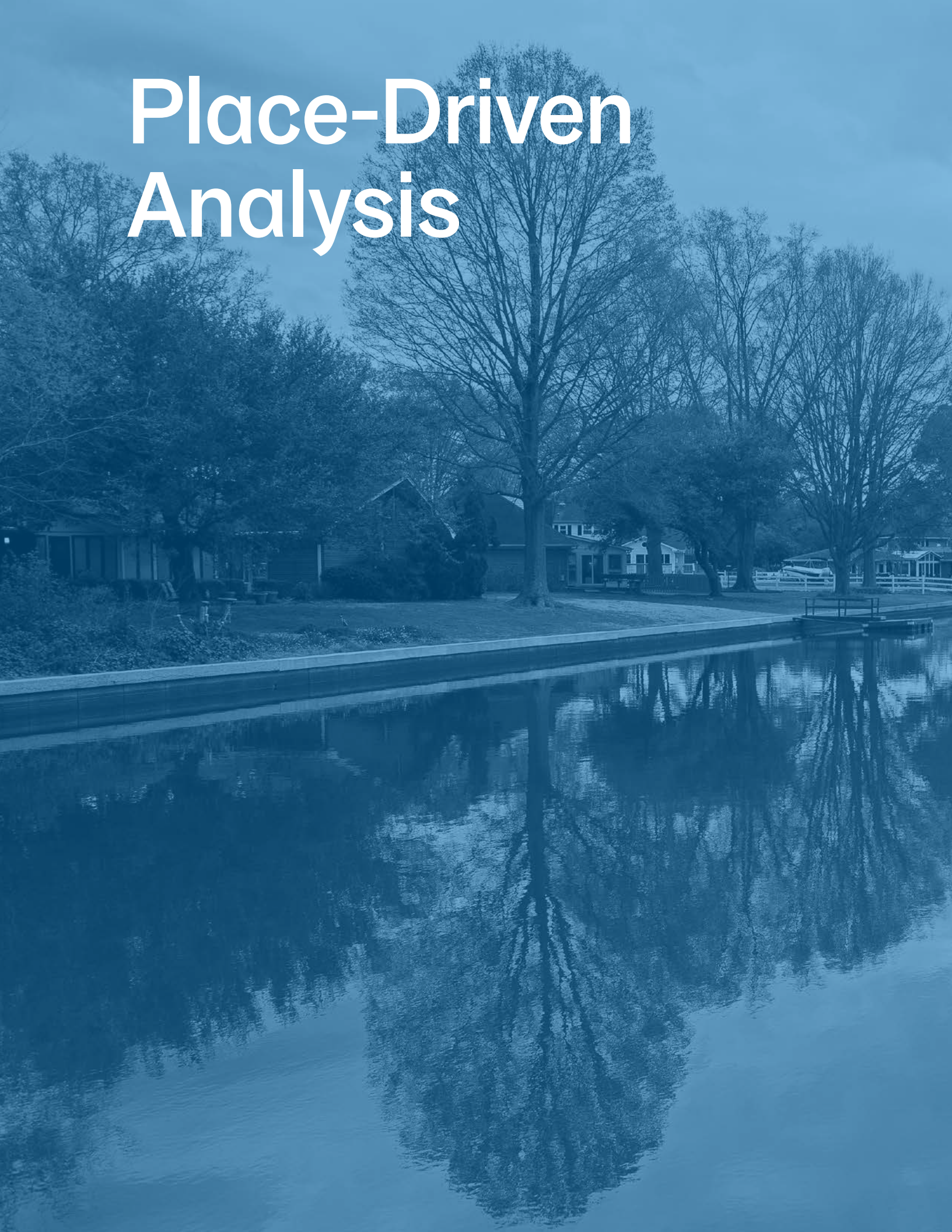
RH8. Hampton will assume a leadership role in making our region a shining example of how to adapt and prosper when faced with the challenges brought on by sea level rise and other impacts of global climate change.

It is an important fundamental value to Hampton that we pursue strategies and solutions at multiple scales. Ultimately, we will not be as effective as we might aspire to be without solutions that extend beyond our city limits. Collectively we should seek out collaborative, innovative solutions and strategies that provide benefits to the entire region. Of critical importance is our role as an active and supportive partner as the Hampton Roads region embarks on the journey to be a resilient region. Hampton should champion progressive change at both the regional and state level in recognition of the critical importance our region plays in the Commonwealth and the country. This region represents an important piece of the country's history, critical national defense assets, as well as significant economic, environmental, and cultural resources. Protection of these key assets will have far-reaching positive affects well beyond the region's borders. We should also recognize that localities have limited resources; our work should try to be as transferable as possible so other localities may benefit from our efforts, solutions, and lessons learned.

RH9. Hampton will develop and utilize an "evaluation tool" as a guide to assist in making the best possible decisions with respect to how community investments enhance our resiliency and respond to our identified community values.

To become the resilient city we aspire to be will require a different approach to making decisions. In order to help guide us and to reinforce this new way of thinking, Hampton will develop and adopt an "evaluation tool" that will be applied to most major investment decisions. While the methodology embedded in the tool may be generally applicable to other communities, our Hampton-specific version will be "tuned" to reflect our local values and parameters. The "tool" will not necessarily generate the definitive answer, but it will provide useful information and context as to how particular investments or policy decisions may "score" relative to the values and goals identified as most important to our community.

Place-Driven Analysis



Living With Water
Houses along Hampton River in the Elizabeth Lakes neighborhood address both their street frontage and water frontage, embracing the water as an asset.

Place-Driven Analysis

The analysis and strategies laid out in the following chapter are the culmination of a series of public workshops and stakeholder meetings. Four public workshops, each addressing a specific area of the city, opened with a brief presentation followed by a table activity aimed at capturing citizen observations, concerns, and proposed solutions. Attendees were asked the following:

- Tell us about flooding events you are experiencing.
- Of these events, what are the most important to address?
- Brainstorm possible actions for these priorities.

In addition to the public workshops, the team consulted city council members and local stakeholders to gather information on risks, current and planned adaptation activities, and available data. Stakeholders involved in the study included representatives from Hampton Roads Planning District Commission, Newport News, Gloucester County, Langley Air Force Base, NASA, Department of Defense, U.S. Army Corps of Engineers - Norfolk District, the City of Hampton Federal Facilities liaison, Ft. Monroe Authority, Veterans Affairs Medical Center, Partnership for a New Phoebus, Hampton University, Old Dominion University, Thomas Nelson Community College, Virginia Institute of Marine Science, and Wetlands Watch. The collected information from these sources has been distilled into city-wide strategies and also location-specific conditions.

City-Wide Strategies

Actions to address resiliency can take a number of forms, from new zoning ordinances, to homeowner adaptations, to training for green infrastructure maintenance. In addition to physical, or structural, adaptations, two of the most frequent themes from the community meetings were land use and maintenance. To cover a broad range of actions, the city-wide strategies are divided into four overarching categories:

Policy
Education & Communication
Physical
Operations & Maintenance

To create a holistic resilience plan, these strategies from each of these categories will need to overlap and correspond.

Opposite:
Citizens use maps to identify areas at risk and discuss potential actions to address those concerns.

City-Wide Strategies

Case Study

CITY OF NEW ORLEANS COMPREHENSIVE ZONING ORDINANCE ARTICLE 23

IN 2015, THE CITY OF NEW ORLEANS ADOPTED A NEW COMPREHENSIVE ZONING ORDINANCE (CZO). ARTICLE 23 OF THE NEW CZO ADDRESSES STORMWATER MANAGEMENT, WITH THE INTENT OF INCREASING SUSTAINABILITY, REDUCING RUNOFF, INCREASING WATER CONSERVATION, AND REDUCING THE URBAN HEAT ISLAND EFFECT. THE NEW CZO REQUIREMENTS STRONGLY ENCOURAGE IMPLEMENTATION OF GREEN INFRASTRUCTURE AS A MEANS OF MANAGING STORMWATER BY REQUIRING A PLAN TO RETAIN, DETAIN, AND FILTER THE FIRST 1.25" OF STORMWATER DURING EACH RAIN EVENT. READ MORE AT HTTP://NOLA.GOV/CITY/STORMWATER.

BELOW: THE GREATER NEW ORLEANS FOUNDATION HEADQUARTERS, BUILT TO COMPLY WITH THE NEW CZO, FEATURES A COURTYARD WITH MULTIPLE WATER MANAGEMENT SYSTEMS INCLUDING RAIN GARDENS, UNDERGROUND CISTERNS, PERMEABLE PAVING, NATIVE PLANTINGS, AND A PERMEABLE ASPHALT PARKING LOT.

Policy

Resilience strategies reflect a broader range of actions than physical, built solutions. Much of the feedback collected during this phase centered on topics of land use/zoning, building codes, insurance, and incentivization of resilient solutions. These topics, often referred to as "non-structural," could be manifested in the form of new policies, zoning ordinances, or funding mechanisms. In a city that values independence and a self-starting attitude, increasing regulation should be balanced with developing incentives for individual actions to create a paradigm shift around climate and living with water.

One of the most prominent policy-related themes heard throughout the process was land use and, specifically, designating space for water storage. Though this is a physical solution, its implementation relies largely on policies that either incentivize or enforce the creation of such space. Patterns of flooding frequently align with historic waterways that have since been infilled and where development has encroached on the edges of shorelines, rivers, and creeks. Providing space for existing waterways to expand during heavy rains or storm events can be achieved in a number of ways, including architectural adaptation of existing structures.

Also contained under the realm of policy is the formation of partnerships. Partnerships with adjoining municipalities are crucial to solving water-based challenges. A prime example is Newmarket Creek, which runs through both Hampton and Newport News. Hampton-exclusive policies that address the creek will remain less effective if not coordinated with Newport News. Similarly, coordination between the City of Hampton and local landowners will be required to address coastal, tidal, and stormwater-related challenges as they affect private property.

Potential solutions to address policy-based needs include:

- Modify zoning and future land use policies to prioritize space for water (eg. retention / detention ponds, etc.).
- Modify zoning and future land use policies to protect certain sensitive or flood-prone areas from non-sensitive development.
- Modify zoning ordinance to limit impervious development or specify stricter on-site water management requirements.
- Expand existing water management policies to address on-site water treatment to improve water quality.
- Modify or expand building codes to encourage adaptation and/or floodproofing measures in new construction and renovation.
- Modify or make exceptions to building codes and regulations to allow/facilitate graywater reuse.
- Examine possibility of using FEMA funds or other grants to demolish slab-on-grade homes and replace with more climate-appropriate architectural solutions (eg. raised houses, etc.).
- Promote/incentivize parcel-level adaptations that reduce flood risk and potential loss (eg. elevate home, elevate mechanical equipment, etc.)
- Promote/incentivize parcel-level adaptations and improvements that reduce runoff (eg. rain gardens, cisterns, etc.).
- Promote/incentivize water-based assets (eg. marinas) to improve recreational opportunities and bolster economy.
- Promote/incubate trades and industries focused on resilience work (eg. elevating houses or relocating HVAC equipment, maintaining green infrastructure, native landscaping, etc.).
- Promote/incentivize educational and recreational opportunities that teach the importance of environment and habitat preservation.
- Partner with adjoining and regional municipalities to create consistent policy on water management.
- Work with landowners and neighborhood associations to create consensus around installation, operation, and maintenance of infrastructure and shoreline stabilization on private property.

Case Study

RESILIENT BRIDGEPORT

INTEGRAL TO THE DESIGN PROCESS FOR A CITY RESILIENCE PLAN, THE DESIGN TEAM HELD REGULAR WORKSHOPS, MEETINGS, AND LECTURES WITH LOCAL STAKEHOLDERS AND COMMUNITY MEMBERS. EVENT PARTICIPANTS WERE ENCOURAGED TO ASK QUESTIONS AND SHARE THEIR THOUGHTS THROUGH INTERACTIVE ACTIVITIES, SUCH AS BUILDING SURGE ALIGNMENTS ON A TOPOGRAPHY MODEL, AND DESIGNING AND DRAWING THEIR IDEAL PARK ON LARGE PLANS.

EDUCATION HELPS RESIDENTS STAY INFORMED OF THE LATEST IDEAS ON SEA LEVEL RISE AND CLIMATE CHANGE IN ORDER TO MAKE INFORMED COMMENTS ON THE DESIGN. DURING THE WORKSHOPS, THE DESIGN TEAM AND COMMUNITY MADE DECISIONS TOGETHER TO COLLECTIVELY AND ACTIVELY MOVE THE PROCESS FORWARD.

TOP: LOCAL RESIDENTS COLLABORATIVELY DEVELOPING DESIGN IDEAS FOR A STORMWATER PARK IN THEIR NEIGHBORHOOD DURING A PUBLIC EVENT IN APRIL 2017.

BOTTOM: FAMILIES PARTICIPATING IN THE SAME EVENT, TAILORED TO CHILDREN.

Education & Communication

Hampton has the advantage of already having many resources available for its use when it comes to predicting storm impacts and longer-term climate change. Many organizations have already begun to collect resources online, creating a widely-available database of information and tools. However, as Hampton is a city with a large volume of military personnel, a portion of its citizenry has a relatively high turn-over rate, and those citizens may be less familiar with tidal action, large storm events, and heavy rains. Furthermore, the City should be able to convey to potential citizens and investors how it plans to use investment to reduce risk and increase quality of life.

A common theme heard throughout the process was "helping citizens help themselves." This can include information sessions or assistance in applying for flood insurance, educational materials or seminars on parcel-level improvements to create and maintain a more resilient home, or providing information on how to prepare for storm events (eg. purchasing groceries, sandbagging, moving cars, etc.). Incentivizing community involvement by getting the community creatively involved in the process can also strengthen a sense of responsibility and shared interest.

Transparency on the decision-making process for new projects - or why certain projects are not pursued - and maintenance of existing infrastructure is also important to Hampton's citizens. With multiple forces of water at work in Hampton (tidal, stormwater, storm surge, groundwater, or combinations of these), clear communication on the root cause of flooding is key. Some solutions may prevent one flooding threat while increasing another, or transferring the problem to another area. Clear and consistent communication will allow citizens and their representatives to create smarter, place-based solutions to local risks.

Potential solutions to address education and communication-based needs include:

- Work with governmental and educational institutions to create a public repository for climate and flood data.
- Empower citizens to adapt and maintain personal property by providing information and educational materials about the benefits, processes, and costs of such systems (eg. raising homes, elevating HVAC equipment, filling in basements, etc.).
- Inform citizens on benefits of purchasing flood insurance and provide opportunities for advice/assistance for citizens to acquire flood insurance.
- Inform citizens of best practices for improving water quality (eg. removing septic systems in favor of tying into city sewer) and filtering stormwater before releasing it into waterways. Empower citizens to report violations of pollution policies to the City.
- Educate citizens on how to prepare for storms and flooding and improve systems for communicating when storms are approaching.
- Designate and signify central evacuation sites in neighborhoods and communicate the conditions in which such sites would be used.
- Increase public notification for outreach events by posting notifications in frequented areas (eg. libraries, community centers, grocery stores, and churches or sending fliers home with schoolchildren) or using social media and websites (eg. Nextdoor.com, etc.).
- Provide opportunities for citizens unable to attend community events to receive information at a separate time (eg. record meetings and replay them on City's television channel, post information on city website, etc.).
- Form citizen steering committees to provide feedback and direction on new city policies and projects.
- Clearly communicate the plan and schedule for maintaining current stormwater infrastructure (cleaning storm drains, ditches, etc.). Consider implications of operations and maintenance when evaluating potential future projects.
- Provide clear communication on citizen responsibility for property maintenance (eg. cleaning ditches) and promote/facilitate neighborhood events around citizen maintenance (eg. neighborhood catch basin cleaning days).
- Educate citizens about the location of the Chesapeake Bay buffer and its importance to shoreline and habitat protection.

Case Study

ROTTERDAM WESTERSINGEL

THE WESTERSINGEL IS A FAMOUS CANAL IN ROTTERDAM THAT FUNCTIONS AS BOTH A WATER MANAGEMENT FEATURE AND A RECREATIONAL PARK. THE CANAL IS DESIGNED WITH OPEN PARK SPACE ON EITHER SIDE TO ACCOMMODATE FLOODING DURING LARGE RAIN EVENTS. THIS PROJECT IS AN EXAMPLE OF INTEGRATED STORMWATER INFRASTRUCTURE THAT PROVIDES MULTIPLE BENEFITS.

TOP: IN SOME AREAS, THE WESTERSINGEL IS BOUNDED BY OPEN, GREEN PARK SPACE, AS SHOWN IN THIS RESIDENTIAL AREA.

BOTTOM: IN OTHER AREAS, THE BANKS OF THE CANAL ARE HARDSCAPED TO PROVIDE WALKING PATHS, SEATING (WHICH, HERE, IS INTEGRATED WITH THE FLOODWALL), AND SPACES FOR ARTWORK. THESE HARDSCAPED AREAS CAN ACT AS PLAZAS FOR SURROUNDING BUSINESSES, SUCH AS SHOPS AND RESTAURANTS.

Physical

Physical, or "structural," strategies can range in scale from parcel-level strategies to regional systems. They are shaped by policy and should be informed by not only current cost and utility, but also operations and maintenance and useful lifespan. Some physical strategies may involve adaptation of human and natural systems to respond to changing climate and sea level. The "evaluation tool" described in this report provides a value-based system for weighing the merits of potential projects in order to promote smart, multi-benefit solutions.

A key physical strategy for the City of Hampton is the strengthening of a network of corridors for safe passage during flood events. With increasing occurrences of nuisance (tidal and stormwater) flooding, citizens and employers alike are concerned about connecting homes to workplaces. Safe ingress and egress is also a point of concern for many communities during major storm events in order to maintain access for evacuation and for emergency services. Continued operation of utilities, specifically power, is also a key physical strategy, and essential for emergency operations such as the VA Medical Center.

As discussed in the "Policy" section, providing space for water should be central to physical strategies. In addition to providing space near existing waterways for expansion and storage, new construction and renovations of structures and spaces can be designed to provide space for water through a variety of means, including shaping of the land, architectural adaptation, and minimization of impermeable surfaces.

Potential solutions to address physical needs include:

- Create a network of raised roads or create multiple ingress/egress options to provide safe egress from flood-prone areas, where feasible .
- Move critical assets (eg. emergency services, police stations, etc.) out of flood zones when feasible.
- Investigate improvements to the power grid to maintain more consistent operation.
- Work with utility companies to examine the feasibility of burying utility lines as a means of improving consistency of service during storm events.
- Expand shoreline stabilization measures to prevent further erosion or degradation (eg. breakwater system, living shoreline, beach replenishment, etc.).
- Broaden the tree canopy to reduce heat island effect and improve air quality.
- Install backflow preventers or other similar devices on outfalls, where deemed appropriate.
- Install infiltration wells to get below the clay soil layer and improve infiltration, where deemed appropriate.
- Utilize needed improvements to public sites and buildings as opportunities to demonstrate sustainability and water management principles (eg. pervious parking lots, under-field water storage, rain gardens, etc.).
- Evaluate the benefits and costs of installing tide gates at various locations. In areas where tide gates are deemed ineffective, inappropriate, or cost/maintenance prohibitive, inform citizens on the reasoning behind the decision and propose alternate scenarios for addressing flooding.
- Evaluate the benefits and costs of installing green infrastructure at various locations. In areas where green infrastructure is deemed ineffective, inappropriate, or cost / maintenance prohibitive, inform citizens on the reasoning behind the decision and propose alternate scenarios.
- Evaluate the benefits and costs of enlarging or installing stormwater infrastructure at various locations. In areas where expansions to stormwater infrastructure are deemed ineffective, inappropriate, or cost/maintenance prohibitive, inform citizens on the reasoning behind the decision and propose alternate scenarios for addressing flooding.
- Evaluate the benefits and costs of installing pump stations to help manage stormwater at various locations. In areas where pump stations are deemed ineffective, inappropriate, or cost/maintenance prohibitive, inform citizens on the reasoning behind the decision and propose alternate scenarios for addressing flooding.

Case Study

GROUNDWORK NEW ORLEANS

THE NEW ORLEANS-BASED CHAPTER OF GROUNDWORK USA, A NOT-FOR-PROFIT FOCUSED ON ENVIRONMENTAL EDUCATION AND STEWARDSHIP, PREPARES HIGH SCHOOL-AGED STUDENTS FOR JOBS IN ENVIRONMENTAL STEWARDSHIP AND IMPLEMENTATION OF GREEN INFRASTRUCTURE. THIS 'GREEN TEAM' HAS WORKED THROUGHOUT THE CITY TO INSTALL AND MAINTAIN GREEN INFRASTRUCTURE PROJECTS BY PARTNERING WITH THE CITY, CIVIC GROUPS, AND OTHER NOT-FOR-PROFIT ORGANIZATIONS. MANY OF THEIR PROJECTS FEATURE INTERPRETIVE MATERIALS TO EDUCATE THE COMMUNITY ON GREEN TECHNOLOGY AND ALTERNATE METHODS OF STORMWATER MANAGEMENT.

TOP: GREEN TEAM MEMBERS PARTNER WITH VOLUNTEERS TO PLANT RAIN GARDENS AT AN ELEMENTARY SCHOOL IN NEW ORLEANS.

BOTTOM: GREEN TEAM MEMBERS MEASURE GROUNDWATER LEVELS IN A RAIN GARDEN (IMAGE SOURCE: GROUNDWORK NEW ORLEANS)

Operations & Maintenance

The cost of a project does not stop at its installation. This is especially true for infrastructure, which requires constant upkeep to ensure proper and efficient operation. Like many cities, Hampton already has more infrastructure than can be properly maintained with current budget and staff allotments. Therefore, strategies for operations and maintenance should be paired with policy and budgetary considerations. Partnerships with citizen groups and neighborhood organizations can also increase awareness of maintenance needs and empower citizens to take some responsibilities for property and public space maintenance.

Potential solutions to address operations and maintenance include:

- Empower citizens to maintain personal property by providing information and educational materials.
- Expand operations and maintenance programs for existing infrastructure.
- Integrate energy-saving measures and low-maintenance materials and systems when repairing or replacing buildings, infrastructure, or making other public improvements.
- Expand monitoring networks (for tides, groundwater, water quality, etc.) as needed.
- Expand programs for stormwater treatment and water quality improvement.
- Evaluate the benefits and costs of dredging at various locations. In areas where dredging is deemed ineffective, inappropriate, or cost/maintenance prohibitive, inform citizens on the reasoning behind the decision and propose alternate scenarios for addressing flooding.

Local Strategies at Work

RESTORE HAMPTON WATERWAYS OYSTER GARDENS
THE CHESAPEAKE BAY FOUNDATION, FUNDED BY A GRANT FROM THE NATIONAL FISH AND WILDLIFE FOUNDATION, INITIATED A SERIES OF PROJECTS AND EVENTS IN HAMPTON, INCLUDING PUBLIC WORKSHOPS. ABOVE, BOOKER ELEMENTARY SCHOOL FIFTH GRADERS BUILD AN OYSTER REEF IN THE BACK RIVER NEXT TO LANGLEY AIR FORCE BASE MARINA. (IMAGE SOURCE: DAILY PRESS[14])

BROCK ENVIRONMENTAL CENTER
THE BROCK ENVIRONMENTAL CENTER,HEADQUARTERS FOR THE CHESAPEAKE BAY FOUNDATION, IS A DEMONSTRATION OF CLIMATE-APPROPRIATE DESIGN. THE CENTER, LOCATED AT PLEASURE HOUSE POINT IN VIRGINIA BEACH, AIMS TO ACHIEVE LIVING BUILDING CHALLENGE CERTIFICATION, MEANING THAT THE BUILDING IS SELF-SUFFICIENT. THE RAISED STRUCTURE, PERVIOUS PAVING, NATIVE PLANTINGS, AND MANY RESOURCE-SAVING SYSTEMS SERVE AS A DEMONSTRATION ON HOW TO CREATE BUILDINGS THAT WORK WITH THEIR LOCAL COASTAL ENVIRONMENT.

BAY STAR HOMES
THE BAY STAR HOMES PROGRAM ENCOURAGES HAMPTON ROADS RESIDENTS TO MAKE PROPERTY IMPROVEMENTS THAT HELP RESTORE AREA WATERWAYS. RESIDENTS CAN ELECT TO JOIN THE PROGRAM AND COMMIT TO TAKING STEPS TO IMPROVE THEIR YARDS, CONSERVE RESOURCES, AND/OR TAKE ON A MORE ACTIVE ROLE IN MAINTAINING COMMUNITY ASSETS. (IMAGE SOURCE: COASTALVIRGINIAMAG.COM[15])

PHOEBUS LIVING SHORELINE
IN 2013, THE CITY OF HAMPTON AND LOCAL VOLUNTEERS INSTALLED THE FIRST PUBLIC LIVING SHORELINE IN PHOEBUS. THE PROJECT FOLLOWS THE 2002 HAMPTON BEACHFRONT AND STORM PROTECTION MANAGEMENT PLAN AND THE PHOEBUS MASTER PLAN. THE LIVING SHORELINE WILL ADD HABITAT, HELP PREVENT EROSION, AND BEAUTIFY THE CORRIDOR FROM PHOEBUS TO FORT MONROE. (IMAGE SOURCE: DAILY PRESS[16])

ELIZABETH RIVER PROJECT LEARNING BARGE
THE ELIZABETH RIVER PROJECT'S LEARNING BARGE IS A FLOATING CLASSROOM USED TO TEACH SCHOOLCHILDREN ABOUT ENVIRONMENTAL STEWARDSHIP. DOCKED AT THE GRANDY VILLAGE LEARNING CENTER IN NORFOLK, THE BARGE ITSELF IS A MODEL OF SUSTAINABILITY, FEATURING SUN AND WIND ENERGY TECHNOLOGIES, A COMPOSTING TOILET, AND A RAINWATER FILTRATION SYSTEM. (IMAGE SOURCE: ELIZABETH RIVER PROJECT[17])

Location-Specific Conditions

While some themes and strategies are common throughout the city, Hampton's unique neighborhoods also require more specific analysis based on hyper-local conditions. Elevation (height above sea level), soils, age and size of existing infrastructure, development patterns, and adjacency/proximity to a range of water bodies can all result in different risks and potential solutions.

In the following pages, the city has been broken down into study areas based on hydrological conditions, grouping together neighborhoods that face similar challenges and may benefit from similar strategies. These areas are roughly classified as low-lying, bay facing, harbor facing, and inland river/creek. Since Hampton has a variety of inland water body conditions, those zones are further separated into sections on the Hampton River, Southwest Branch Back River, and Newmarket Creek. After completion of the Hampton-Langley Joint Land Use Study addendum, Langley Air Force Base will be added as a seventh study area; its function as a national defense asset necessitates a different set of risks and opportunities.

Hydrologically-Based Study Areas

Major Topics

1. NUISANCE FLOODING IS A LARGE CONCERN. CITIZENS IN THIS AREA ARE ADAPTING TO THREATS FROM MAJOR EVENTS, SO THESE ARE LESS OF A CONCERN.
2. PROTECTING ACCESS IN AND OUT OF THE NEIGHBORHOOD AND TO RESOURCES IS IMPORTANT.
3. BALANCING GOVERNMENT INTERVENTION WITH THE COMMUNITY'S VALUE OF PRIVACY.

Strategies

1. CREATE DRY/SAFE EGRESS ROUTES IN FLOOD-PRONE AREAS.
2. IMPROVE THE POWER GRID TO MAINTAIN CONSISTENT OPERATION (EG. BURY UTILITY LINES, RAISE SUBSTATIONS, ETC.).
3. CREATE A CENTRAL EVACUATION SITE.
4. IMPROVE CITY COMMUNICATION ABOUT IMPENDING STORM EVENTS AND DEVELOP/IMPROVE THE SYSTEM FOR COMMUNICATING WITH EMERGENCY SERVICES DURING/AFTER EVENTS.
5. ENHANCE OR CREATE WATER-BASED ASSETS (EG. MARINAS) TO ENHANCE RECREATION AND ECONOMY.

Low-Lying

Foxhill, Grandview, Harris Creek

Hampton's northeast region is characterized by low-lying, marshy lands and a high water table. Desirable for its natural beauty and proximity to water and wildlife, many area families have owned and passed property down through generations in this largely residential area. As such, residents tend to be knowledgeable about how major storm events and flooding can impact their lives and assets and have adapted accordingly.

Due to its low elevations and coastal proximity, this area can be heavily impacted during storm events. Flooding can be caused by multiple sources: tides, stormwater (rain events), or major events (hurricanes or nor'easters). While increasingly frequent tidal flooding is the main stress for this area, nor'easters are also a concern, as they can cause more damage due to their long duration.

Beach Road, the main transportation artery for Foxhill, can flood during storms, inhibiting safe egress. Similarly, Harris Creek Road and the approach to the bridge over Long Creek flood frequently. Establishing safe egress during storm events and also safe corridors to resources is key for these neighborhoods.

The age of the neighborhoods have also resulted in some infrastructure being located on private property, or property ownership interfering with the construction of continuous infrastructure, such as drainage ditches. Finding a balance between government policy and intervention and citizen-led action to improve infrastructure is important to the area's residents.

Recorded Flooding

Resident Observed Flooding

Resident Comment

There is development built up to the Chesapeake Bay buffer and residents encroach without knowing.

Routine tidal flooding.

Drainage chokepoint.

Prone to flooding in heavy rain.

Bridge floods and cuts off neighborhood.

Flooding has affected identity and culture. Some have sold and moved.

Foxhill

Canal floods and backs up into neighborhood.

Beach Road is the only egress route.

Land subsidence is visible, along with sea level rise.

A portion of Foxhill could be used as a test case.

Beach Road does not drain like it once did; water doesn't wash out.

After flooding, water remains for several days; cuts off the neighborhood.

Severe flooding makes roads impassable.

North King St

Major Topics

1. MAJOR EVENTS CAN CAUSE DAMAGE IN THIS COASTAL AREA AND ERODE THE SHORELINE.
2. TIDAL FLOODING AND WATER BACKFLOW THROUGH EXISTING INFRASTRUCTURE ARE CHALLENGES FOR PHOEBUS AND FORT MONROE.
3. THE FUTURE OF FORT MONROE WILL VASTLY AFFECT THE ECONOMY AND SUCCESS OF THIS AREA, AND SPECIFICALLY PHOEBUS.

Strategies

1. EXPAND SHORELINE STABILIZATION MEASURES TO PREVENT EROSION/DEGRADATION AND LOOK FOR CO-BENEFIT OPPORTUNITIES TO EXPAND RECREATIONAL OPPORTUNITIES AND/OR CREATE HABITAT.
2. IMPROVE THE POWER GRID TO MAINTAIN CONSISTENT OPERATION (EG. BURY UTILITY LINES, RAISE SUBSTATIONS, ETC.).
3. EXPLORE ARCHITECTURAL ADAPTATIONS AND/OR FLOODPROOFING MEASURES THAT ARE SENSITIVE TO HISTORIC BUILDINGS.
4. ADAPT SUBSURFACE DRAINAGE OUTFALLS TO PREVENT BACKFLOW.

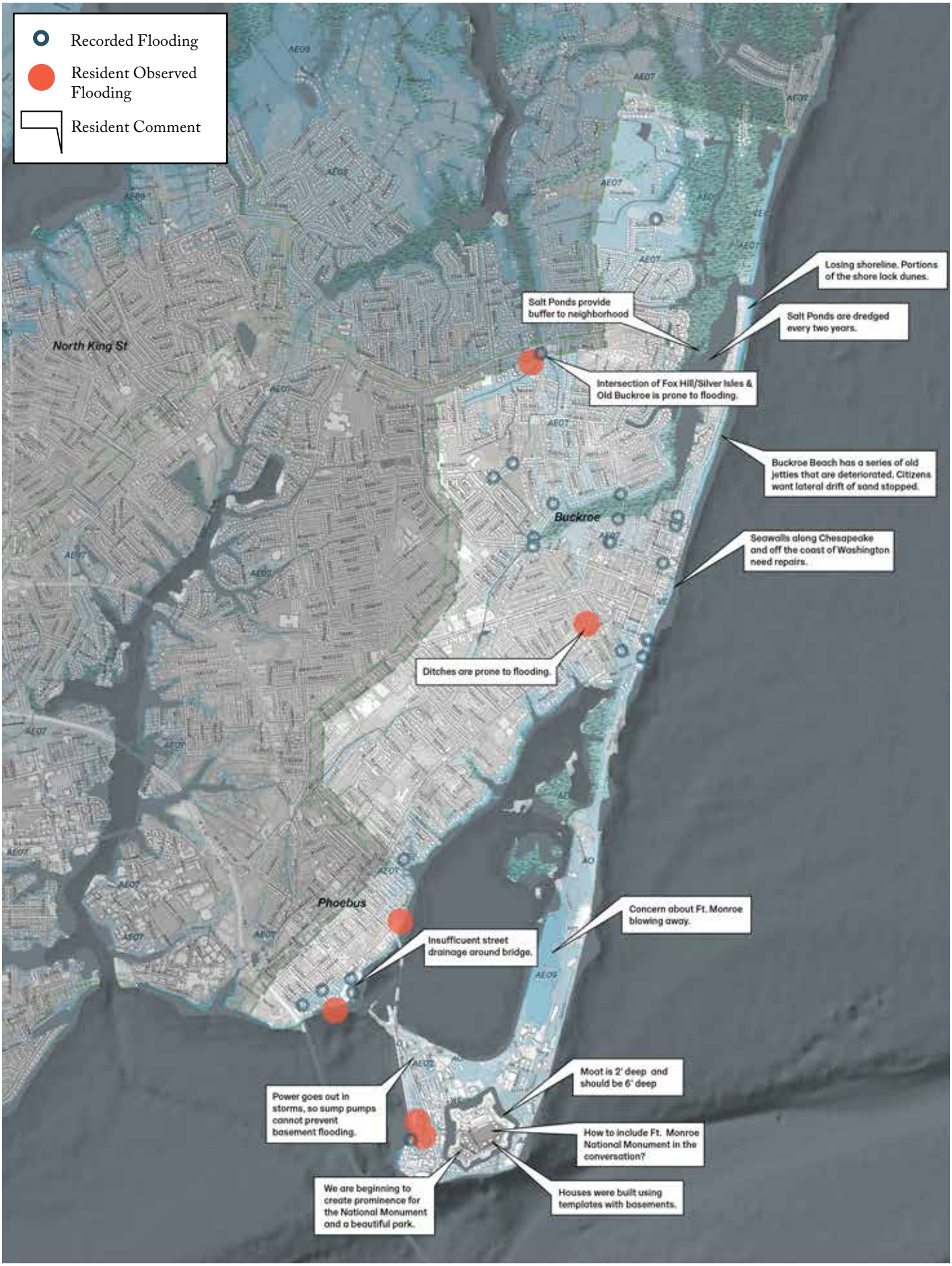
Bay Facing

Buckroe, Phoebus, Fort Monroe

The eastern edge of the city, facing the Chesapeake Bay, contains some of Hampton's oldest neighborhoods. Spanning from Buckroe Beach southward to Phoebus and Fort Monroe, this area has also provided a variety of recreational opportunities through the years. With the transition of Fort Monroe to a mixed use neighborhood and national monument, this area could continue to be a recreation and tourism focus area for the city.

Due to its proximity to the Chesapeake Bay, this area is susceptible to large storm events. During Hurricane Matthew in 2016, Buckroe Beach and Fort Monroe both sustained damage, though it manifested in different ways. Buckroe Beach suffered extensive shoreline damage and received federal funds for emergency restoration. At Fort Monroe, loss of power inhibited pumping out of basements and other facilities. Buffered by Old Point Comfort (the site of Ft. Monroe), Phoebus has some defense from major storms. However, both Fort Monroe and Phoebus are experiencing increasingly frequent tidal flooding, exacerbated by water backflow through the stormwater drainage infrastructure during high tides.

Buckroe, Phoebus, and Fort Monroe have all been designated as urban development areas by the City of Hampton, meaning the City has designated these areas for growth. Master planning efforts have identified means of improving urban fabric and inserting appropriate development. With a large stock of historic structures, one of the biggest challenges for this area is merging resiliency and preservation. Strategies in this area should not only focus on creating multiple benefits, but also preserve existing assets, speak to the rich history of the area, and develop new economic opportunities for sustained viability.


Recorded Flooding
Resident Observed Flooding
Resident Comment
North King St
Buckroe
Phoebus
Losing shoreline. Portions of the shore lack dunes.
Salt Ponds provide buffer to neighborhood
Salt Ponds are dredged every two years.
Intersection of Fox Hill/Silver Isles & Old Buckroe is prone to flooding.
Buckroe Beach has a series of old jetties that are deteriorated. Citizens want lateral drift of sand stopped.
Seawalls along Chesapeake and off the coast of Washington need repairs.
Ditches are prone to flooding.
Concern about Ft. Monroe blowing away.
Insufficient street drainage around bridge.
Moat is 2' deep and should be 6' deep
Power goes out in storms, so sump pumps cannot prevent basement flooding.
How to include Ft. Monroe National Monument in the conversation?
We are beginning to create prominence for the National Monument and a beautiful park.
Houses were built using templates with basements.

Fort Monroe

Now a National Monument, Fort Monroe has a long and prominent history as a site for national defense as well as the emancipation of enslaved African Americans during the Civil War. The closing of Fort Monroe as a military base in 2011 had a negative economic effect on the City of Hampton, and saw the loss of 4,500 jobs. Now in a transition of land ownership from the Army to the Commonwealth of Virginia and the National Park Service, Fort Monroe is in the process of transitioning from a restricted military installation to a mixed use neighborhood which includes a national monument and museum. The Fort Monroe Authority, the Commonwealth's entity for managing Fort Monroe, has set forth the goals of protecting, maintaining, and providing public access to the Fort "as a place that is a desirable one in which to reside, do business, and visit, all in a way that is economically sustainable."[18]

Located largely within the 100-year floodplain and with 145 historic buildings on the property - many of which have basements that are susceptible to flooding - strategies for Fort Monroe must combine resiliency and preservation. The Fort Monroe Authority and the National Park Service have already begun development of plans for retrofitting and remaking the fort to better align with its new use and purpose. Many of the fort's facilities and infrastructure were constructed for military use, and adapting systems for a new use can be challenging. Leveraging federal, state, and local knowledge and resources is crucial to preserving this historic asset, telling its incredible story, and making it an economically sustainable entity.

Adjacent to Fort Monroe, The Chamberlin is an example of successful adaptive reuse. Built in 1927 as a luxury hotel, the building was renovated in the 2000s as a retirement community.

Top, left:
Freed slaves, "contraband of war," outside of Fort Monroe during the Civil War. (Image source: National Park Service[19])

Second, left:
View of historic buildings in and around Fort Monroe. (Image source: Detroit Publishing Co.[20])

Third, left:
Present-Day Fort Monroe houses the Casemate Museum.

Bottom, left:
Old Point Comfort Lighthouse was constructed in the early 1800's.

Opposite, top left:
Mellen Street houses a variety of locally-owned restaurants and stores.

Opposite, bottom left:
A living shoreline at Phoebus Waterfront Park was installed with the help of local volunteers.

Opposite, top right:
New residences in Buckroe are raised on crawlspaces.

Opposite, bottom left:
The fishing pier at Buckroe Beach, reopened in 2008, to replaces one destroyed by Hurricane Isabel in 2003.

Phoebus

Once an independent city, Phoebus, the "gateway to Fort Monroe," was incorporated into the City of Hampton in 1952. The community was home to an overflow of Union troops who formed Camp Hamilton, an encampment across the banks from Fort Monroe, during the Civil War. The urban structure of the area was formed post-war, when a street grid was laid out and the former Camp Hamilton was parceled into lots, forming the town known as Chesapeake City. With railroad and ferry access connecting from Norfolk to Hampton, the area - renamed Phoebus in 1900 - was a commercial center for both Fort Monroe and the surrounding cities. However, the opening of the Hampton Roads Bridge Tunnel in 1957 created a bypass around Phoebus and stunted both development and local economy.

Today, revitalization efforts are visible along Mellen Street, the heart of Phoebus's commercial zone. Restaurants and bars, which once served soldiers and staff at Fort Monroe, are intermixed with boutique stores. In 2007, the City created a master plan for Phoebus, which was updated by Urban Design Associates in 2013. Phoebus's designation as a National Historic District, acquired in 2006, could provide access to a wider pool of funds for further revitalization efforts. Physically and economically linked to Fort Monroe, Phoebus's future success will likely correspond to that of Fort Monroe.

Buckroe

Used as a fish camp until after the Civil War, the installation of rail and trolley service to the area in the late 1800s enabled Buckroe to grow into a resort community. With separate boardwalks, beaches, and amusement park facilities for both black and white visitors, Buckroe was a popular summer destination. The addition of the Hampton Roads Bridge Tunnel in the 1950s changed the nature of the area by expanding access to other beachfront destinations. In the 1960s, Buckroe was designated as a redevelopment area and many of the historic facilities were razed.

The area now features mostly year-round residential development, much of which is built on piers or crawlspaces characteristic of its coastal setting. However, with public beaches, pavilions, and fishing piers, the area still provides an abundance of recreational opportunities for residents and visitors. Vehicular traffic along the Pembroke corridor (East and West Pembroke Avenue), formerly a commercial services corridor, links Buckroe to the retail centers in Phoebus and Downtown. The spit of land connecting Buckroe and Fort Monroe could potentially provide pedestrian and cyclist connections between these assets, though private property between the public areas limits development opportunities.

Major Topics

1. TIDAL FLOODING IS A CONCERN, ESPECIALLY AROUND THE AREA'S MULTIPLE CREEKS.
2. SHORELINE MAINTENANCE CAN BE INHIBITED BY PRIVATE PROPERTY OWNERSHIP.
3. OLD UTILITIES IN THE AREA ARE UNRELIABLE.
4. BALANCING GOVERNMENT INTERVENTION WITH THE COMMUNITY'S VALUE OF PRIVACY.

Strategies

1. EXPAND SHORELINE STABILIZATION MEASURES TO PREVENT EROSION/DEGRADATION. WORK WITH RESIDENTS TO DESIGN HOLISTIC SOLUTIONS WHERE THE SHORELINE IS LOCATED ON OR NEAR PRIVATE PROPERTY.
2. WORK WITH RESIDENTS TO DEVELOP CONSISTENT STRATEGIES FOR MAINTAINING INFRASTRUCTURE ON PRIVATE PROPERTY.
3. REPLACE OUTDATED UTILITIES AND LOCATE THEM IN LOWER-RISK AREAS.

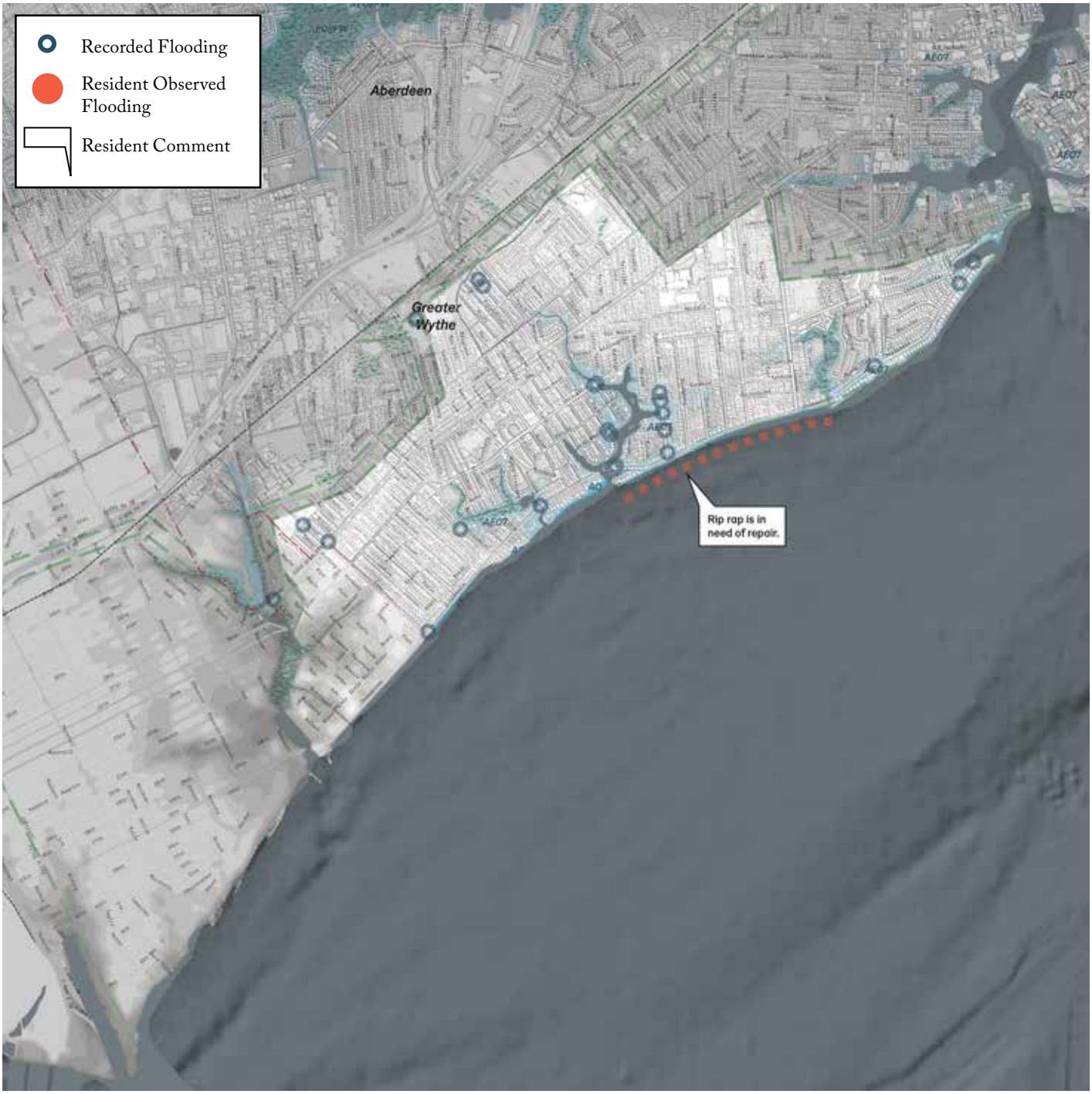
Harbor Facing

Wythe, Magruder, Armstrong Gardens

Spanning between downtown Hampton to the east and Newport News to the west, the harbor-facing area was influenced by the development of both cities. It contains several historic and present-day east-west (southeast - northwest) corridors, including Chesapeake Avenue, Kecoughtan Road, and Victoria Boulevard. A trolley line running along Victoria Boulevard spurred early development along the harbor, which then grew inland as subdivisions developed.

The area is punctuated by a series of creeks running inland from the harbor, including Indian River Creek and Salters Creek. These tidal creeks tend to be fairly shallow, exacerbated by erosion and storms that silt in the creeks. While dredging may provide greater opportunity for recreation in these areas, it would not provide additional storage capacity, as water levels are controlled by the tides. Rising sea levels have led to more frequent tidal flooding events, which tend to affect low-lying areas near the northern ends of the creeks, where they have been infilled. Older utilities in the area are also susceptible to damage and can be unreliable during storms. Modernization of the area's utilities could help residents weather storms.

Much of the shoreline along the harbor has rip-rap or seawall edge conditions, which can be damaged during major storm events. In some areas, the land on the harbor side of Chesapeake Avenue is privately owned, which can limit consistent maintenance and repairs along the full length of the shoreline. During major storm events, storm surge can overtop the shore's edge. However, the harbor's edge is generally at a higher elevation relative to other areas of Hampton's waterfront, so access and egress is less of a concern. Partnerships between private landowners and the City to develop consistent shoreline stabilization systems could help restore and reinforce the harbor edge.


Recorded Flooding
Resident Observed Flooding
Resident Comment
Aberdeen
Greater Wythe
AE07
Rip rap is in need of repair.

Major Topics

1. LARGE AMOUNTS OF IMPERVIOUS SURFACE LEAD TO EXCESSIVE STORMWATER RUNOFF AND CONTRIBUTE TO POLLUTED WATERWAYS.
2. WATER BACKFLOW THROUGH EXISTING INFRASTRUCTURE CAN CAUSE FLOODING DURING HIGH TIDES AND EXACERBATE FLOODING WHEN RAIN EVENTS COINCIDE WITH HIGH TIDES.
3. PROTECTING ACCESS IN AND OUT OF NEIGHBORHOODS AND TO RESOURCES IS IMPORTANT.

Strategies

1. DESIGNATE SPACES TO DETAIN AND CLEAN WATER.
2. CREATE DRY/SAFE EGRESS ROUTES IN FLOOD-PRONE AREAS AND TO CRITICAL ASSETS.
3. EXPLORE ARCHITECTURAL ADAPTATIONS AND/OR FLOODPROOFING MEASURES FOR BUILDINGS AT A RANGE OF SCALES (EG. RESIDENTIAL, COMMERCIAL, INSTITUTIONAL).

Hampton River

Downtown, Hampton University, VA Medical Center

The Hampton River touches many elements of Hampton's culture and economy: dense urban centers, industry, educational campuses, governmental and healthcare facilities, and single- and multi-family residential. It is an important channel for both industrial and recreational use, and sections of the river are regularly dredged to maintain these functions. With an abundance of economic assets - including Downtown, the VA Medical Center, and Hampton University - reduction of risk in this area is crucial to the city's continued growth and development.

During rain events, impervious surfaces in this densely developed area causes large amounts of untreated stormwater runoff to flow directly into the Hampton River. Impervious surfaces can also contribute to flash flooding during heavy rains. Though there are many drainage pipes leading from this area of the city to the river, rising seas have made the drainage system less effective during high tides and combination events (high tides plus rains), when water can back up through the drainage system. Locating spaces to store and clean water until it can be discharged could help alleviate flooding and improve water quality. Architectural adaptations to rising water levels can also alleviate financial loss due to flooding.

With many creeks radiating from the main river channel, the Hampton River provides many miles of waterfront property. However, during flood events, these tributaries can also close off access and isolate campuses and neighborhoods. From Pasture Point to the VA Medical Center, flooded roads can inhibit access and prevent people from reaching needed resources. Improved transportation networks not only provide safe ingress/egress, but also provide economic benefit by connecting people with services.

Recorded Flooding

Resident Observed Flooding

Resident Comment

North King St

Fox Hill Road is prone to flooding in several locations.

Ditch maintenance needed.

The intersection of Glascow Way and Nickerson Blvd floods in rain events, recorded at 2'.

The Hampton River is toxic.

Street intersections are prone to flooding during heavy rain events (but not during Isabel). Meeting attendee reported being stuck in neighborhood several times since 1995 with over 2' of standing water.

Kings Point is prone to river flooding from nor'easters; water can remain as long as 12 hours, depending on tide.

The Pasture Point neighborhood is prone to flooding from heavy rains (4-6 hrs) and from the Hampton River.

Could there be water storage above ground?

Pasture Point needs a road for egress at the back of the neighborhood.

Pembroke Ave is prone to tidal flooding.

Downtown

Hampton University is self-contained. Requests have been made for a tram to downtown.

Phoebus

Backflow preventers needed at all outflow pipes

Downtown

Often considered the oldest continuously English-speaking settlement in the United States, Hampton was officially formed in 1705. The area of present-day Hampton was home to a native Kecoughtan population, who were displaced by British settlers by the early seventeenth century. In 1691, construction of the port and the platting of the King and Queen Street crossroads laid the foundation for Downtown's development. The area's growth was stunted by several fires - most notably in 1861 by retreating Confederate soldiers and a second fire in 1884. St John's Episcopal Church, built in 1728 and located along Queen Street near downtown's original crossroads, is one of the oldest buildings downtown, its exterior walls still intact. During the Reconstruction period of the late 1800s, seafood became a major export for Hampton. City growth led to the creation of a trolley system connecting Downtown to Newport News to the west and Phoebus to the east.

In 1952, the consolidation of Hampton, Elizabeth City County, and Phoebus, created the modern-day City of Hampton. The vast expansion of the city took focus away from Downtown, as other areas received development attention. However, through the later half of the twentieth century, Downtown did see some large-scale developments such as City Hall, Virginia Air & Space Center, and a waterfront hotel. The area is now a Business Improvement District, meaning that Downtown has a voluntarily higher tax rate and the City provides matching funds for improvements to the district.

Over the course of three centuries of development, much of Downtown has been largely covered with impermeable surfaces. Generations of infrastructure have also created a large number of subsurface pipes radiating from the Hampton River which, as sea levels rise, can bring water from the river up into the streets. As one of the first areas developed in the city, Downtown has a prime location situated both adjacent to water and on higher ground. This prominent location could provide opportunities to demonstrate higher-density urban development paired with increased water storage. Projects that improve water quality through cleaning of stormwater runoff are also important to life along the Hampton River and Hampton's long-running seafood industry.

Right:
Downtown Hampton sits along the waterfront of the Hampton River.

Below, left:
Sunset Creek, a dredged channel, is bordered by water-based industries.

Below, right:
St. John's Episcopal Church, built in 1728, is the oldest continuously existing Anglican parish in America.

Hampton University

From its inception, Hampton University has been a preeminent institution of equal education for all citizens. The first class of what would become Hampton University was held on September 17, 1861 when Mary Peake, a free woman of color, taught class to a group of emancipated slaves under an oak tree. After the Civil War, the government purchased 165 acres of farmland for the school which, in 1868, was named Hampton Normal and Agricultural Institute. In 1930, the institution became a college, named Hampton Institute and, in 1984, was renamed Hampton University. Early classes emphasized trades and industrial skills, and many of the campus's structures - including the flagship Virginia Hall - were constructed with student labor and are still in use today.

Situated on a bend from the Hampton River, across the river from Downtown and adjacent to the VA Medical Center and Phoebus, Hampton University is embedded in the city's urban core. However, high-speed corridors such as Interstate 64 and Highway 60 (Settlers Landing Road) reduce opportunity for pedestrian and cyclist access to surrounding assets. Reconnecting the university to the larger City should provide mutual benefit to both students and the surrounding community.

VA Medical Center

The VA Medical Center (VAMC) is located south of Hampton University, where the Hampton River meets the harbor. Originally named the Southern Branch of the National Home for Disabled Volunteer Soldiers, the medical facility opened in 1870. Today, the 86-acre site contains over fifty buildings and employs 1800 people. Buildings on the campus span from 1860 to present, with the main hospital building constructed in 1938. A boiler plant with underground tunnels for steam lines provide critical heat and water to the facilities. Sub-surface utilities and mechanical equipment in basements or at grade are a liability with increasing tidal flooding and flooding from extreme events.

The VAMC has already made strides in adapting to changing climate and rising seas. New facilities are designed with a 9' first floor elevation, new development locates structures away from the shoreline, and the front entrance has been realigned onto higher ground. However, as sea levels rise, both of the campus's entrances could be at risk during extreme events. Reliable power is also critical. After flooding from Hurricane Isabel, some critical electrical infrastructure was relocated, but the facility is still reliant on city-wide energy infrastructure maintaining operation during storm events.

Left, top & bottom:
Hampton University's historic campus sits opposite Downtown, along the Hampton River.

Top:
High waves dampen the sidewalk lining the VAMC campus.

Bottom:
The main hospital building was constructed in 1938.

Southwest Branch Back River

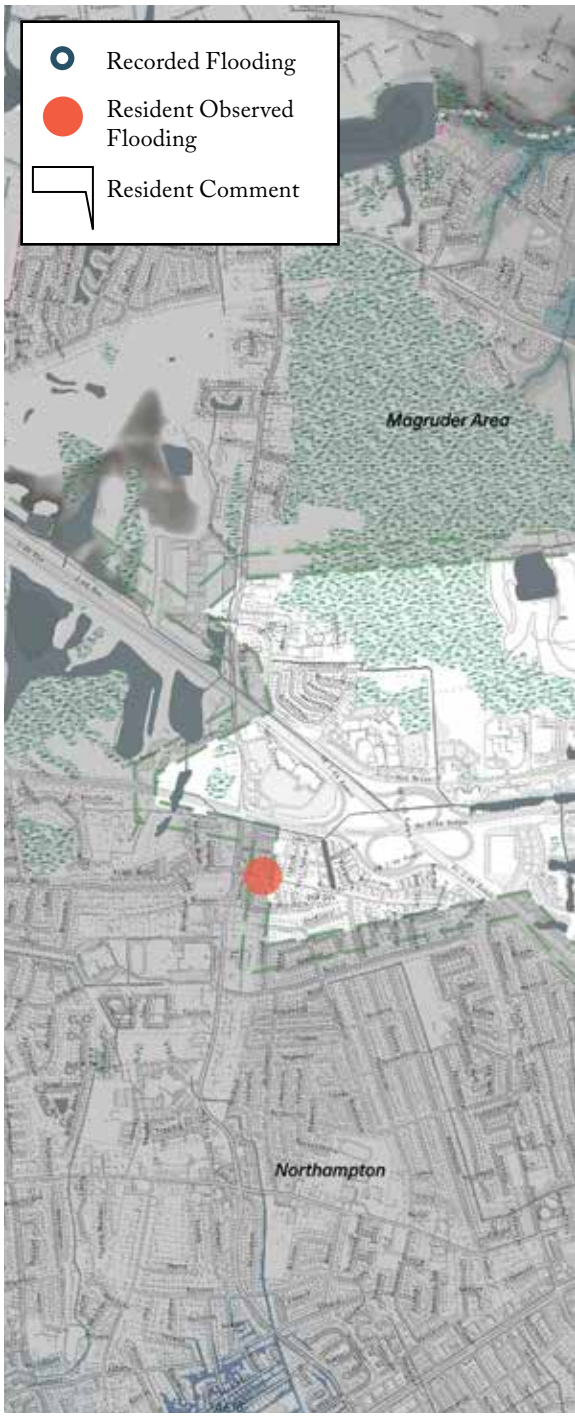
Riverdale, Seldendale, Pastures, Tide Mill

The Back River and its surrounding communities provide a gateway to Langley Air Force Base. A series of commercial corridors, primarily running north-south - including LaSalle Avenue, King Street, Armistead Avenue, and Magruder Boulevard - connect this area to downtown Hampton and to neighboring Poquoson.

Along the river, low-lying lands are largely affected by tidal flooding, especially in neighborhoods like Riverdale and the Pastures, located near the confluence of the southwest branch of the Back River and Newmarket Creek. Residents fear that erosion and loss of marsh areas are contributing to more rapid and expansive flooding. Architectural adaptations paired with shoreline stabilization and habitat/marsh improvements could help reduce loss from tidal events.

The proximity to Langley Air Force Base has limited some development in this area where aircraft and runway safety zones preference limited development. This creates opportunities for upland water storage in undeveloped or largely green areas. Areas such as Hamptons Golf Course could be considered for improved upland water retention to reduce stormwater runoff draining toward low-lying lands bordering the river.

Pairing raised egress with surge protection systems may also be a viable strategy for this area, though more study would be necessary. LaSalle Avenue, an important artery for Langley Air Force Base, roughly parallels the western bank of the river. There may be opportunities to raise the road to create a safe egress route while simultaneously protecting the area west of the road from surge and tidal events. However, this would require intense investigation into viability and potential adverse environmental effects.



Major Topics

1. TIDAL FLOODING IS THE PRIMARY THREAT FOR RESIDENTS IN THIS AREA.
2. SHORELINE EROSION AND MARSH LOSS INCREASE FLOODING RISK.

Strategies

1. EXPLORE ARCHITECTURAL ADAPTATIONS AND/OR FLOODPROOFING MEASURES FOR RESIDENTIAL STRUCTURES.
2. CREATE UPLAND WATER STORAGE IN UNDEVELOPED AREAS.
3. CREATE DRY/SAFE EGRESS ROUTES IN FLOOD-PRONE AREAS AND TO CRITICAL ASSETS.

Langley

Bridge prone to flooding.

North King St

Armistead floods 4-5 times a year.

Mercury Central

Mercury Blvd is a corridor opportunity from LaSalle to King.

Riverdale could be used as a test case.

Air Power Park could be a test case.

A Portion of Mercury could be used as a test case.

Newmarket Creek

Major Topics

1. TIDAL AND STORMWATER FLOODING AFFECT PROPERTIES THROUGHOUT THE AREA, AND ESPECIALLY THOSE BORDERING THE CREEK.
2. LARGE AMOUNTS OF IMPERVIOUS SURFACE LEAD TO EXCESSIVE STORMWATER RUNOFF AND CONTRIBUTE TO POLLUTED WATERWAYS.
3. EROSION OF CREEK BANKS FILL IN CREEKS AND REDUCE STORAGE AND CONVEYANCE CAPACITY.
4. INCONSISTENT STANDARDS AND POLICIES BETWEEN ADJOINING MUNICIPALITIES CAN MAKE SOLUTIONS LESS EFFECTIVE.

Strategies

1. PARTNER WITH NEWPORT NEWS TO ENACT POLICIES AND STRATEGIES THAT CONSIDER THE FULL LENGTH OF NEWMARKET CREEK.
2. REVISE ZONING AND LAND USE POLICIES TO PROTECT SENSITIVE AREAS FROM FURTHER ENCROACHMENT AND DEVELOPMENT.
3. LOOK FOR OPPORTUNITIES TO CREATE BUFFER AREAS AROUND THE CREEK; WHERE POSSIBLE, UTILIZE THESE SPACES FOR RECREATION.
4. CREATE SPACES TO DETAIN AND CLEAN WATER.

Covering much of the central area of Hampton, Newmarket Creek extends from Newport News to the Back River. Over the course of its length, Newmarket Creek takes on a variety of different characters. Though further subdivisions of character can be noted, the creek can generally be defined by three distinct parts. Nearest Back River, the "bay creek" creates a wide, meandering path with marshy borders. From around Hampton Coliseum to where the creek intersects with Newport News, the "residential creek" varies in width, but is generally straighter and lined on either side with single- and mutli-family housing. Near the Hampton - Newport News line, the creek becomes narrower and, in some areas, channelized.

The creek is tidal from the Back River to around Aberdeen Road, with the remaining length being tidally influenced. Stormwater runoff can affect the flow of the creek, such that sections of the creek can flow in different directions based on the combination of forces acting on it. This confluence of factors can complicate potential strategies for reducing flooding around the creek. In Newport News, the channelized Government Ditch is used to divert water from the creek. Originally designed to divert water during a 25-year storm event, the ditch is now diverting smaller events as well.

With extensive development around Newmarket Creek, stormwater runoff from the large drainage shed can overwhelm the creek during rain events. Encroaching development on the creek's banks limit possibilities for expanded water storage and are also often the first areas to flood. The force of runoff can also lead to erosion, which silts in the creek and can further reduce water storage capacity. With such an extensive drainage shed, even areas at higher elevations, such as Northampton, can be affected by Newmarket Creek flooding.

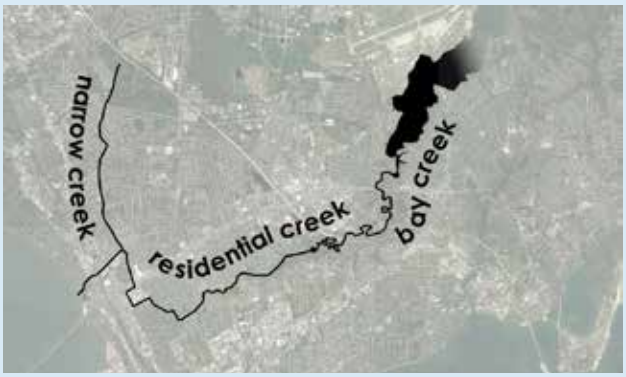
Despite the complex issues facing the creek, opportunities for investment and development still exist. Coliseum Central has already seen some revitalization efforts, and is set up for future development as a Business Improvement District, which taxes itself at a higher rate and, in turn, receives matching funds from the City for improvements. At a hinge point in Newmarket Creek, reinvestment in Coliseum Central could positively influence Newmarket Creek through sensitive development. The San Antonio Riverwalk, which displays a number of characters and settings along its length, is a relevant precedent for development that reinforces water as an asset.

With many large shopping centers and adjoining parking lots along Mercury Boulevard - Hampton's prime commercial zone - opportunities exist for reducing runoff through green infrastructure and expansion of the urban tree canopy. Pervious parking lots, bioswales, and subsurface cisterns can slow water and, in some instances, improve water quality.

Retrofitting of the residential areas around Newmarket Creek will be a challenge, as much of the development along the creek is older and moderately dense. These types of development tend to be in lower areas that were developed later, as higher grounds became built out. As properties in this area come up for redevelopment, creating more ecologically sensitive models for residential development could create more attractive housing while also adding space for water and recreation.

Newmarket Creek could also serve as a model for partnerships among adjoining municipalities to implement holistic policies and strategies for local waterways. It is imperative that the cities of Hampton and Newport News work together to address flooding concerns and create resilient strategies for Newmarket Creek and the surrounding area. This type of "smart" redevelopment could be the impetus for rebirth for many of these areas.

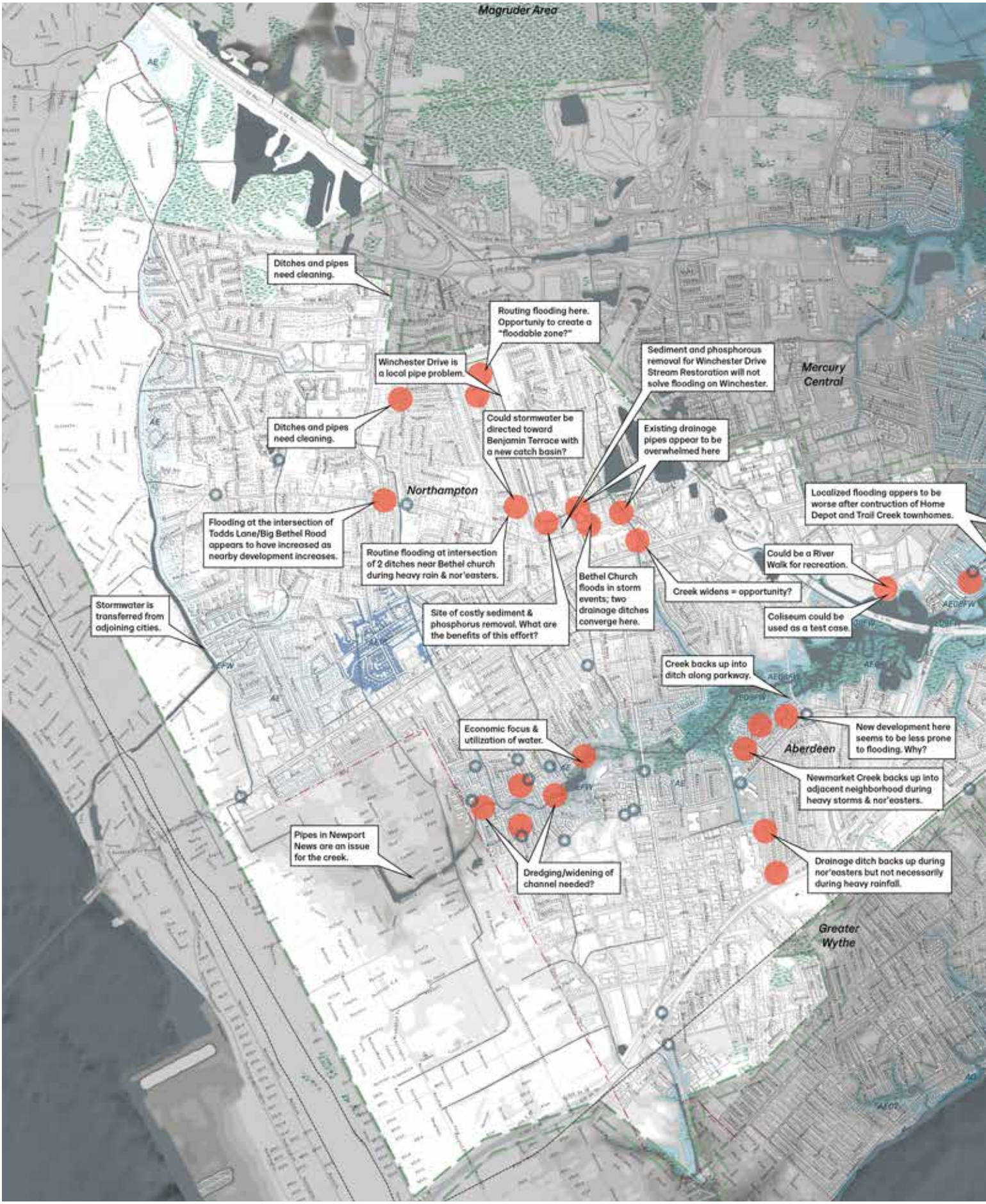
Newmarket Creek Conditions



BAY CREEK
IN AREAS LIKE THOSE AROUND HAMPTON COLISEUM, THE CREEK IS WIDER AND HAS MARSHY EDGES.

RESIDENTIAL CREEK
LONG STRETCHES OF NEWMARKET CREEK RUN THROUGH THE BACK YARDS OF RESIDENTIAL AREAS. IN SOME AREAS, BUILDINGS AND ACCESSORY UNITS ENCROACH ON THE CREEK'S BANKS.

NARROW CREEK
IN COMMERCIAL AREAS, THE CREEK HAS LARGELY BEEN STRAIGHTENED AND CHANNELIZED.


Magruder Area
Ditches and pipes need cleaning.
Routing flooding here. Opportunity to create a "floodable zone?"
Winchester Drive is a local pipe problem.
Sediment and phosphorous removal for Winchester Drive Stream Restoration will not solve flooding on Winchester.
Mercury Central
Ditches and pipes need cleaning.
Could stormwater be directed toward Benjamin Terrace with a new catch basin?
Existing drainage pipes appear to be overwhelmed here
Northampton
Localized flooding appers to be worse after contruction of Home Depot and Trail Creek townhomes.
Flooding at the intersection of Todds Lane/Big Bethel Road appears to have increased as nearby development increases.
Routine flooding at intersection of 2 ditches near Bethel church during heavy rain & nor'easters.
Bethel Church floods in storm events; two drainage ditches converge here.
Creek widens = opportunity?
Could be a River Walk for recreation.
Coliseum could be used as a test case.
Stormwater is transferred from adjoining cities.
Site of costly sediment & phosphorus removal. What are the benefits of this effort?
Creek backs up into ditch along parkway.
New development here seems to be less prone to flooding. Why?
Aberdeen
Economic focus & utilization of water.
Newmarket Creek backs up into adjacent neighborhood during heavy storms & nor'easters.
Pipes in Newport News are an issue for the creek.
Dredging/widening of channel needed?
Drainage ditch backs up during nor'easters but not necessarily during heavy rainfall.
Greater Wythe

Recorded Flooding
Resident Observed Flooding
Resident Comment
North King St
Bridge prone to flooding.
Downtown

Potential Focus Areas

Based upon the work represented in this document, the following geographic areas are recommended as candidates for future phases of work. Each area represents a specific type of issue that is faced in Hampton. Often, similar conditions are found in several parts of the city, so this approach could produce prototypical solutions that may be replicated in other areas of the city. In each selected area, the guiding principles and values identified in this report will be applied to arrive at potential solutions. The evaluation tool will assist us in understanding which solutions most closely align with the matrix of key attributes that represent the "best decisions" for Hampton.

Recommended Pilot Areas for Phase II:

1. Newmarket Creek to Langley AFB

- Major asset of national importance; economic driver
- Central to the city – touches many neighborhoods
- Wide range of challenges and potential solutions
- Potential partnership with Newport News
- Potential to assist vulnerable populations

2. Downtown Hampton

- Cultural heart of the city – many historic and cultural assets
- Economies tied to the seafood industry, tourism, institutions (Hampton University, VA Medical Center, etc.)
- Publicly-owned lands to use for demonstration projects
- Pilot green infrastructure (storage) solutions and urban river edge typology – applicable to Phoebus and Coliseum Central as well

3. Neighborhood Strategies: Fox Hill and Riverdale

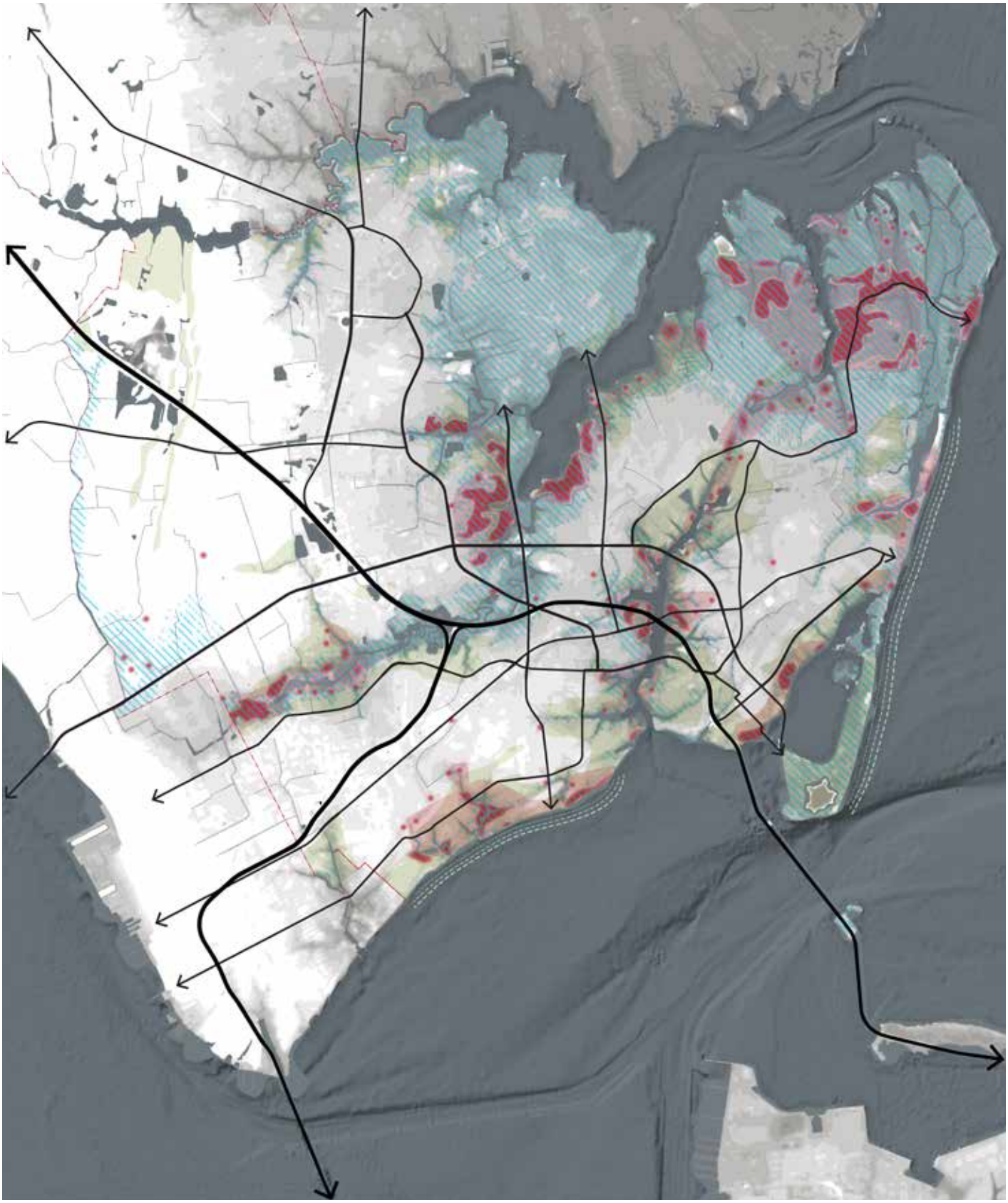
- Potential solutions at the parcel scale
- Specific strategies for individual neighborhoods
- Increasing resiliency of critical infrastructure like roads and the power grid – process applicable to most neighborhoods (although specific solutions may be different)

4. Buckroe Beach & Boardwalk

- Recreational and tourism asset
- Hardened bay-facing edge typology – applicable to Fort Monroe
- Smaller scale – project based

Notes:

1. The more choices selected for Phase II work, the more funding will be required to accommodate the broader scope of work
2. Phase II work will focus on specific areas and will identify implementable projects with concept level cost estimates.



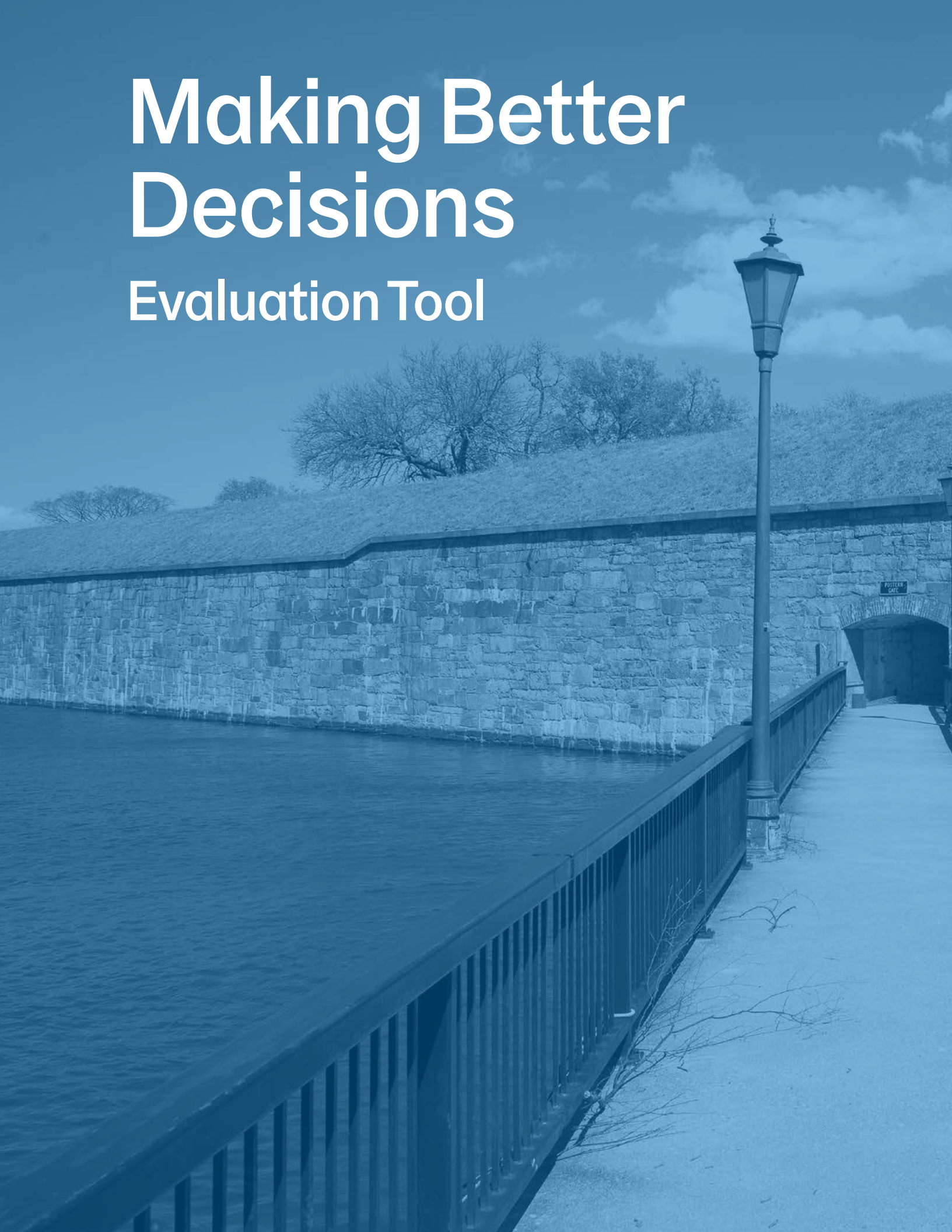
Potential Project Locations

The map above shows existing major roadways and highways as connectors between neighborhoods in Hampton and cities in the region, along with a "heat map" of repetitive loss property clusters and larger zones. Based on analysis of groundwater depths and soil types, areas that could potentially accommodate green infrastructure are shown, along with zones for coastal restoration.

- Repetitive Loss Zone
- Repetitive Loss Cluster
- Water
- 100-Year Floodplain
- Potential Green Infrastructure Area
- Potential Coastal Restoration/Living Shoreline
- Interstate
- Major Road

Making Better Decisions

Evaluation Tool



Historic Hampton
The city has a long and incredibly rich history, dating back before the founding of the United States. Important assets such as Ft. Monroe demonstrate the character of the place and the importance of preserving its culture and history.

Evaluation Tool

Purpose

To be successful in becoming a more resilient city, we must begin to evaluate our choices in a broader context. One of the main goals of the Phase I Report is to establish important community values and guiding principles that will steer future work as the City goes forward. These values and principles will serve as a "compass" so that each decision, small or large, contributes in some positive way toward becoming resilient. Making better decisions will require both local government and community partners to evaluate key decisions in a much more holistic context that considers multiple community factors.

The evaluation tool is designed to assist in institutionalizing this new way of making decisions by guiding decision-makers in understanding how an investment or project "scores" relative to each of these values and principles. It will allow decision-makers to develop a greater awareness of the interrelationships between various public objectives related to making the community more resilient. In order to be effective, use of this tool will need to become a regular step in the evaluation of each investment or project.

It is important to note that the evaluation tool does not necessarily make the decision, but should serve as an important piece of the analysis used by decision-makers. This tool should also not be viewed as static; rather, as with any evaluation tool, it will likely need to be refined as we gain experience in its use and as better data and knowledge emerge.

Most importantly, the tool is set up to be comprehensible and useful to decision-makers and community leaders and present conclusions in a simple and easy format that can be readily understood by a wide range of audiences.

Using the Evaluation Tool

Although the evaluation tool process will result in unique solutions to specific locations and conditions, the ultimate goal is to apply these outcomes citywide. Compared to conventional methods of reviewing a project, the evaluation tool is a holistic assessment, tailored to the needs of Hampton. A simple matrix for each value shows points that can be earned for achieving each attribute of that value; points can also be deducted for not meeting the criteria. At the end, points are totaled to give each project a score. Beginning with City agencies looking at their own public projects, the evaluation tool could also be applied to private sector projects, with the intent of achieving smart and resilient development moving forward.

Value Intent Statement

The following values, described earlier in this document in guiding principles, are the basis of the evaluation tool. They have been established by a community-driven process in collaboration with the City of Hampton. Certain criteria are applicable broadly, but the evaluation tool is specific to the unique environment of Hampton. For each value, several attributes capture how a project does or does not align with Hampton's stated values.

1. Safe
The City of Hampton needs to show current and prospective residents, industries, and employers that it has a strategy for addressing climate challenges, evolving into a safe, resilient community with reduced risk, while also prioritizing quality of life for both humans and the environment. Attributes of Safe include Egress: Maintenance, Egress: Connections, Energy and Power, Critical Facilities, Reduce/Adapt Floodplain Development, and Storm-Resistant Structures.

2. Equitable
The City of Hampton believes in prioritizing strategies that create benefits for all. Equity also focuses on specifically strengthening marginalized sectors of the community who are disproportionately affected by environmental risks such as flooding or pollution, or through socio-economic factors such as lack of services or investment. Attributes of Equitable include Neighborly, Citizen Ownership and Involvement, Widespread Access to Benefits and Services, and Social Justice.

3. Natural
Hampton is strategically located in a natural harbor and takes advantage of both coastal proximity and inland access. Hampton values its environment and coastal edges, which must be maintained, repaired, and renewed as ecosystems to maintain and restore the protection that they provide. Attributes of Natural include Nature-Based Solutions, Water Quantity, Water Quality, Reduce Greenhouse Gas Emissions, Vegetation, Restorative, and Ecological Benefits.

4. Heritage
In Hampton, valuing heritage and culture means appreciating the history and traditions that have developed over time as a result of the local landscape, waterways, and diverse inhabitants, which should also be preserved and supported into the future. Attributes of Heritage include Prioritizes Historic and Cultural Resources, Advances Hampton's Story, Respects Neighborhood Culture and Character, and Reinforces "Culture of Water."

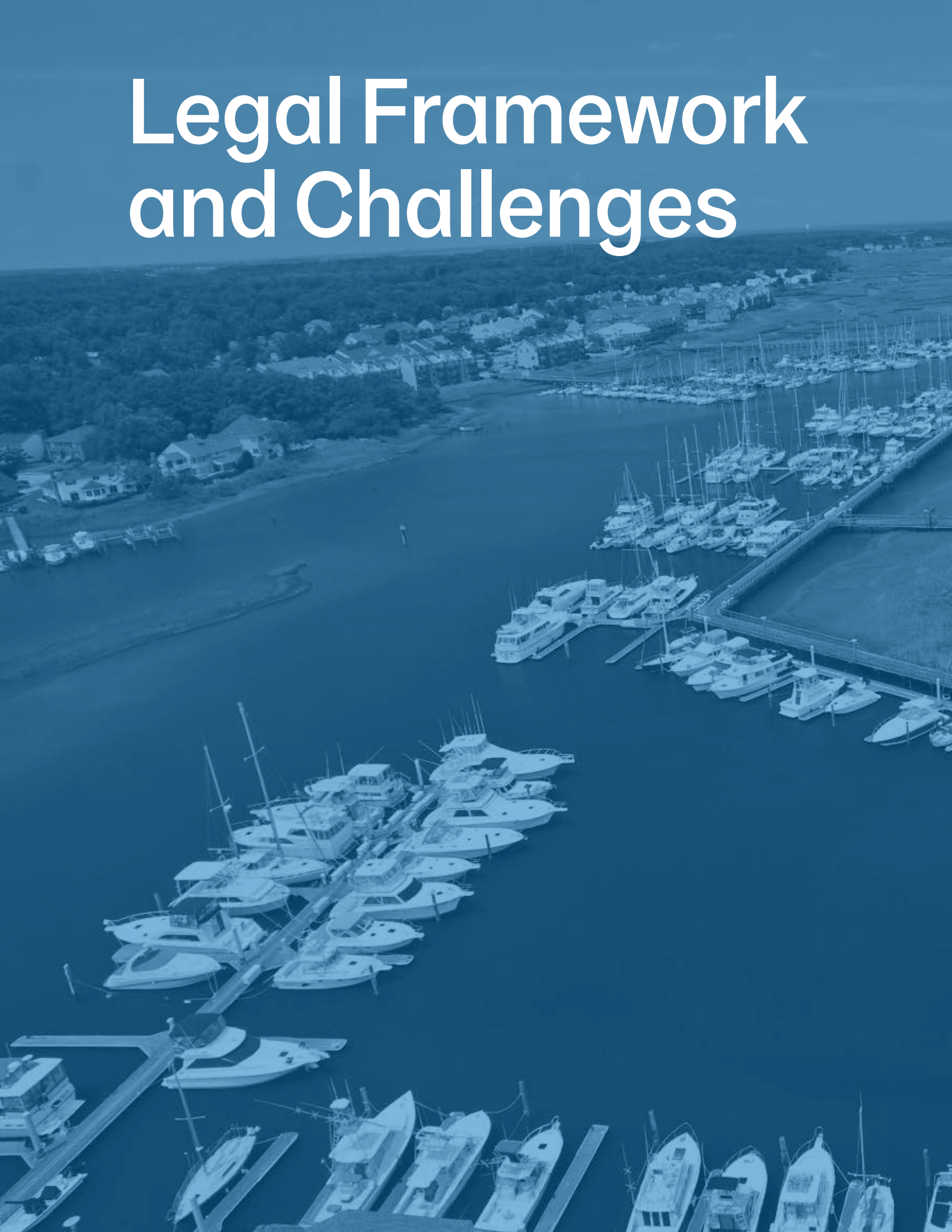
5. Integrated
Connection of different systems, benefits, and participants leads to a more holistic result that addresses a range of values and create strategies with multiple benefits. Attributes of Integrated include Multiple Benefits, Collaborative, and Informed.

6. Sufficient
Similar in some ways to equity, the value of sufficiency aims to leverage public investment to improve the financial health of residents while using funding in the most effective and beneficial manner by securing livelihoods, developing new industries, creating jobs, and strengthening the local economy. Attributes of Sufficient include Supports Livelihoods, Improves Property Values, Supports Higher-Income Jobs, Fiscal Responsibility, and Sustainable/Reductive Resource Consumption.

7. Nimble
The value of nimbleness, or flexibility and adaptability, is central to developing strategies that can accommodate changing conditions in Hampton over time, including physical, social, and/or environmental aspects. Attributes of Nimble include Implementable, Adaptive, Considers All Scales, Iterative Process, and Replicable.

8. Innovative
Hampton has long been a place of innovation, and this forward-thinking attitude and creativity should also be applied to the climate-based challenges the city faces, becoming a model city for places in Virginia and along the coast, as well as for itself. Attributes of Innovative include Raises or Exceeds Standards, Long-Term Thinking, Addresses Local Needs, and Fits to Place.

Legal Framework and Challenges



Balancing Investment and Resilience
Smart development in places vulnerable to flooding presents complex challenges. Above, a relatively new residential area in between Salt Ponds and the Chesapeake Bay.

Legal Framework and Challenges

Sources of Legal Authority

Hampton is an independent city (in legal terms, a "municipal corporation") of the Commonwealth of Virginia. The City as it is known today was created in 1952 with the adoption of a consolidated charter by the Virginia General Assembly that merged the former city of Hampton and the county of Elizabeth City, which included the former town of Phoebus.

As an independent City, Hampton has all of the powers that are given to it through Code of Virginia and its charter. Importantly, Virginia follows the "Dillon Rule" of strict construction, which provides that local governments have and can exercise only those powers expressly granted by the General Assembly, those necessarily or fairly implied from those express powers, and those that are "essential and indispensable." [1] It must exercise those powers in ways that comply with the U.S. and Virginia Constitutions. For example, the City must respect due process and equal protection rights, particularly with regard to private property ownership and application of local law. Hampton's City Council is the governing body authorized by the General Assembly to exercise the City's powers by adoption of ordinances, resolutions, policies, and other measures.

In practice, this means that any action that the City desires to take in furtherance of sea level rise adaptation will require authorization from the Commonwealth and enabling language in either the City charter or Code of Virginia. If the City enacts legislation without authority, it would likely be subject to expensive legal challenges. If doubt exists as to whether a local government has the authority to legislate something, the doubt is usually resolved against the locality. In some cases, such as planning and zoning, the Commonwealth has already provided broad authority to local governments. In other cases, such as condemnation powers, the state has limited the City's authority.

1 Bd. of Zoning Appeals of Fairfax Cty. v. Bd. of Sup'rs of Fairfax Cty., 276 Va. 550 (2008).

Existing Legal Authority & Limitations Related to Sea Level Rise Adaptation

The Commonwealth of Virginia has provided some specific authority to local governments related to resiliency, including:

Comprehensive Planning

- Required local governments in the Hampton Roads area, as of July 1, 2015, to "incorporate into the next scheduled and all subsequent reviews of its comprehensive plan strategies to combat projected sea level rise and recurrent flooding" in coordination with the Hampton Roads Planning District Commission.[2]

Physically Adapting

- Authorized local governments to construct dams, levees, seawalls, and other structures and devices to prevent tidal erosion, flooding, and inundation and declared such action to be a governmental function for a public purpose.[3]

Acquiring Property

- Authorized local governments to acquire by condemnation lands, buildings, easements, earth, and water[4] with just compensation to the property owner and only when the property is taken for a public use.[5] A public use is found, in part, when property is taken for the "construction, maintenance, and operation of public facilities," with public facilities including "flood control, bank and shore protection, watershed protection, and dams."[6] No more private property may be taken than that which is necessary to achieve the stated public use.

- Authorized local governments to acquire, by voluntary conveyance, real property for public uses[7] and, more specifically, for open, undeveloped spaces.[8] Virginia recognizes riparian property rights, which means that waterfront property owners usually have a real property interest connecting their property to the abutting water body.[9] The City is authorized to acquire and condemn riparian rights or easements over riparian areas, for public uses, such as dredging and living shorelines.

2 Va. Code Ann. § 15.2-2223.3 (2017).
3 Va. Code Ann. § 15.2-970 (2017).
4 Va. Code Ann. § 15.2-1901.1 (2017).
5 Va. Code Ann. § 1-219.1 (2017).
6 Id.
7 Va. Code Ann. § 15.2-1800 *et seq*.
8 Va. Code Ann. § 10.1-1700 *et seq*.
9 Carr v. Kidd, 261 Va. 81, (2001).

Regulating

- Formally declared that controlling flooding is in the public interest.[10]
- Authorized (and, in some cases, required) local governments to administer environmental laws on matters such as Stormwater Management, Erosion and Sediment Control, Chesapeake Bay Protection, and Wetlands Management at the local level.[11]
- Authorized localities to enact regulations consistent with the National Flood Insurance Program (NFIP) administered by FEMA.[12]
- Granted local governments substantial planning and zoning powers that expressly allow localities to adopt regulations based upon, "the trends of growth or change… the preservation of flood plains, the protection of life and property from impounding structure failures… and the encouragement of the most appropriate use of land throughout the locality."[13]
- Required zoning ordinances adopted by localities to be designed to give reasonable consideration to, among other purposes, "flood protection."[14]

Incentivizing Conservation and Adaptation

- Grants tax incentives to property owners who make land donations for conservation purposes under the Virginia Land Preservation Tax Credit program.[15]
- Authorizes local Economic Development Authorities[16] and Housing Authorities[17] to make loans and grants to private parties for permitted purposes, which could include sea level rise adaptation measures.
- Authorizes local governments to implement "incentive zoning," which allows localities to grant bonuses in the form of increased project density or other benefits to a developer in return for the developer providing certain features, design elements, uses, services, or amenities desired by the locality, including but not limited to, site design incorporating principles of new urbanism and traditional neighborhood development, environmentally sustainable and energy-efficient building design, affordable housing creation and preservation, and historical preservation, as part of the development.[18]

10 Va. Code Ann. § 10.1-658 (2017).
11 For example, the Virginia Erosion and Sediment Control Program, Chesapeake Bay Preservation Act, and Stormwater Management Act, all enable and require applicable localities to act. [add formal cites]
12 [add cite]
13 Va. Code Ann. § 15.2-2284 (2017).
14 Va. Code Ann. § 15.2-2283 (2017).
15 Va. Code Ann. § 58.1-512 et seq. (2017).
16 Va. Code Ann. § 15.2-4905 et seq. (2017).
17 Va. Code Ann. § 36-19 et seq. (2017).
18 Va. Code Ann. § 15.2-2286 (2017).

Additional Legal Authority Needed for Adaptation Measures

In order to maximize local governments' ability to adopt resiliency measures, the General Assembly should:

- Provide express authority, similar to the comprehensive plan language described above, for localities to adopt zoning and other development regulations in order to "combat projected sea level rise and recurrent flooding." Doing so would eliminate doubt as to the legitimacy of regulations based upon data projections from reliable sources.
- Provide express authority to require structures to be floodproofed and regulate methods of construction over and above the base Uniform Statewide Building Code requirements, even when located outside of a FEMA-designated flood zone.
- Provide additional opportunities for funding of sea level rise adaptation projects.

Additional Legal Reference Material

Hampton Roads Intergovernmental Pilot Project: Memo and Legal Primer (VCPC)
http://law.wm.edu/academics/programs/jd/electives/clinics/vacoastal/reports/cover%20memo%20and%20primer%20final.pdf

Wetlands Watch Sea Level Rise Adaptation Guide
http://wetlandswatch.org/sea-level-rise-adaptation-guide

Next Steps

Prioritizing Unique Values
Planning for a more resilient future requires a holistic vision for a new type of waterfront city, including economic, recreational, and ecological values.

Next Steps

This report represents the first phase of analysis and recommendations aimed at setting broad direction for Hampton's holistic approach to addressing sea level rise and resiliency. The findings and recommendations in this first phase of work focused on three main objectives: (1) Assessing our current conditions and challenges as well as understanding projections for future conditions utilizing the best data available; (2) Understanding what is important to the community and, in doing so, gain an appreciation and awareness for what differences may exist from neighborhood to neighborhood; and (3) Establishing goals and recommendations which will provide a clear foundation to help guide our future actions and decisions.

Based upon this work, it is recommended that the following "next steps" be undertaken as logical action items:

- Amend the Hampton Community Plan to reflect the work of this document and incorporate the recommendations.
- Undertake a comprehensive effort to review and amend City codes and ordinances to support the goals and objectives adopted into the Hampton Community Plan from this document.
- Refine the evaluation tool as necessary and institutionalize its use as an integral part of decision making for public projects.
- Pursue changes to legal frameworks at the State level, if necessary.
- Set "resiliency targets" for the community and establish a process to track and measure our progress.
- Identify one or two geographic "focus areas" which will be the subject of the Phase II work. Phase II work will take a more detailed look at the identified geographic "focus areas" to apply what we have learned in Phase I. The goal for these areas will be development of a holistic set of strategies that can be implemented.
- Continue to work with our partners to learn, share, innovate and advocate for regional progress on sea level rise and resiliency issues.
- Work with our partners to develop a community education program which raises awareness with regards to the value of being a resilient community. Additionally, the education program will identify strategies and action items applicable to businesses, individual homeowners, institutions, and other stakeholders.
- Continue to work with Langley Air Force Base to develop a resiliency component to the existing Joint Land Use Study.
- Establish and support a "Hampton Resilience Partnership" in order to create a formal structure to bring community, business, academic, and regional partners together on a formal basis to assist in moving our resiliency goals forward.

Addendum to the Hampton-Langley Joint Land Use Study

Expanding the reach of this study and report, a related study will specifically address sea level rise and resiliency issues in Hampton that may impact current and future operations at Langley Air Force Base. The study will create an addendum to the adopted 2010 Joint Land Use Study (JLUS) between the City of Hampton and Langley Air Force Base and will also expand the "Place-Driven Analysis" section of this report. The addendum will provide an overall narrative to introduce sea level rise and resilience strategies. It will also include an Implementation Strategy that defines implementation actions and provides rough order of magnitude cost estimates. The Hampton-Langley JLUS Addendum will help solidify a path forward to the City of Hampton and Langley Air Force Base to identify and implement resilience strategies that ensure continued feasibility of base operations in the face of sea level rise and recurring flooding.

Phase II - Implementable Projects

Based on recommendations in this report, a geographic area will be selected as a 'pilot area.' An overall area plan will identify actionable steps and recommend pilot projects. Education and outreach efforts will continue forward, informing the work. Phase II will provide an opportunity to test and calibrate the evaluation tool. While a specific geographic area will be selected for the next phase, it does not preclude work in other areas of the city. Instead, this pilot area will provide an armature through which to demonstrate, measure, and revise the methodology established in this report.

Atlas

Water Economy
The Hampton River supports a range of water-based commerce, including the local seafood industry, ------ transport, and recreational activities.

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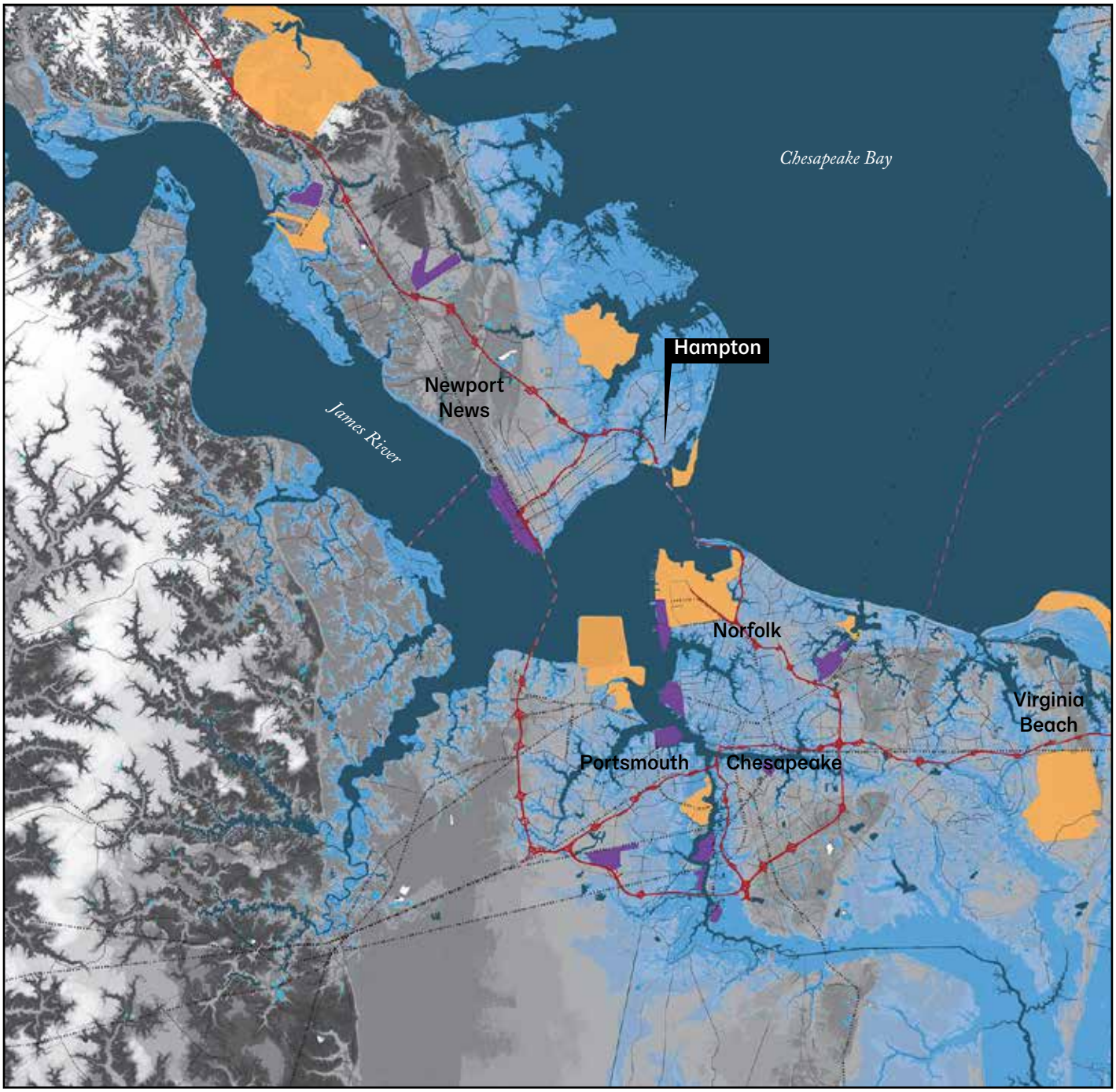
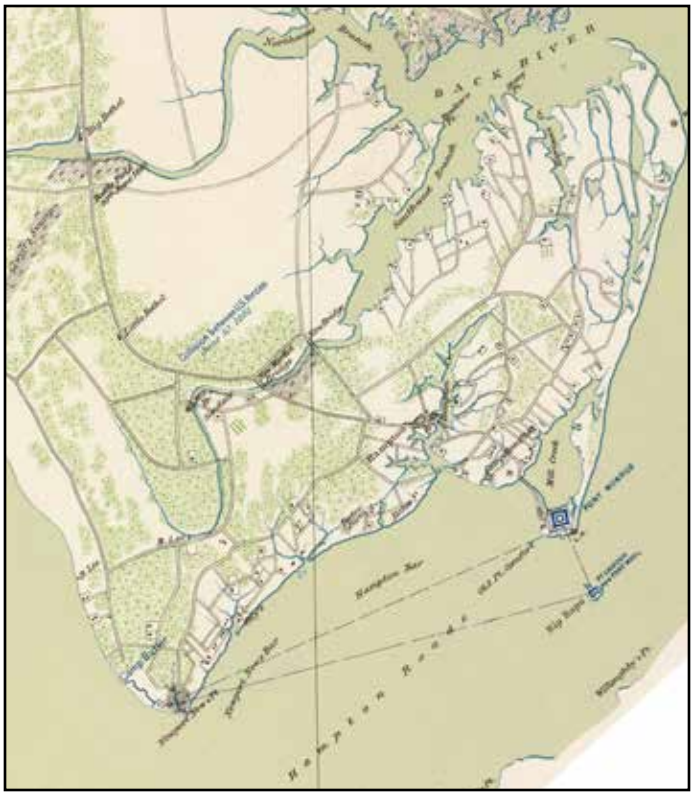
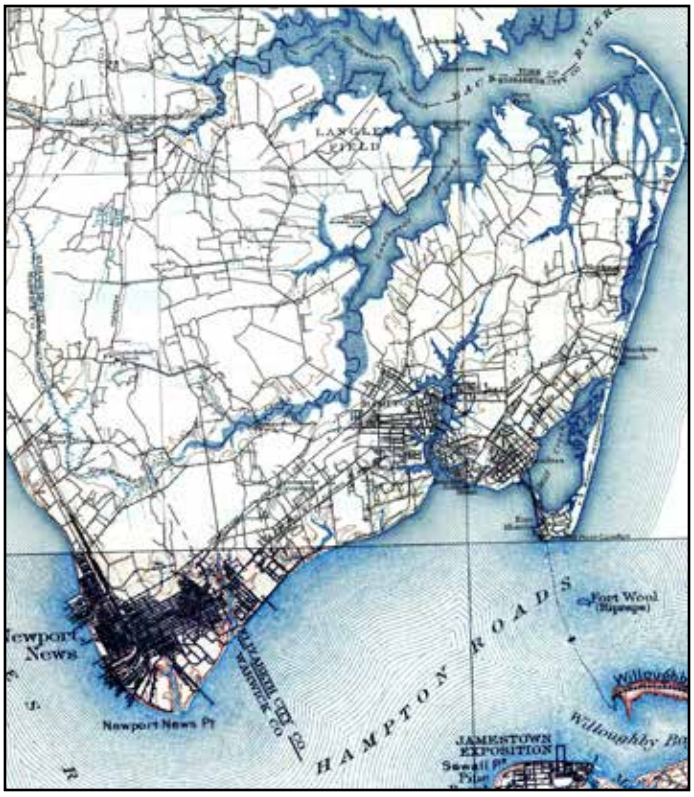


Regional Corridors, Infrastructure, and Risk
The cities in the Hampton Roads region are linked through a network of waterways and transit corridors. A key natural harbor, the region's ports are critical for both industry, trade, and national defense.

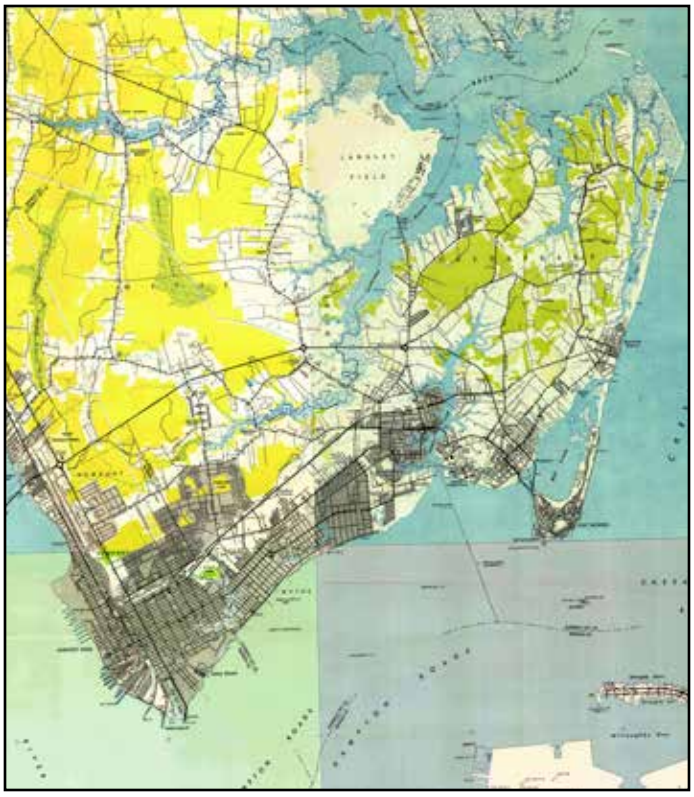
- 0'-8' Above Sea Level
- 8'-13' Above Sea Level
- Federal Facilities
- Industrial Zones
- Interstate
- Secondary Roads



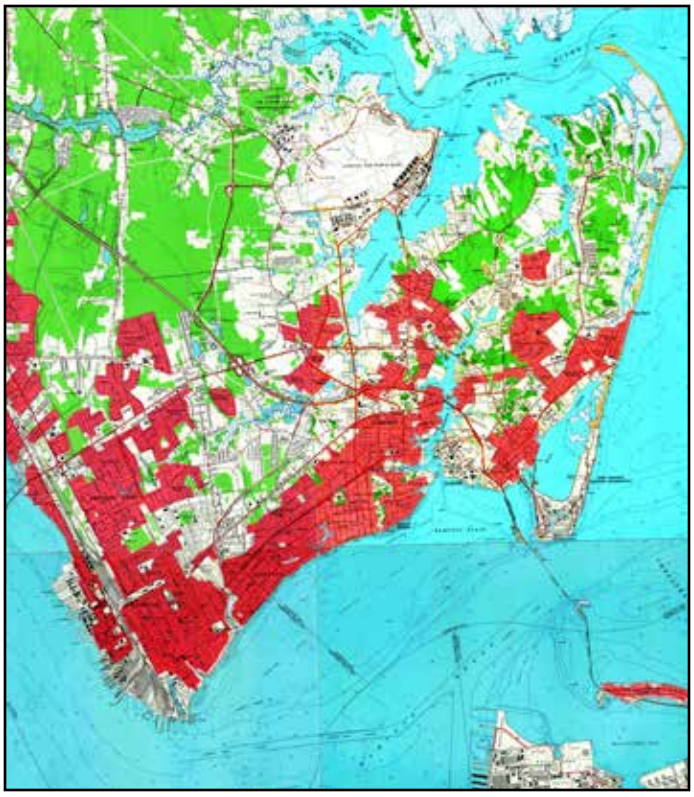
circa 1861 - 1865; Civil War map
This Civil War era map illustrates the importance of proximity to water for early development.



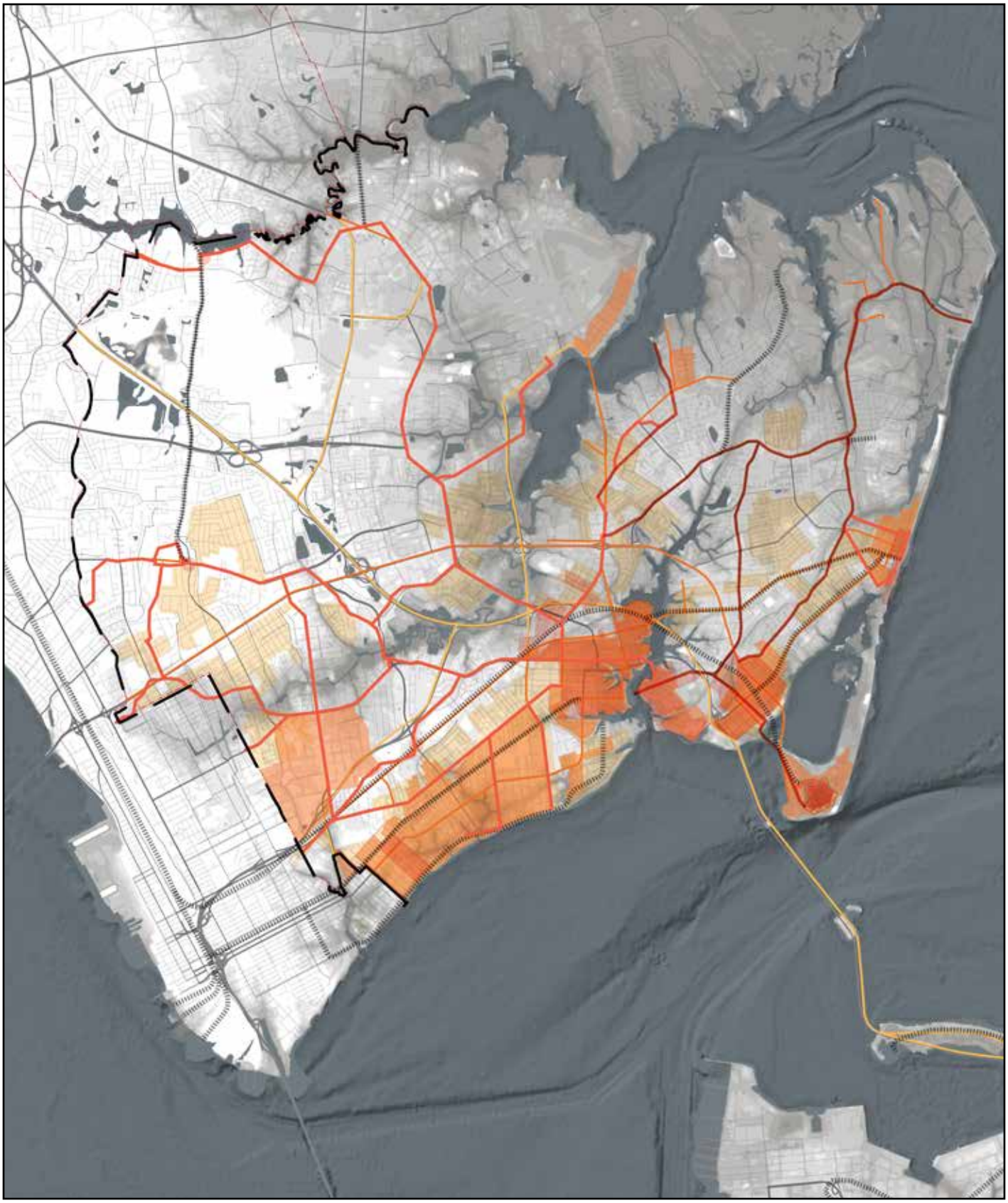
1907 USGS map
Historic development patterns near the Hampton River and Old Point Comfort are evident in the above map.



1944 USGS map
Near the end of World War II, the city still centered on the bay and Hampton River areas, with increasing density along the harbor.



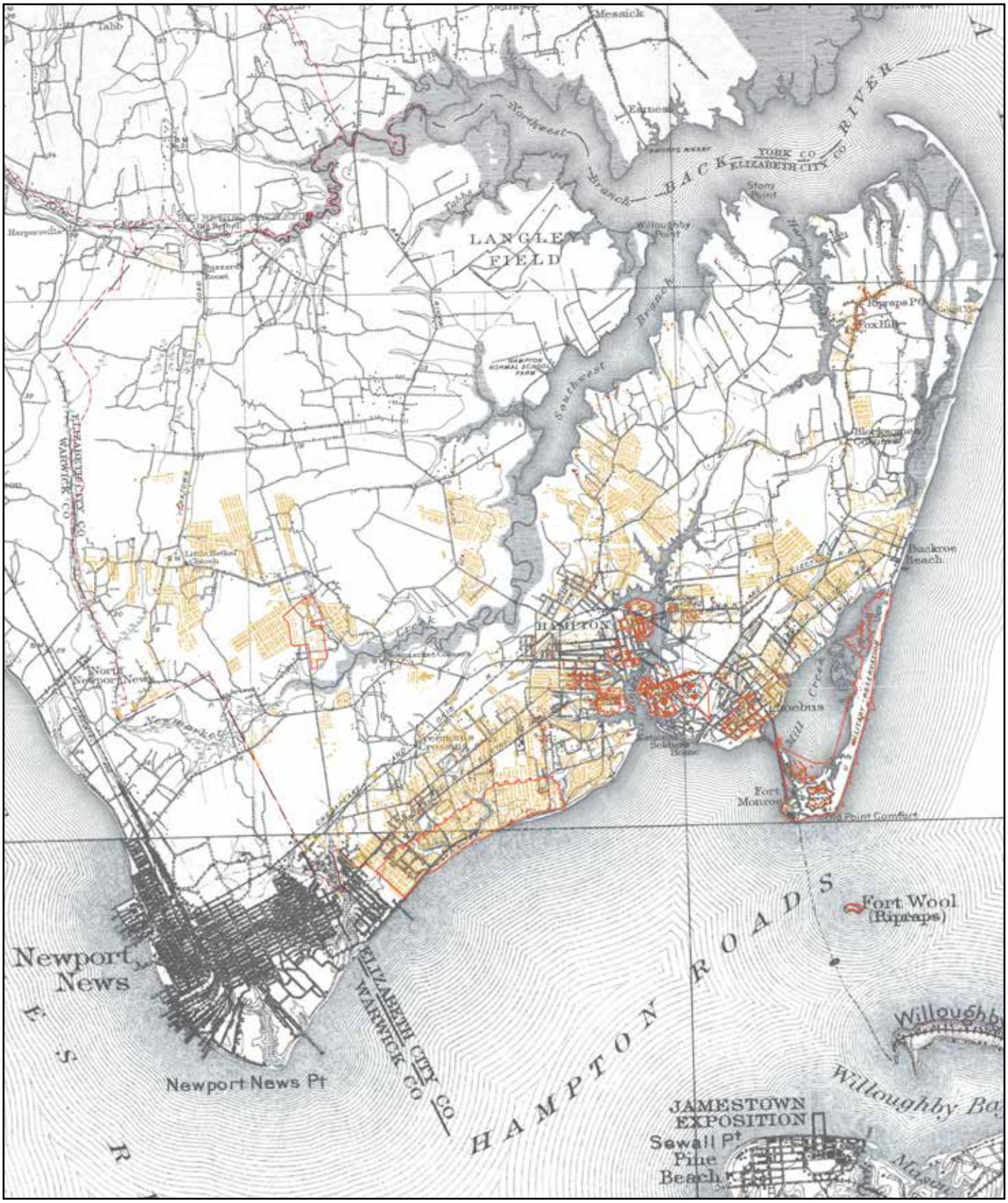
1965 USGS map
The modern development shown in this 1965 USGS map indicates how development expanded into lowland areas as the city grew.



Historic Corridors and Development Patterns

Many of Hampton's historic corridors still function as transportation arteries today. This map illustrates the development pattern of the city over time, moving first along the coast, then inland and north from the harbor.

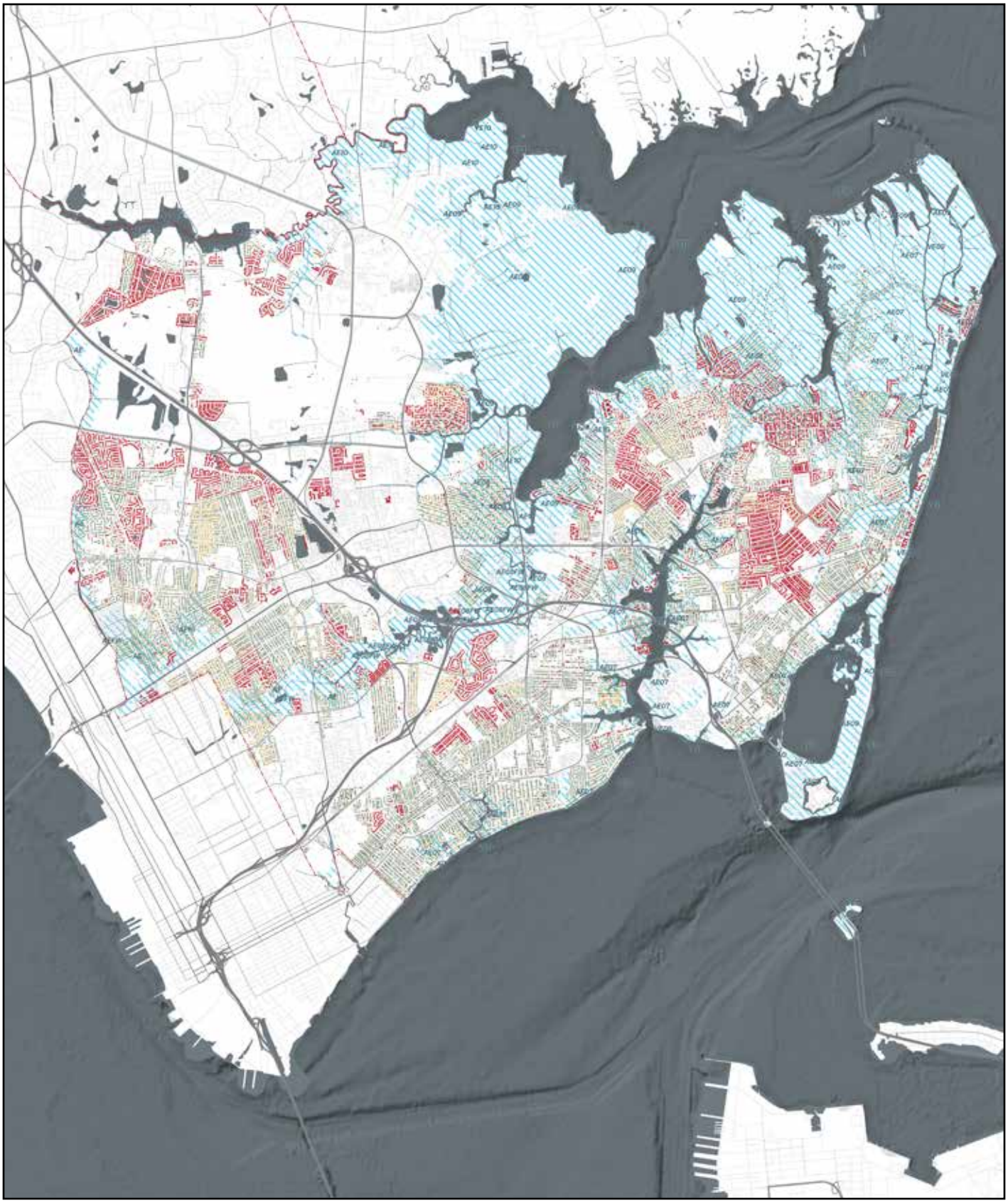
- 1860 Roads
- 1907 Roads
- 1944 Roads
- 1965 Roads
- 1860 Development
- 1907 Development
- 1944 Development
- 1965 Development



Historic Structures

This map shows the expansion of the city through building age. Many of the facilities at Fort Monroe were constructed in the late 1800's, while the city saw great expansion inland from 1910-1960. Early development preferenced either strategic coastal areas or higher ground.

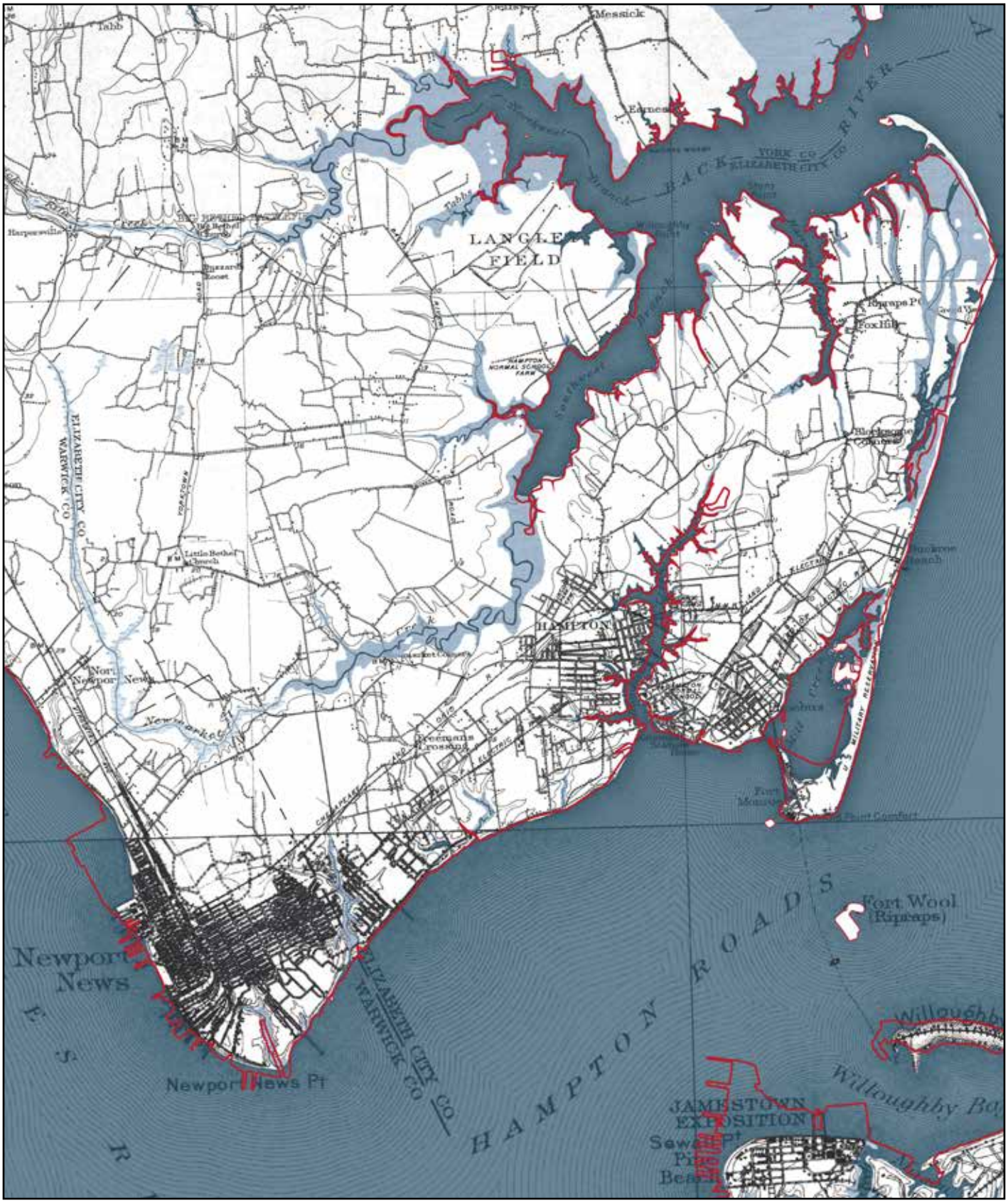
- 1720 - 1860
- 1860 - 1910
- 1910 - 1960
- Historic Districts



Foundation Type

Many inland structures are slab-on-grade or basement construction and have a higher risk of flooding as sea levels rise and storms become more frequent.

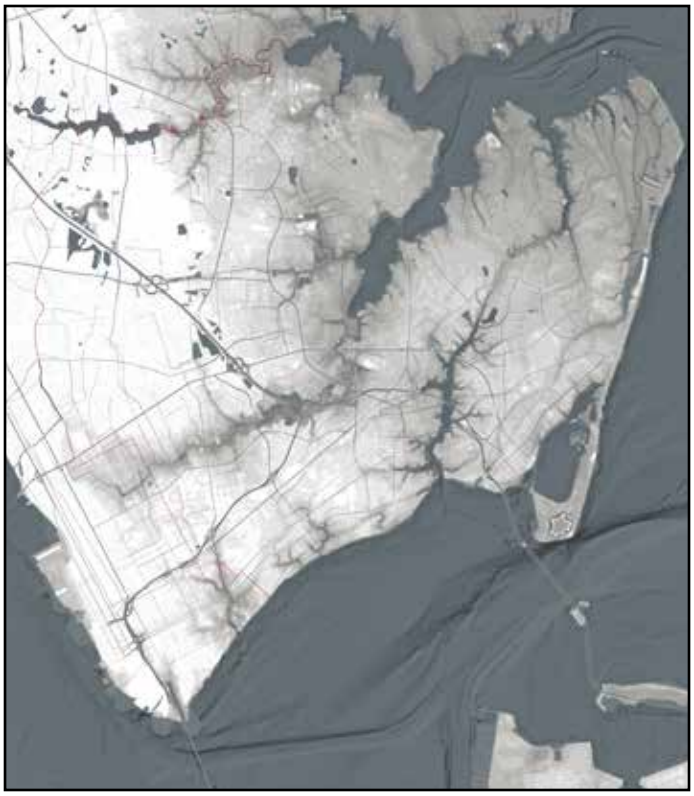
- Basement
- Slab
- Raised / Crawl Space
- 100-Year Floodplain



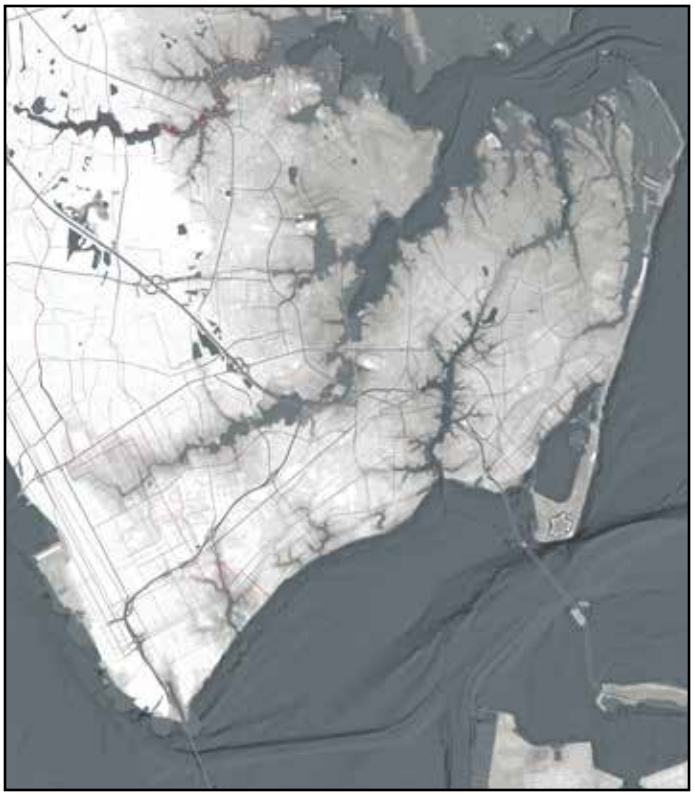
Historic Shoreline

The overlaid current shoreline, shown in red, indicates either the areas filled for human occupancy or lost to erosion. Many of the historic wetlands surrounding the creek, mapped in 1907, have been manipulated and the shoreline along the harbor has extended into the water. Today, the city of Hampton has an incredible 124 miles of navigable waterfront.

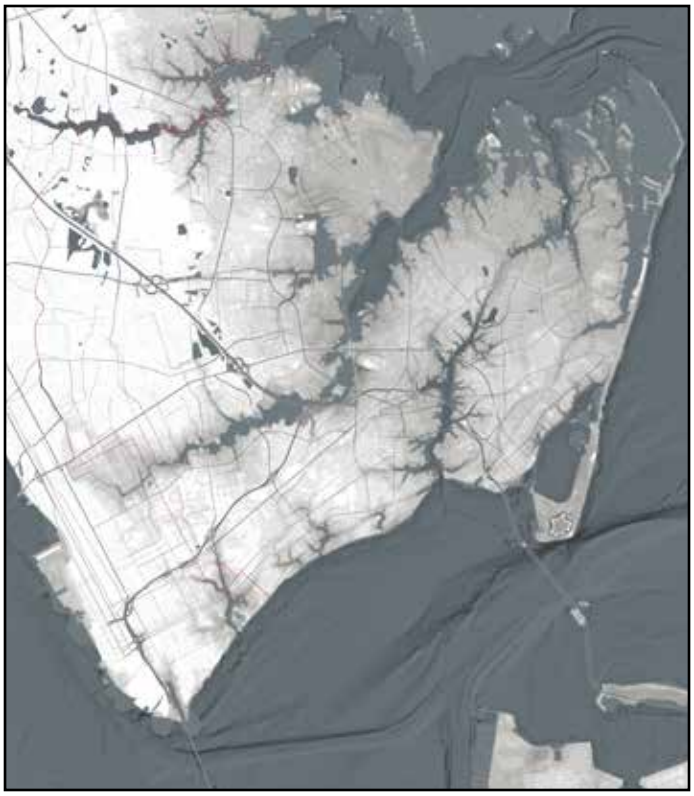
- Current Shoreline
- Historic Wetlands
- Historic Water



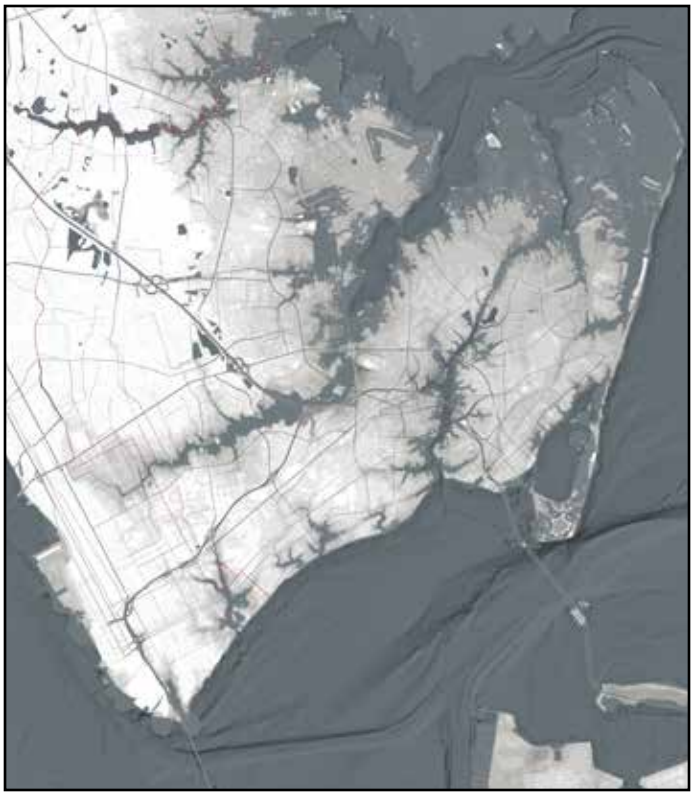
Shoreline Condition, 2017
Current condition.



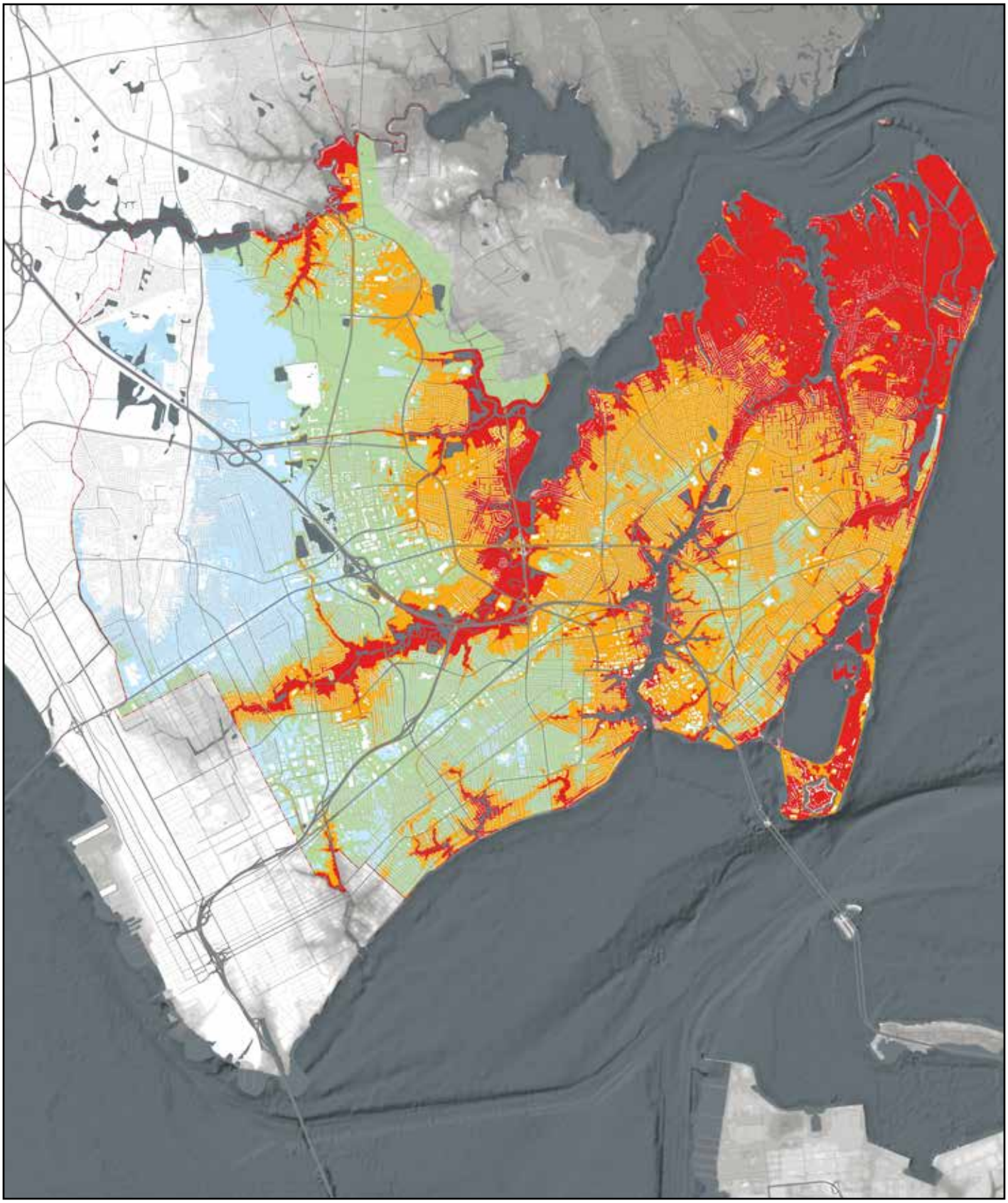
Shoreline Condition, 2050
Illustrating a predicted 2' of sea level rise at high tide.



Shoreline Condition, 2070
Illustrating a predicted 3' of sea level rise at high tide.



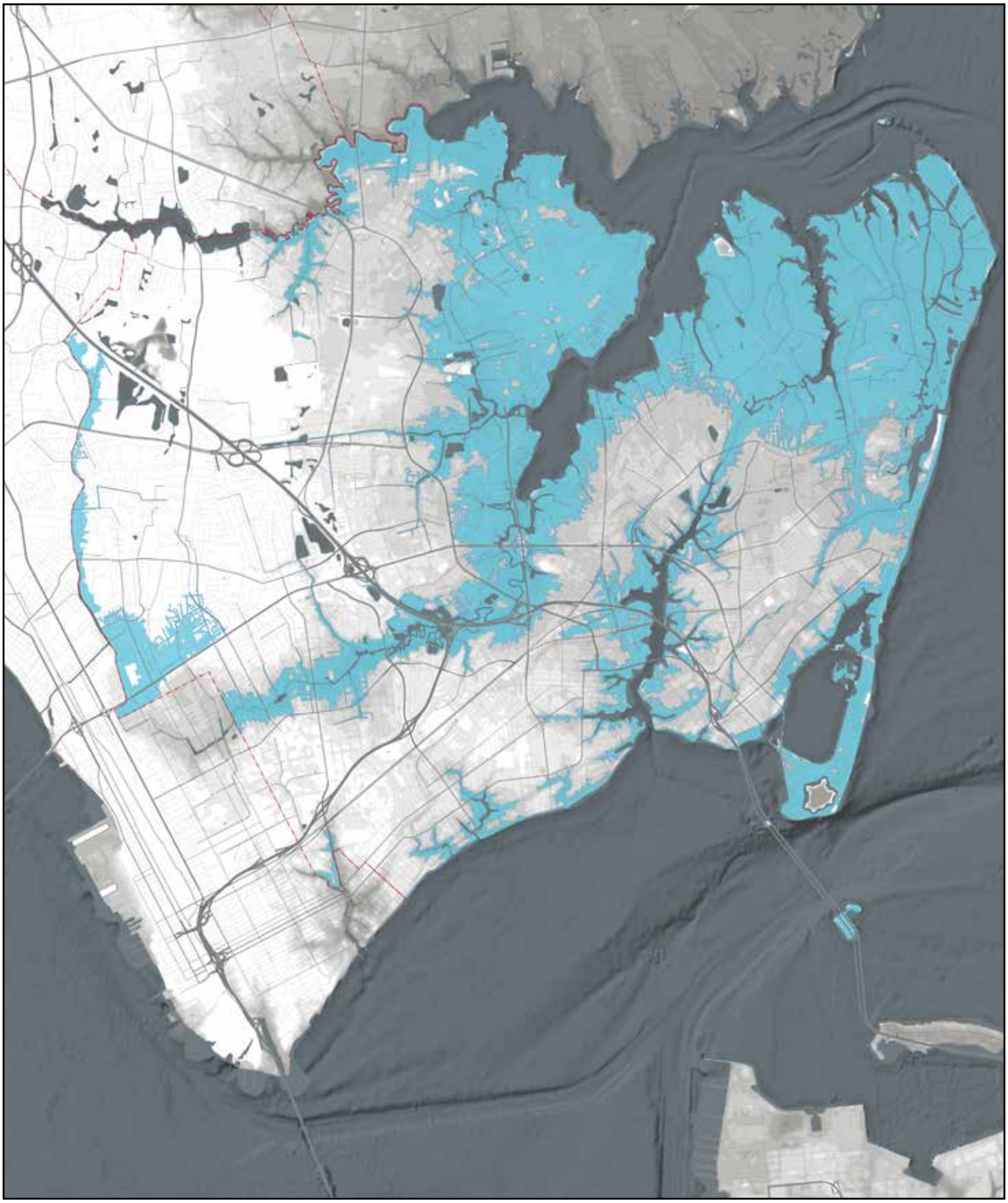
Shoreline Condition, 2100
Illustrating a predicted 5' of sea level rise at high tide.



Storm Surge

This map illustrates the maximum of the maximum modeled surge extents by category of storm. As shown, flooding extents from a category 4 storm would affect much of the city, while a category 1 storm impacts areas around the coast, rivers, and creeks.

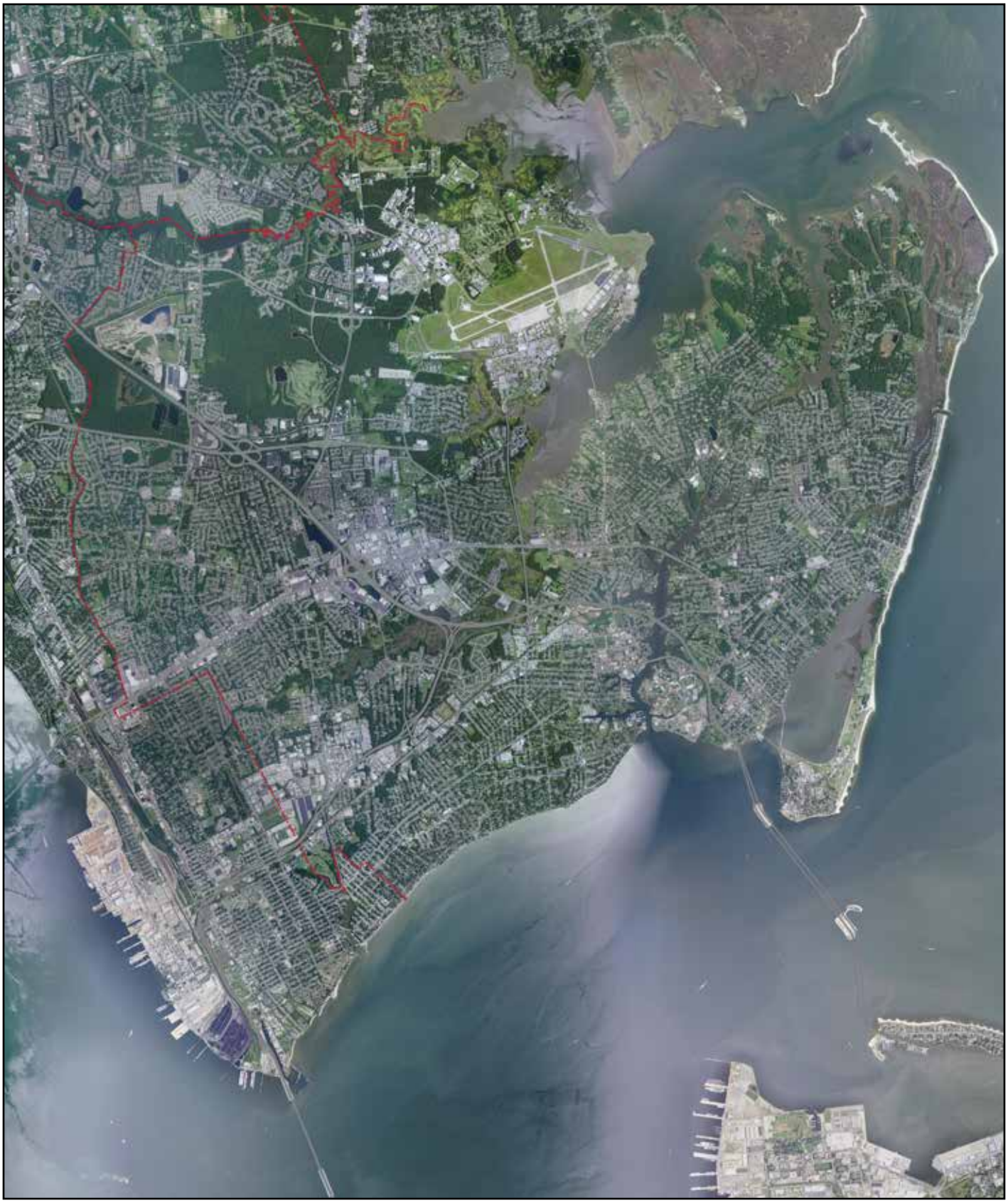
- Category 1 storm
- Category 2
- Category 3
- Category 4



FEMA 100-Year Floodplain

The area shown in blue on the map above indicates the extents of the 100-year floodplain, or the area that has a 1% annual chance of inundation. The 100-year floodplain corresponds with the National Flood Insurance Program; after major events, the extents of the floodplain main be reexamined and redefined based on new data.

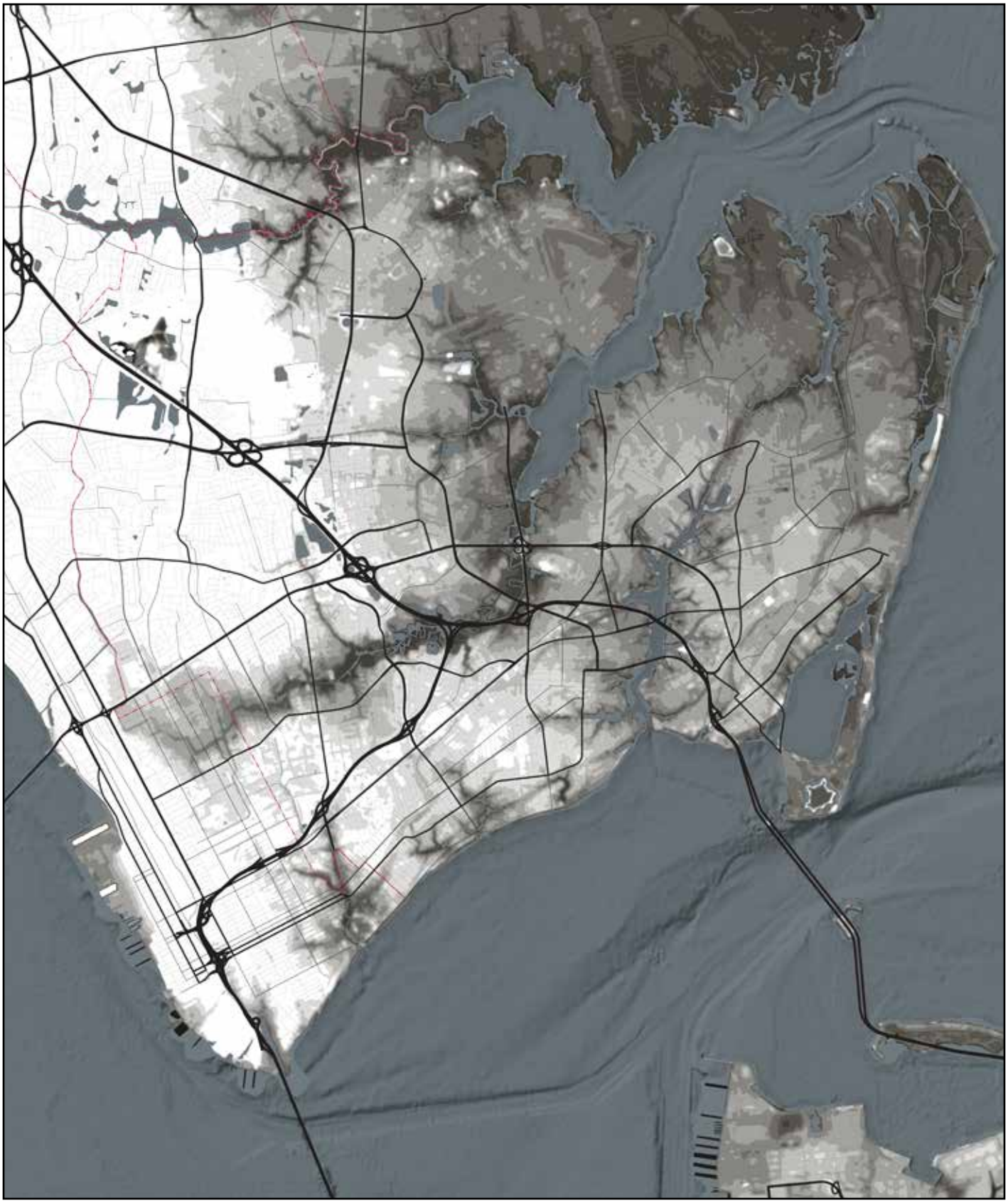
100-Year Floodplain



Aerial

This aerial imagery allows for clear delineation of density and land use as well as landscape type. Major corridors and protected open space can be seen cutting through Hampton.

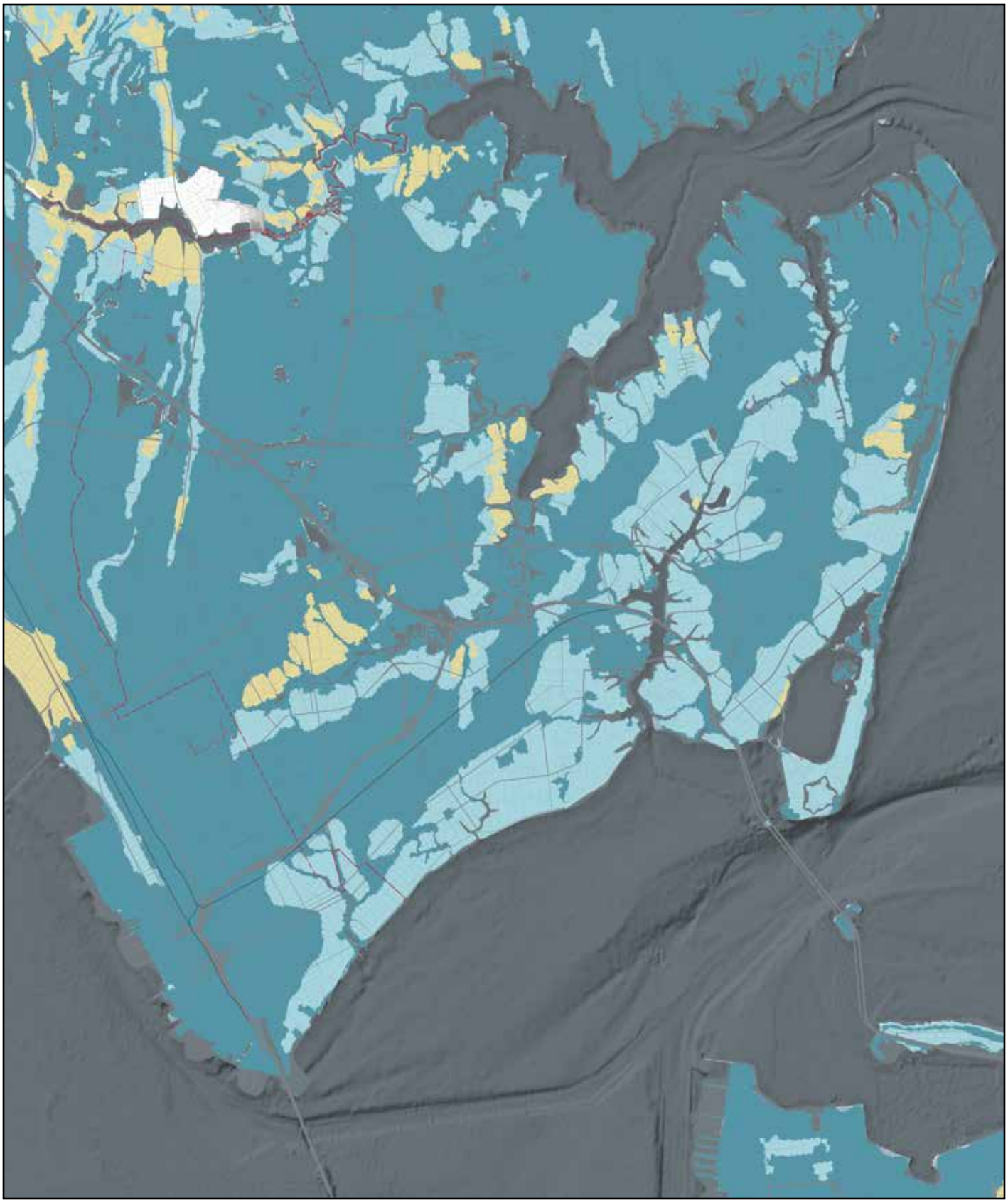
City Boundary



Elevation

The topography of Hampton, with its low elevations, exposes the reason for many flooding issues, but also illustrates the advantages of humans occupying this landscape. The low wetlands with proximity to the bay and the higher ground on the harbor side allow for varied shore conditions.

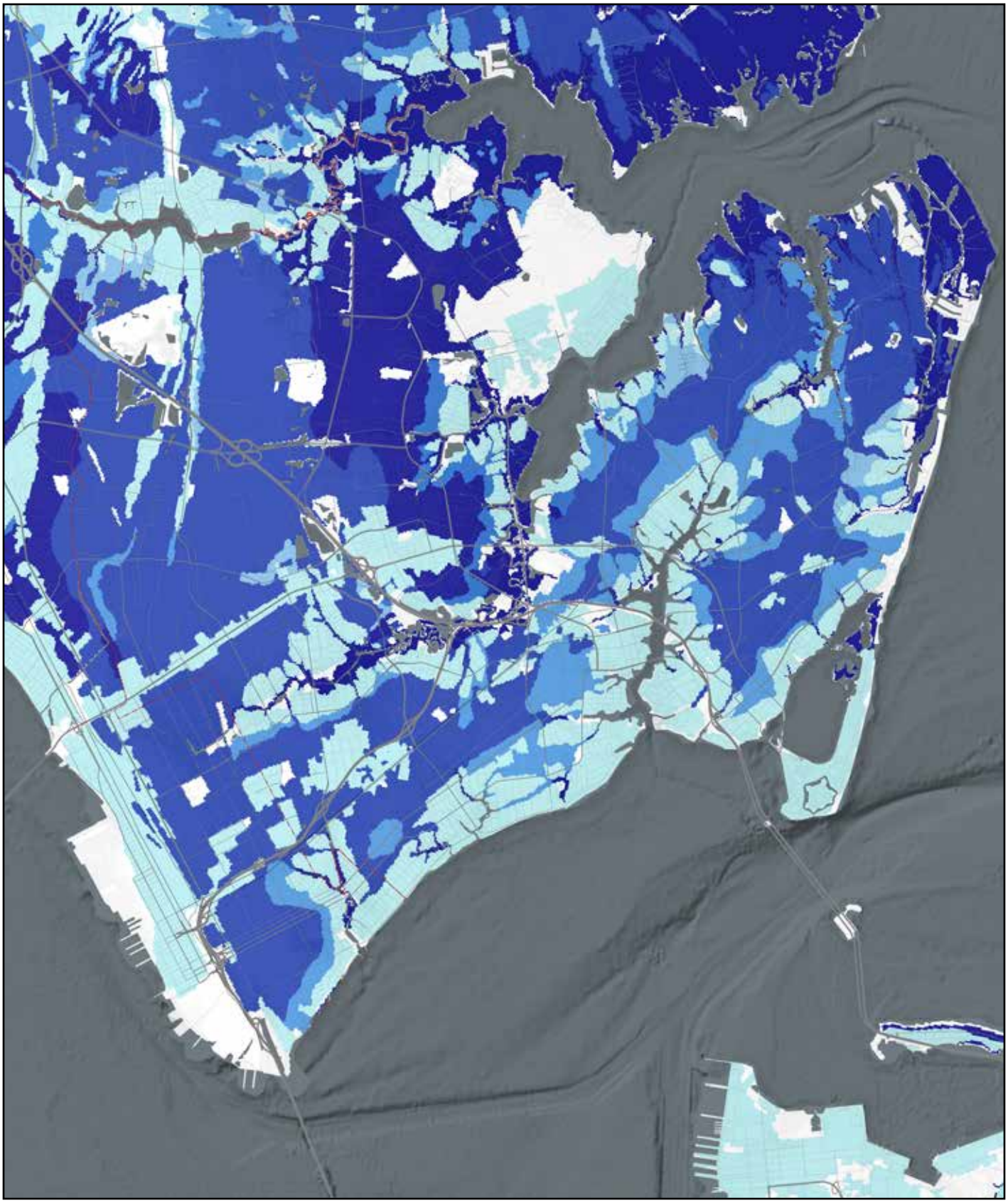
-1'- 0'	5'-6'	11'-12'
1'- 2'	7'-8'	13'-14'
3'-4'	9'-10'	15'+



Hydric Soils

Hydric soils are those which formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions. Hydric soils are susceptible to subsidence if drained or dried. Non-hydric soils have greater capacity for subsurface water storage and green infrastructure.

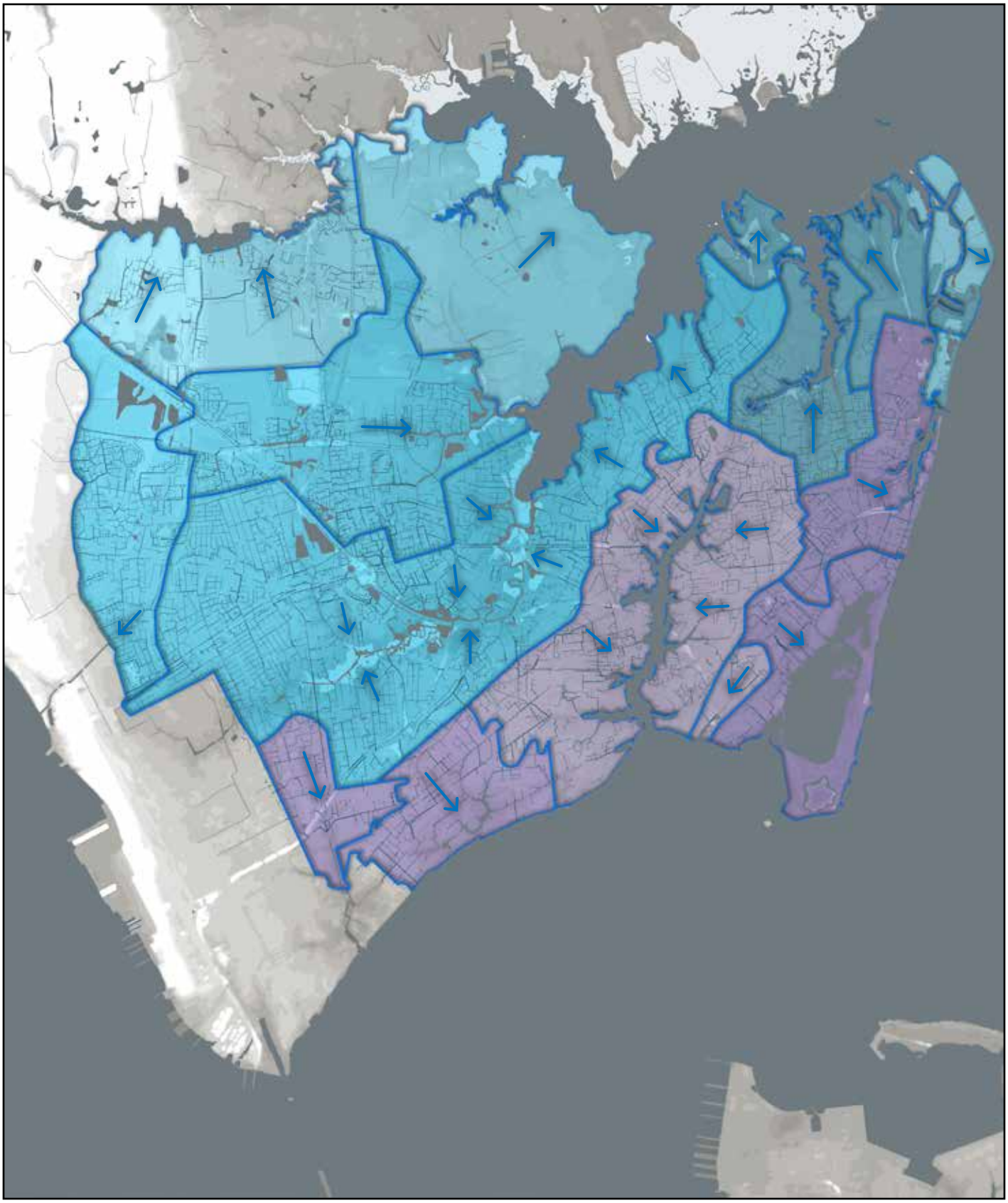
- Not Hydric
- Partially Hydric
- Hydric
- No Data



Depth to Groundwater

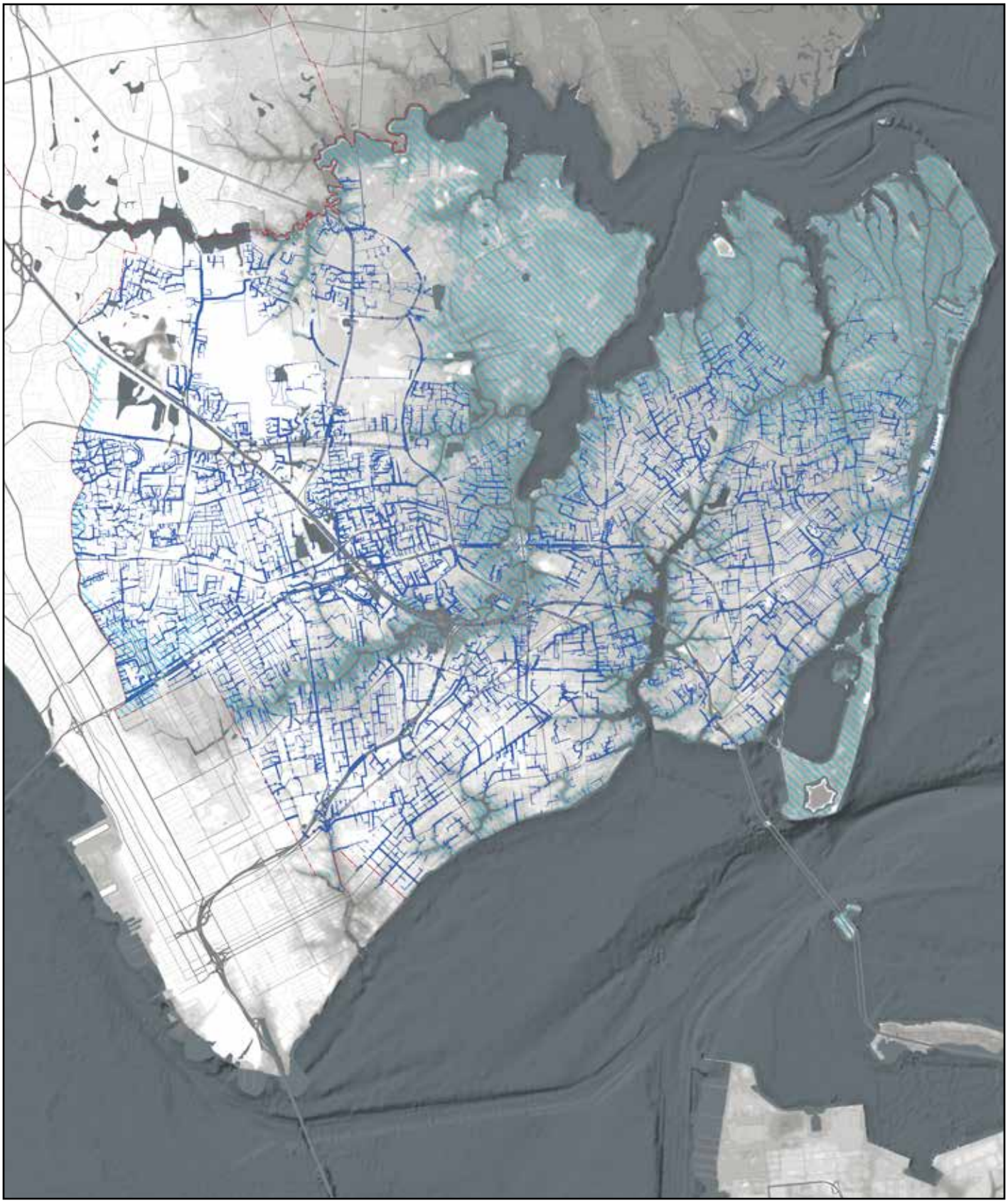
The depth to groundwater is important when considering green infrastructure measures. The deeper the groundwater, the more storage can be accommodated in that area. Depth to groundwater corresponds to soil type, with non-hydric soils generally providing greater depth to groundwater.

- 0' - 1'
- 1' - 2'
- 2' - 3'
- 3' - 4'
- 4' - 5'
- 5'+
- No Data



Drainage Sheds

The colored areas shown in the map above illustrate drainage sheds, or watersheds. These watersheds are tied together through their stormwater networks. Within a watershed, all rainwater drains in one direction to an outfall system. The arrows shown on the map above diagrammatically indicate the direction of flow.

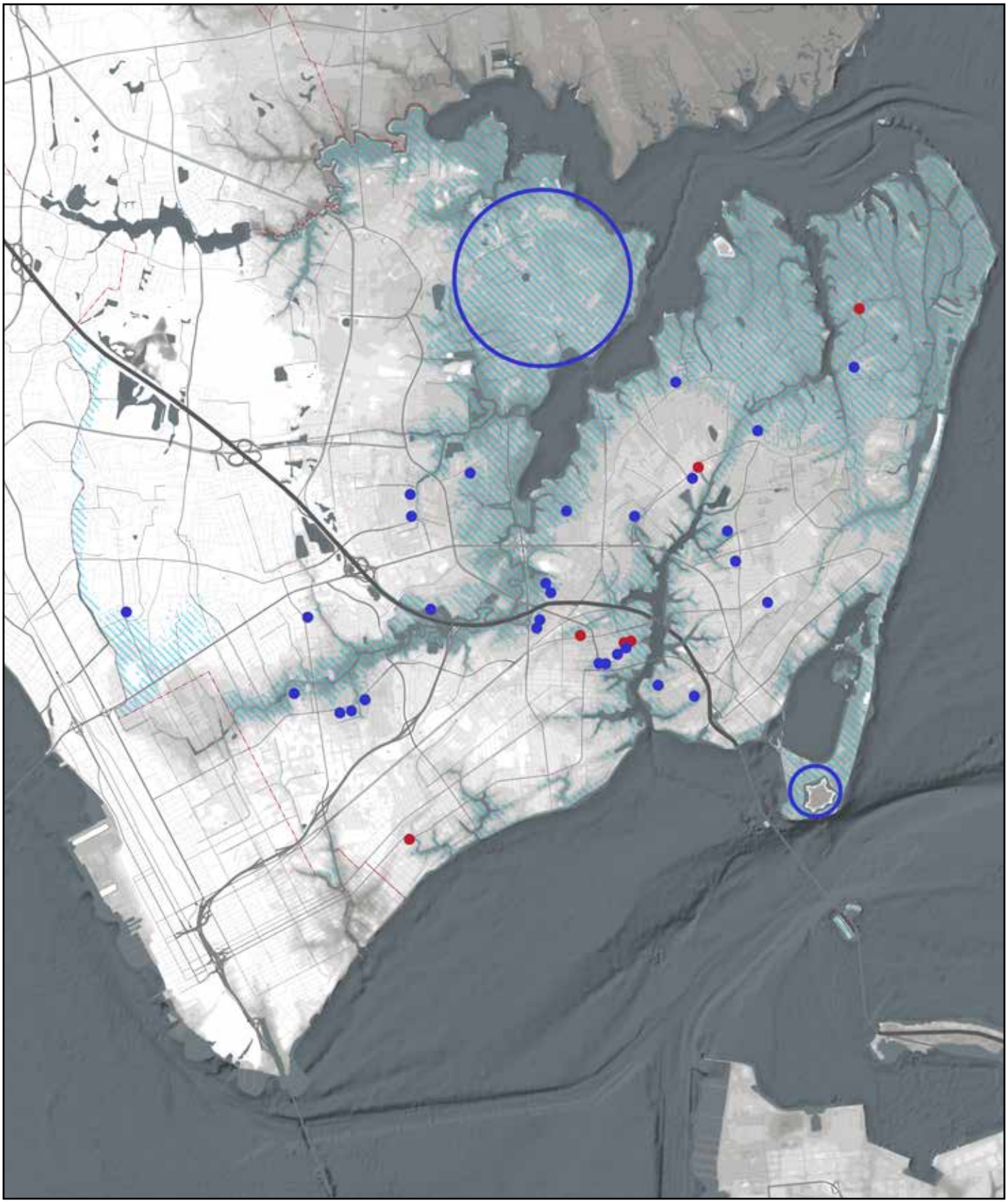


Drainage Infrastructure

This drainage map indicates the current location of stormwater infrastructure and the relative size and capacity of those lines (the thicker the line, the greater the size/capacity). Much of the drainage system flows towards inland bodies of water such as Hampton River and Newmarket Creek.

Drainage Line

100-Year Floodplain



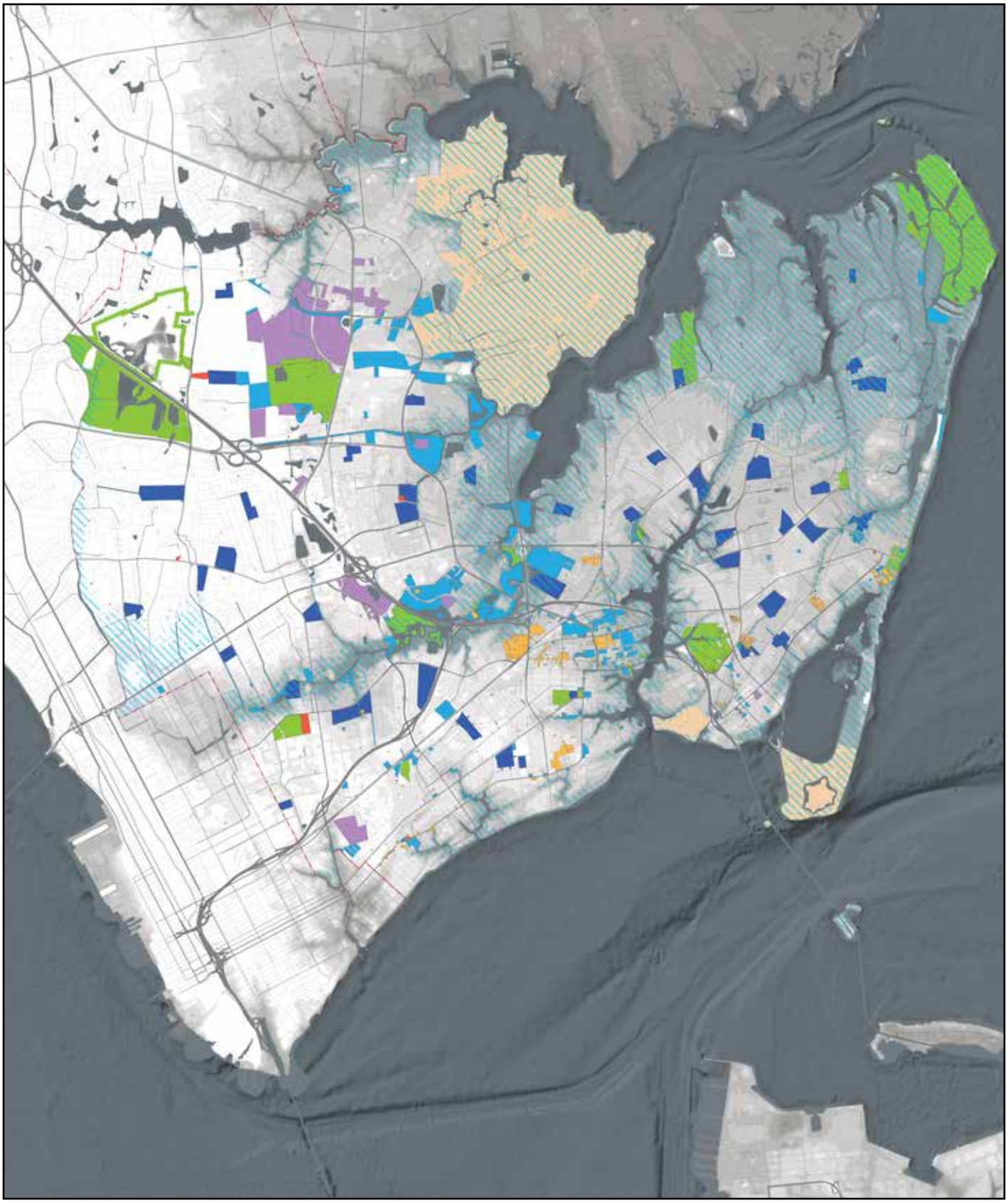
Facilities at Risk

A significant amount of public facilities are currently located in areas at risk for flooding. This map shows those assets which are located in the 100-year floodplain. Several public safety facilities, such as fire and police stations, are vulnerable. Similarly, a wide range of institutions, from schools to municipal offices to community centers and health clinics, are also at risk.

Public Safety

Institution/Education/Social

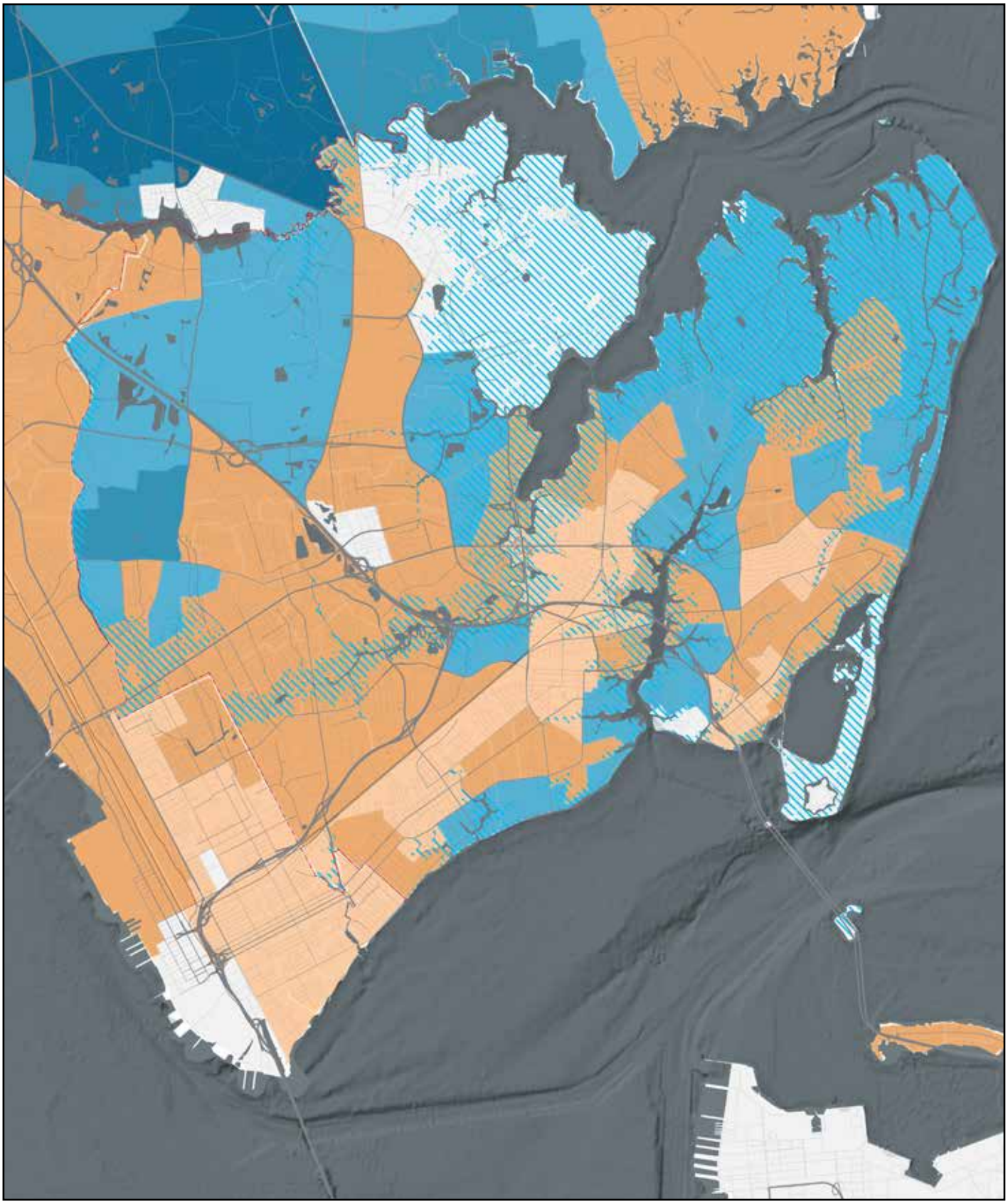
100-Year Floodplain



Public Property

Publicly owned properties — municipal, state, and federal government — provide an opportunity for resilient development. These sites can be used to demonstrate smart practices in different conditions: adaptation for low lying properties, and stormwater storage for upland sites.

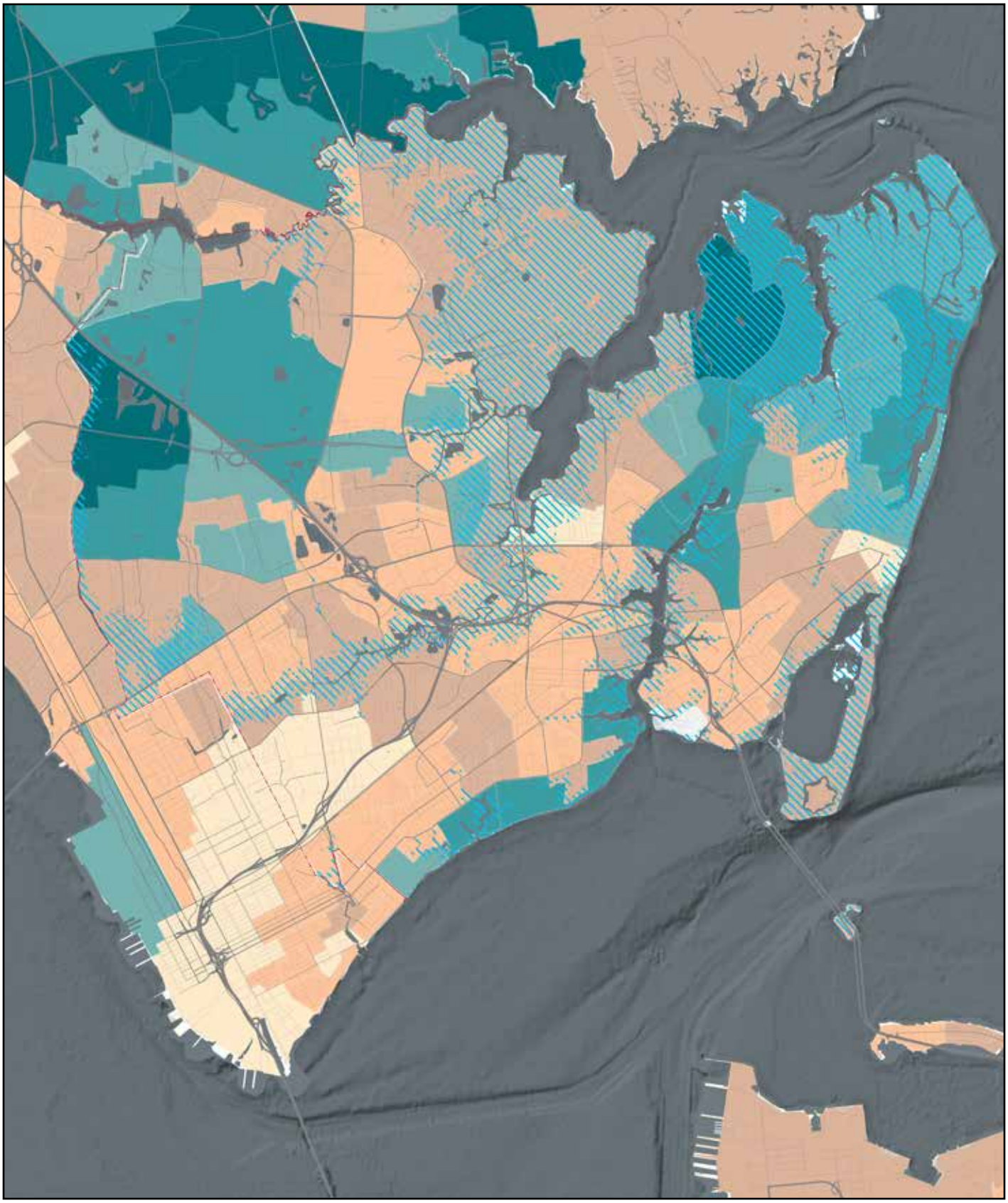
- Fire Stations
- Hampton Redevelopment Housing Authority
- U.S. Federal Government
- Parks / Open Space
- City of Hampton
- Hampton School Board
- Economic Development Authority
- Pump Stations
- 100-Year Floodplain



Median Home Value

As shown in the map above, the highest median home values are located in the coastal areas and the higher-elevation inland areas.

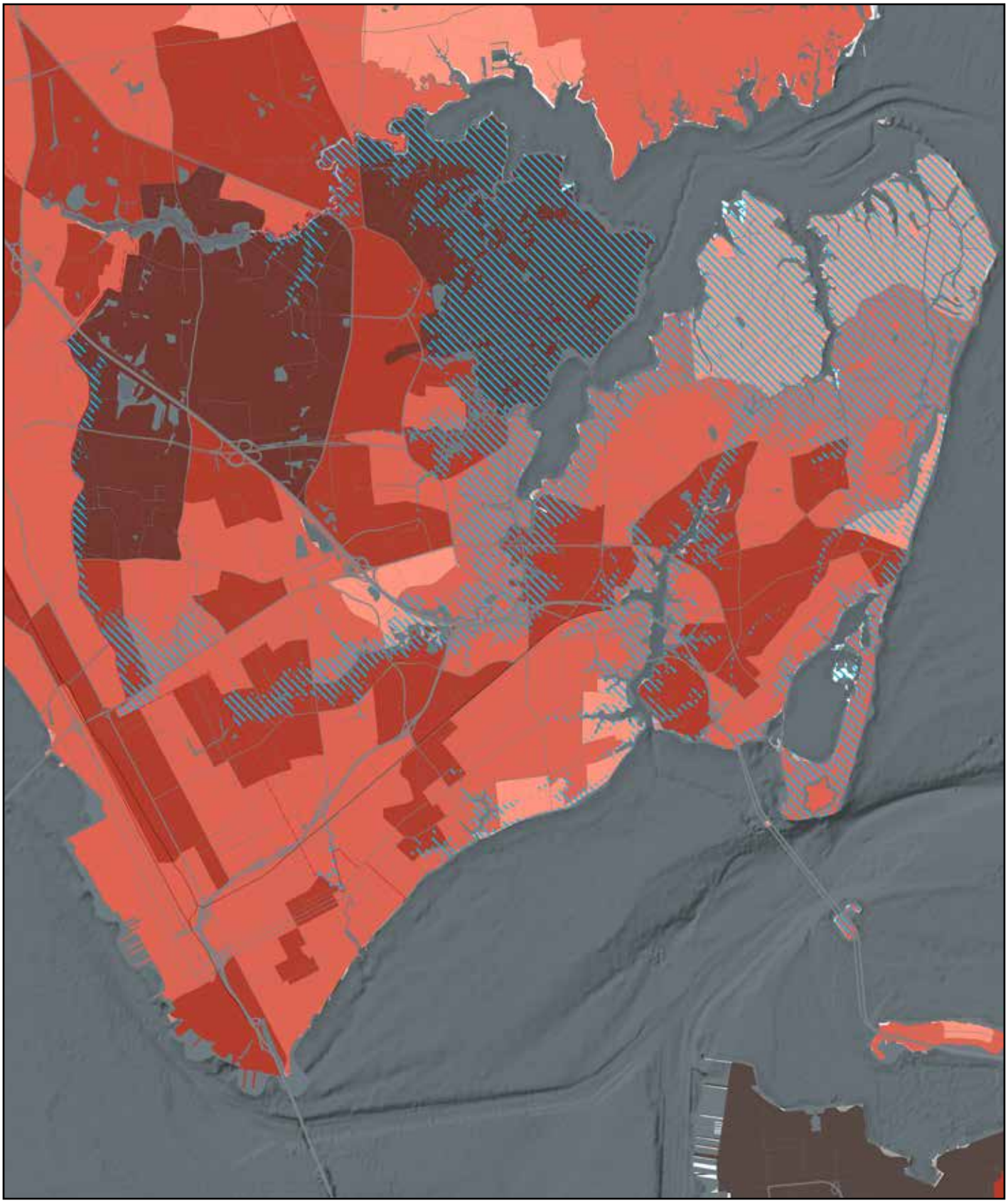
- > $348,000
- $274,001-$348,000
- $200,001-$274,000
- $127,001-$200,000
- $53,001-$127,000
- < $53,000
- No Data
- 100-Year Floodplain



Median Income

The areas with the highest income correlate to available jobs as well as historically wealthier neighborhoods. These areas typically are coastal in location or have easy access to major corridors.

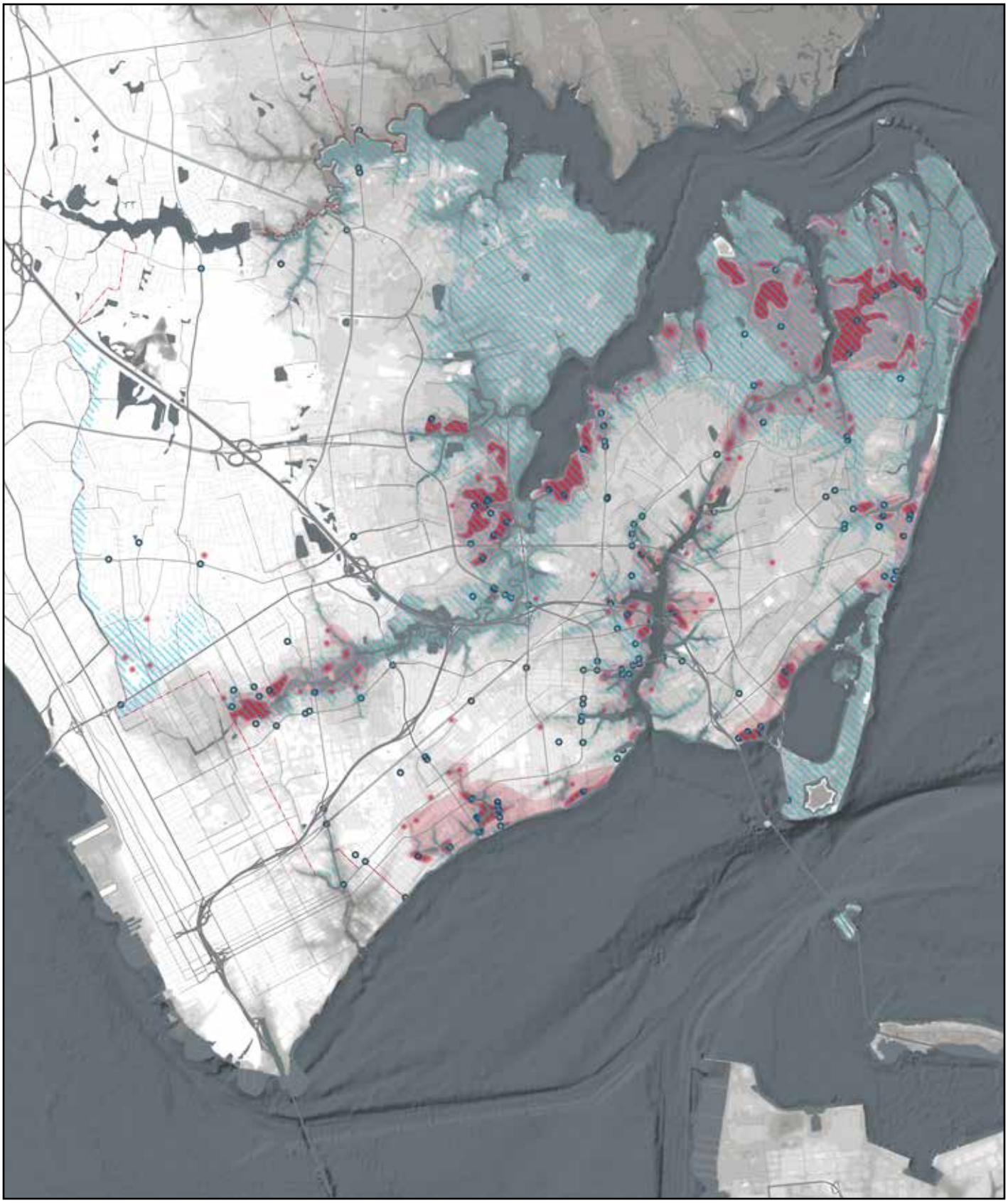
- > $82,000
- $68,000-$82,000
- $53,001-$68,000
- $39,001-$53,000
- $24,001-$39,000
- < $24,000
- No Data
- 100-Year Floodplain



Social Vulnerability Index

The Social Vulnerability Index (SVI) refers to the resilience of communities when confronted by stresses such as natural or human-caused disasters or epidemics. Reducing social vulnerability can decrease both human suffering and economic loss. Areas where high vulnerability coincides with the floodplain can be particularly hard-hit during storm events.

- Low
- Normal
- High
- Very High
- No Data
- 100-Year Floodplain

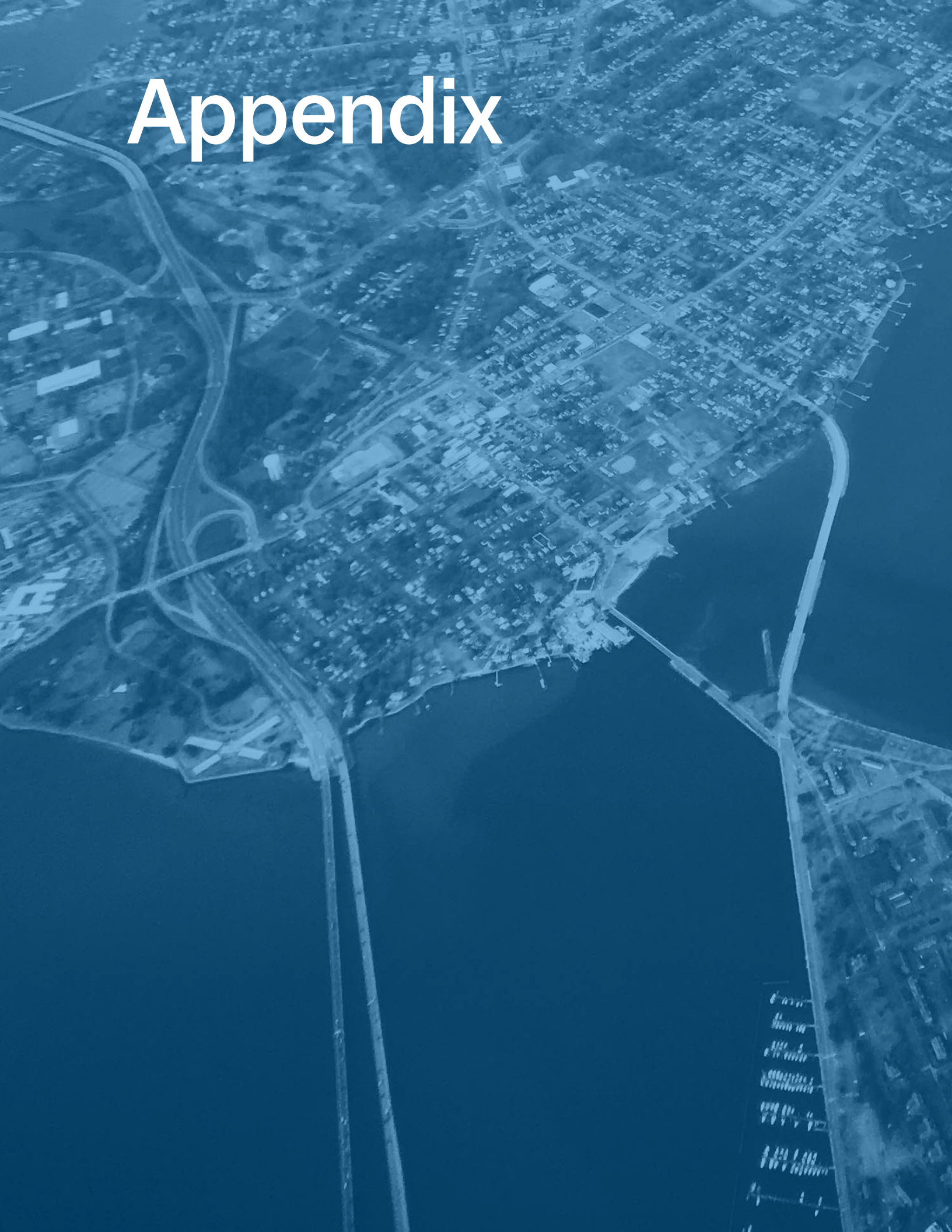


Repetitive Loss

Areas of repetitive loss are those which have been inundated several times and received damage, which may have been covered by flood insurance. These areas should be addressed within a resilience citywide strategy. As shown on the map above, areas of repetitive loss frequently correspond with areas of recorded street flooding.

- Repetitive Loss Zone
- Repetitive Loss Cluster
- Recorded Flooding
- 100-Year Floodplain

Appendix



Multilayered Systems
In the foreground at bottom, historic Fort Monroe stands at the crossroads of regional waterways, while the beaches, harbors, and bridges of Hampton connect neighborhoods within the city, and link the city to the region, the east coast, and the rest of the country.

Glossary: Talking About Water

10-year storm (10% storm)
An event that has a 10% chance of occurring or being exceeded any given year. Also known as a **T10 storm**, where the "T10" refers to the return period.

100-year storm (1% storm)
An event that has a 1% chance of occurring or being exceeded any given year. Also known as a **T100 storm**, where the "T100" refers to the return period.

adaptation
Adjustments to a changing climatic characteristics such as rising sea levels. These may include structural changes such as the lifting of levees or the raising of homes, as well as changes in policy and management practices that reduce vulnerability and risk to communities. See also **climate change**.

anaerobic
Absence of oxygen or growing in the absence of oxygen. Soils that are heavy textured (clay), compacted, wet or flooded tend to be anaerobic because they have less oxygenated air to carry out oxidative reactions. Anaerobesis of soil is also responsible for widespread soil-borne diseases. **Hydric soils** in Hampton can be anaerobic.

base flood
A flood with a 1% chance of being equaled or exceeded in any given year. This regulatory standard is used by the National Flood Insurance Program (NFIP) and other federal agencies for determining flood insurance rates and regulating new development.

base flood elevation (BFE)
An elevation (height) set by the Federal Emergency Management Agency (FEMA) that measures the elevation to which floodwater is anticipated to rise during a base flood. To receive FEMA funds in the case of storm damage, FEMA requires the lowest floor of the building to be at or above BFE.

berm
A raised barrier dividing space, which may be used to prevent flooding or erosion. Berms can be incorporated into landscape designs to create detention and retention basins.

best management practice (BMP)
A method or technique that consistently yields outcomes superior to those achieved by other means and generally agreed upon by a community of experts to be the most effective means of delivering a particular outcome.

biofiltration
The process of vegetation slowing down and filtering pollutants out of stormwater, improving the water quality.

bioswale
A linear depression in the landscape constructed to slow and filter stormwater with vegetation and soil media. Bioswales can remove silts, pollutants, and pathogens, and reduce the quantity of runoff from a site.

brackish water
A mix of freshwater and seawater found in places like estuaries and deltas.

canal
A man-made channel for water, often built as connections to larger bodies of water.

catch basin
Also known as a **storm drain** or **curb inlet**, a catch basin is a receptacle that captures stormwater runoff, as well as solids and large sediment, typically at the point where water passes from a gutter into a piped drainage system.

catchment area
An area where all runoff is conveyed to the same outlet, with boundaries typically defined by ridges or other topography. See also **watershed**.

climate change
Changes in temperatures, precipitation patterns, and the frequency of extreme weather events commonly linked to human activity. In Hampton, climate change has resulted in some of the highest rates of relative sea level rise in the world, and is likely to increase the intensity of storms as well as instances of drought.

culvert
A closed drain, pipe, or channel used to convey water (eg. from beneath a roadway from one side to another).

detention
The holding of stormwater temporarily in a **swale**, **detention basin**, or other features. Water detention reduces **peak discharge** by allowing the slower and more controlled release of runoff, but does not allow for the permanent pooling or storage of water.

discharge
The emptying of stormwater runoff or sewage from the drainage system into a waterway.

drainage canal
An artificial channel built to drain an area with no natural outlet for runoff. Government Ditch in Newport News is an example of a drainage canal. A large portion of Newmarket Creek in western Hampton near Newport News also functions as a drainage canal.

Dutch Dialogues Virginia: Life at Sea Level
A workshop between held in 2015 that focused on sustainable water management and regional planning in Hampton and Norfolk. The workshops were run by Waggonner & Ball and the Royal Netherlands Embassy in Washington D.C., and brought together US and Dutch experts trained in engineering, urban design, architecture, landscape architecture, city planning, and geohydrology. The workshop results were the basis for the work in this report.

ecological services, ecosystem services
The beneficial products and processes provided to humanity by the natural systems of the biosphere. These services include, but are not limited to, the production of clean water, crop pollination, waste decomposition, climate regulation, and recreational benefits. In stormwater management, for example, wetlands and urban forests provide these services in the form of pollutant bioremediation, evapotranspiration, and groundwater recharge.

egress
An established safe route to higher ground that is designed to stay dry and passable in the event of an emergency such as flooding. An egress route could be a roadway that is above the base flood elevation, connecting a low lying area to a higher elevation so that people can evacuate.

elevation
The altitude of a given location relative to sea level.

estuary
A partially-enclosed body of water where freshwater from rivers and streams flows into the ocean, mixing with seawater and forming brackish water. Estuaries are rich habitats influenced by tides but protected from the direct impact of ocean waves and winds by surrounding land, wetlands, and barriers islands. The Chesapeake Bay is the largest, and one of the most ecologically diverse, estuaries in the country.[21]

first flush
The initial stormwater runoff from a rain event. This typically has higher concentrations of pollutants such as organic debris, sediments, oil, and other surface pollutants that accumulate on rooftops and roadways in the period before the storm.

flood
The temporary condition of inundation of what is usually dry land. Floods can be caused by an overflow of inland or tidal waters, or the rapid accumulation of stormwaer runoff in drainage ditches or inland waterways. Flash floods are floods that subside in fewer than six hours.

floodplain
An area of typically flat land that is susceptible to inundation by water from any source. Floodplains are typically fertile agricultural areas as a result of nutrient-rich sediments deposited by floodwaters.

floodwall
A vertical barrier, usually made of concrete, constructed to contain floodwaters from a river, lake, or sea in order to prevent flooding in urbanized areas. Floodwalls are used in densely developed areas where building levees is not feasible, or atop levees in order to increase the level of safety provided by the levee. In Hampton, part of Fort Monroe's perimeter is surrounded by a low floodwall.

floodgate
A movable structure that can be opened or closed in order to adjust the flow of water through a canal, or to prevent the flow of water as part of a levee and floodwall system.

fluvial
Of or relating to rivers and streams, and the flooding, erosion, and soil deposition associated with these waterways.

freeboard
The distance between an established water level, such as a **base flood elevation**, and maximum water levels. This could apply to drainage infrastructure, such as in a drainage canal or a retention basin, or to a structure. The freeboard is used to calculate the capacity of a given water feature. Freeboard can also be considered the additional elevation of safety. For example, if the lowest level of an elevated building was built to be two feet above the base flood elevation, it would have two feet of freeboard.

geohydrology, hydrogeology
The study of **groundwater**, including its flow and its physical and chemical interactions with soils and surface water.

gray infrastructure
Traditional mechanisms for stormwater management and wastewater treatment, such as pipes and sewers.

graywater
Wastewater generated from domestic activities such as dishwashing, laundry, or bathing. Properly treated, it can be recycled for other uses like irrigation.

green infrastructure
An approach to stormwater management that utilizes natural processes to filter and reduce runoff. In contrast to gray infrastructure, green infrastructure can provide additional benefits such as improved air quality and more verdant streetscapes.

groundwater
Water held in underground permeable rock or soil layers. When these layers hold enough water to be usefully extracted for human use, it is called an aquifer.

groundwater monitoring network
A system of wells, gauges, and data collection for tracking groundwater levels and quality. Such a network allows for a more comprehensive understanding existing groundwater issues such as **subsidence** and **saltwater intrusion**, and the management of soils and groundwater.

harden
To make structures and utilities resistant to storms and natural hazards.

hazard mitigation
Sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects. Hazard mitigation can include the building of levees, elevating of structures, or the relocation of assets. Improving urban water management is also a form of hazard mitigation.

hydraulics
An applied science that studies the properties of water and other fluids, especially in relation to the application of mechanical forces. The term **hydraulic** indicates a system or activity involving fluid under pressure.

hydric soil
A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part of the soil layer. Hydric soils are commonly found in wetlands, and support unique landscapes, including vegetation that adapts to absorb oxygen from the atmosphere rather than the soil.

hydrograph
A chart that graphically describes the rate of flow — of water, for example — relative to a specific point over a period of time. A hydrograph can help in describing the contours of a rain event, and in the planning and design of waterways and water control structures.

hydrology
The study of the distribution, flow, and quality of water. This includes the water cycle, water resources, and watershed sustainability. The term hydrologic refers to the movement of water between land areas, waterways, water bodies, and the atmosphere.

impervious surface
A material or area that cannot be penetrated by water. This includes most rooftops and structures like roads, sidewalks, and parking lots that are paved with concrete, asphalt, or stone. Impervious surfaces prevent rainfall from infiltrating into the ground and recharging groundwater, and accelerate runoff.

infiltration
The passage of water into below-ground soil layers. The velocity at which this occurs is called the infiltration rate, which is dependent on the composition of surface soil layers. Infiltration replenishes groundwater and raises the water table.

infrastructure
Foundational systems and installations necessary to maintain and enhance basic social, economic, governmental, economic, and military functions. These include drinking water systems, drainage systems, sewers, hurricane defenses, schools, transportation networks, electrical grids, and telecommunications networks.

inundation
Flooding, the overwhelming of an area by floodwaters.

levee
A linear earthen ridge that divides areas hydrologically, and can be used to protect inhabited areas from flooding. Many natural levees have been reinforced with additional soil, rock, concrete, and/or grass. Levees are also known as **dikes**.

LIDAR
Light Detection and Ranging (LIDAR) is a remote sensing method that uses a pulsed laser to measure variable distances to the earth. LIDAR systems help scientists and mapping professionals examine both natural and manmade environments with greater accuracy. LIDAR is one of many tools used to create more accurate shoreline maps and digital elevation models.

marsh
A wetland that is frequently inundated with water and characterized by soft-stemmed vegetation adapted to saturated soil conditions. Nutrients are typically abundant, allowing plant and animal life to thrive in these areas. Marshes help reduce flood damage by slowing and storing flood water. As water moves slowly through a marsh, sediments and other pollutants settle to the marsh floor. Some municipalities are now building urban wetlands to harness these natural processes in cleaning stormwater and wastewater.

Multiple Lines of Defense
A core concept of the importance of naturally-occurring and manmade features in protecting inhabited areas from the direct impact of storms. Manmade features include levees, flood gates, pump stations, elevated structures, highways that serve as ridges, and hurricane evacuation routes. Natural features include offshore shelves, barrier islands, sounds, marsh land bridges, and natural ridges.

National Flood Insurance Program (NFIP)
A national program providing flood insurance to property owners. The NFIP also works to mitigate the impacts of flooding by encouraging floodplain management regulations and promoting the purchase of risk and flood insurance. The NFIP is run through the Federal Emergency Management Agency (FEMA).

outfall
The pipe, channel, or opening through which water is emptied into another body of water, such as a river or bay, or the location where such discharge occurs.

oxidation
The decomposition and compaction of organic matter that occurs in the presence of oxygen. Oxidation is a primary cause of subsidence in areas where highly organic soils with lowered water tables are exposed to oxygen.

peak rainfall
The duration or point in a rain event when rain is falling at its highest intensity.

peak discharge
The highest volume of stormwater runoff or sewage exiting the drainage system and flowing into a waterway.

peak stage
The highest level reached by water flowing through a channel, relative to a datum such as mean sea level. Improved stormwater management can lower a canal's peak stage.

periodic inundation/permanent inundation
When water is present in a landscape, such as when designed for stormwater storage, occasionally and for a short amount of time, compared to always being wet, such as in wetlands.

pervious paving
Materials for walkways, roadways, and parking lots that allow stormwater to be absorbed by the ground where it falls, reducing runoff into the drainage system.

pluvial
Of or relating to rainfall.

pump, pumping
The mechanical removal of water from an area. When pumps remove groundwater in addition to stormwater, it can cause subsidence.

pumping capacity
The volume of water that a pump station can move over a given period of time, typically measured in cubic feet per second (cfs).

rain garden
A shallow excavated basin that collects and cleans stormwater runoff on a small scale. Soil layers and plantings are designed for **infiltration** and the removal of pollutants.

resilience
The capacity to anticipate potential threats, reduce a community's vulnerability to hazard events, respond to and recover from specific hazard events when they occur, and adapt to changing risks and hazards. In Hampton, resilience refers to the region's ability to withstand and recover from major flooding and coastal storms. With climate change, the long-term future of the Hampton Roads region depends on the region's ability to enhance its resiliency.

repetitive loss
"A repetitive loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the **National Flood Insurance Program (NFIP)** within any rolling ten-year period, since 1978. A RL may or may not be currently insured by the NFIP. Currently, there are over 122,000 repetitive loss properties nationwide."[22]

retention
The holding of stormwater permanently in basins, ponds, or cisterns. **Retention basins** allow stormwater to infiltrate the ground, and for the collected stormwater to be repurposed for other uses such as irrigation.

retrofit
A measure taken to adapt existing infrastructure or buildings to operate more efficiently and effectively, without having to completely rebuild existing systems.

risk
A predictive measure of harm or loss due to the likelihood of a hazard occurring, and the consequences of such an event.

runoff (surface runoff)
Stormwater flowing from rooftops, streets, and other surfaces that neither infiltrates into the ground nor evaporates, but instead collects and must be drained away in order to prevent flooding.

saltwater intrusion
When the flow of freshwater, such as from a river or groundwater in the soil, is not sufficient to balance the flow of saltwater from encroaching into aquifers. Normally, freshwater flows towards the sea, and prevents saltwater from dispersing farther inland.

scarp
A steep bank, slope, or cliff formed by folded or eroded layers of rock; an escarpment. The Suffolk Scarp is the higher land that rises just west of Hampton and other areas along the eastern coast of southern Virginia.

sea level rise
An increase in the mean sea level, caused by changes in air temperatures that are linked to global climate change. Sea level rise poses a growing risk to low-lying coastal communities. With land subsiding at high rates as well, coastal Virginia is experiencing some of the highest rates of relative sea level rise in the world.

slow, store, discharge
A new approach to stormwater management: slow water as it hits the ground, create spaces in the city to store water and use it as a resource, and discharge into larger water bodies when tides allow.

stormwater
Commonly called rainfall, the water from precipitation (and snow or ice melt). Stormwater can infiltrate into the soil, remain on a surface and evaporate, or become **runoff**.

stormwater management
Techniques, methods or policies that control planning, maintenance, and regulation of stormwater (rainfall). Stormwater management is critical in Hampton in order to prevent flooding and reduce **subsidence**.

subsidence
The sinking or compaction of land relative to sea level. Subsidence can be caused when stormwater is unable to penetrate the ground due to impervious surfaces, or by the excessive pumping of groundwater. As groundwater is removed, the soil from which it is drawn compresses and highly organic soil layers are able to oxidize. Subsidence damages buildings, streets, and other infrastructure, and its effects are irreversible. *Note: subsidence in the Hampton Roads area might also be due to soil compaction resulting from the bolide strike about 35 million years ago.

surge
The rise in seawater caused by a storm. Surge is generated by the force of winds pushing water towards the shore. This is commonly referred to as **storm surge**.

sustainability
The ability to manage human and natural resources in a productive and holistic way in order to support future generations. Generally, sustainability often refers to resource consumption, such as water or energy, and global climate change.

swale
A linear depression in the landscape constructed to slow or convey stormwater. Some swales feature vegetation and soil media meant to slow and filter water; see **bioswale**.

tidal action
The process of fluctuating water levels between low and high tides.

topography
The position and **elevation** of natural and artificial features in an area, and also the study of the surface shape and features of an area. Topographic maps and models provide graphic representations of features that appear on the earth's surface, including infrastructure and development, waterways and water bodies, relief (mountains, valleys, slopes, depressions), and vegetation.

water assignment
The volume of stormwater for a given rain event that exceeds the total storage and pumping capacity of a catchment area. The water assignment provides a rough measure of flooding that may occur if such an event were to occur, without taking into account finer variations in rainfall intensity and distribution that determine the actual impact of each rain event.

water balance
The calculation of the various inputs and outputs of water in an area, including rainfall, groundwater withdrawals, drinking water withdrawals, and both stormwater and sewage discharges.

water literacy
An understanding of how water impacts and functions in a given landscape—where water is coming from, how it is used, how it is stored, and risks and opportunities associated with water. The community's water literacy is an important aspect of a sustainable water future for Hampton.

water quality
A measure of how suitable water is for a particular type of use (such as drinking or bathing) based on physical, chemical, and biological characteristics such as temperature, turbidity, mineral content, and the presence of bacteria.

water table
The boundary between water-saturated soils and unsaturated soils. Typically, deeper soil layers are saturated with water while those closer to the surface are drier. The water table is the depth between ground surface, or "grade," and groundwater.

watershed
A land area, and distinct hydrological entity, where all water drains to the same point. See also **catchment area**.

weir
Barriers that alter the flow of waterways to prevent flooding, to store water, or for navigation purposes, while allowing the steady flow of water over the top of the structure.

wetlands
Ecosystems that are saturated with water, including bottomland hardwood forests, swamps, marshes, and bayous. The presence of water drives the nature of soil development, as well as characteristic plant and animal communities living in and above the soil. Wetlands are natural storm buffers that store and filter runoff. They are also habitats that support hundreds of thousands of species of plants and animals, as well as myriad fishing, hunting, agriculture, and recreational uses. Much of Hampton's natural ecosystems are comprised of wetlands.

Data Checklist

Political

- ▫ City/town boundaries
- ▫ State/legislative boundaries
- ▫ Congressional boundaries
- ▫ Concilmanic boundaries
- ▫ State legal tools
- ▫ Local legal tools

Demographics

- ▫ Population density
- ▫ Population trends
- ▫ Social Vulnerability Index (SVI)
- ▫ Diversity
- ▫ Income
- ▫ Employment access
- ▫ Home sales
- ▫ Major employers
- ▫ Commute patterns

Land/Property

- ▫ Parcels
- ▫ Buildings
- ▫ Zoning
- ▫ Land use (future)
- ▫ Planning districts
- ▫ Historic districts
- ▫ Land cover
- ▫ Impermeable surfaces
- ▫ Landscape types
- ▫ Brownfields
- ▫ Vacant sites
- ▫ Current/future development sites

Infrastructure

- ▫ Roads - centerline
- ▫ Roads - curb to curb
- ▫ Other pavement (sidewalks, etc.)
- ▫ Railroad
- ▫ Transit routes
- ▫ Port facilities
- ▫ Drainage network
- ▫ Drainage pumps
- ▫ Drainage sheds
- ▫ Sewer networks
- ▫ Sewer lift and pump stations
- ▫ Sewer sheds
- ▫ Sewer treatment
- ▫ Septic systems/areas
- ▫ Water networks
- ▫ Water treatment
- ▫ Water towers
- ▫ Oil & gas platforms
- ▫ Oil & gas pipelines
- ▫ Gas distribution networks/corridors
- ▫ Electricity distribution networks/corridors
- ▫ Power plants & substations
- ▫ Critical infrastructure
- ▫ Emergency response facilities (Fire, EOC, etc.)
- ▫ Shelter facilities
- ▫ Critical facilities (hospitals, federal facilities of national significance, etc.)
- ▫ Emergency routes

Risk

- ▫ FEMA DFIRM
- ▫ FEMA repetitive loss
- ▫ SLOSH/MOMs modeling (storm surge)
- ▫ Drainage system flood modeling
- ▫ Reported flooding/frequently flooded areas
- ▫ SLR projections
- ▫ Land loss/subsidence
- ▫ First floor elevations

Water

- ▫ Watersheds
- ▫ Watershed studies
- ▫ Water bodies/hydrology
- ▫ Wetlands
- ▫ Tidal marsh inventory
- ▫ Navigation channels

Ground

- ▫ LIDAR/DEM
- ▫ Contours
- ▫ Geology
- ▫ Soil classes
- ▫ Hydric soils
- ▫ Aquifers
- ▫ Shallow groundwater

Environmental

- ▫ Critical habitats
- ▫ Fisheries
- ▫ Hazardous/regulated facilities
- ▫ Shoreline erosion evaluation
- ▫ Shoreline inventory

Plans

- ▫ Community plan
- ▫ Master plan/small area plans
- ▫ Regional transportation plan
- ▫ Regional SLR and storm surge impacts
- ▫ Joint land use studies (JLUS)

Additional Resources

Related Projects, Tools, and Organizations

Projects

Dutch Dialogues Virginia: Life at Sea Level
http://www.lifeatsealevel.org/

Hampton Strategic Investment Areas
www.hampton.gov/509/Strategic-Investment-Areas

Tools

Sea Level Rise Viewer
NOAA Office for Coastal Management
https://coast.noaa.gov/digitalcoast/tools/slr

Native Plants for Southeast Virginia
Virginia Coastal Zones Management Program
http://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/Native-Plants-for-Southeast-Virginia-Guide.pdf

Stemming the Tide: How Local Governments Can Manage Rising Flood Risks
Georgetown Climate Center
http://www.georgetownclimate.org/reports/virginia-case-study-stemming-the-tide-how-local-governments-can-manage-rising-flood-risks.html

Who is doing what in Coastal Virginia? A Guide to Current Adaptation Efforts to Sea-Level Rise and Flooding
Center for Coastal Resources Management, Virginia Institute of Marine Science (VIMS)
http://www.vacoastadapt.org/Whoisdoingwhat.pdf

Climate Change/Sea Level Rise Publications
Center for Coastal Resources Management, Virginia Institute of Marine Science (VIMS)
http://www.vacoastadapt.org/

Sea Level Rise Adaptation Guide
Wetlands Watch
http://wetlandswatch.org/adaptation-guide-directory/

Organizations

Adapt Virginia
Virginia Institute of Marine Science
http://www.adaptva.com/

Systems Approach to Geomorphic Engineering
http://www.sagecoast.org/

Commonwealth Center for Recurrent Flooding Resiliency
http://www.floodingresiliency.org/

Center for Coastal Resources Management
Virginia Institute of Marine Science (VIMS)
http://www.ccrm.vims.edu/ccrmp/index.html

Mitigation and Adaptation Research Institute (MARI)
Old Dominion University
http://www.mari-odu.org/

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