



COASTAL RESILIENCE STRATEGY

Resilience: the capacity to adapt to stress and change

CREATING AWARENESS AND ENCOURAGING ACTION

NORFOLK'S BEGINNINGS

The City of Norfolk features more than 144 miles of shoreline along lakes, rivers and the Chesapeake Bay. These natural waterways provided food and transportation to Native Americans who thrived in the area. European colonists also recognized the natural advantages of this land and made Norfolk one of the first European settlements in North America.

Norfolk began as a mere 50 acres of land deeded along the Elizabeth River and blossomed into a thriving city of more than 243,000 residents. Norfolk's coastal amenities include:

- **World's largest naval base**
- **Deep water ports**
- **Active shipyards**
- **Robust maritime industries**
- **Waterfront recreation**

Norfolk owes its success to the waterways that have shaped its land, history and culture. Living in Norfolk means embracing the benefits of waterways and also the challenges. By harnessing its resilient spirit, City leaders and residents can develop strategies to build a better, stronger Norfolk.



Watercolor drawings by
John White, 1585-86.



Watercolor by Kenneth Harris, Virginia Coal Pier No. 2, 1953.

CREATING A STRATEGY

The Norfolk Flooding Strategy is an integrative process of planning, preparing, mitigating and communicating to reduce flood danger and help our community better cope with severe storms.

PLAN

Fully understanding our flooding challenges is vital. Norfolk has collaborated with research specialists in the private and public sectors to create sound public policy and effective plans.

PREPARE

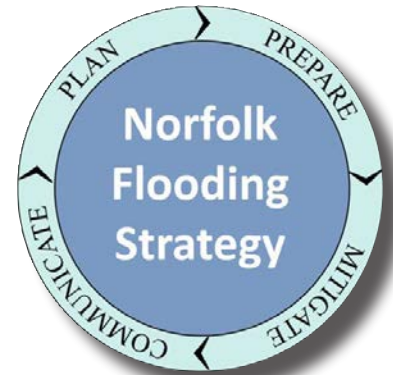
Nature can be unpredictable. Norfolk's residents and its government must address that unpredictability with thoughtful preparation. Community preparation resources include community response teams, detailed transportation and evacuation strategies, sound planning practices and use of a National Incident Management System to vet preparedness concepts and principles.

MITIGATE

Like other coastal cities, Norfolk is vulnerable to the increased severity of storms and flooding caused by relative sea level rise. Immediate and long-term solutions range from simple landscaping techniques that allow adequate storm water drainage to complex engineering projects designed to reroute and deflect water.

COMMUNICATE

Communication is a critical link in implementing Norfolk's flooding strategy. To prepare for future events as well as to cope during an event, direct and timely communication between the government and citizens is fundamental. Norfolk actively seeks input from residents. The City uses a wide range of communication tools to achieve these goals.



Downtown Norfolk at sunset.



Green spaces beautify the City and provide recreation.



Public access walkways connect residents and visitors to the Chesapeake Bay.

PLAN

EXAMINING THE PAST TO PLAN FOR THE FUTURE



Granby Street flooding due to the Ash Wednesday Storm in 1962. Norfolk's current downtown flood wall was constructed as a result of this storm event. Granby Street has not flooded to this extent since the construction of the wall.



McCullough's Docks, Norfolk VA in 1902. Situated at the end of City Hall Avenue, present-day Boush Street is located approximately where the bridge crosses the water.

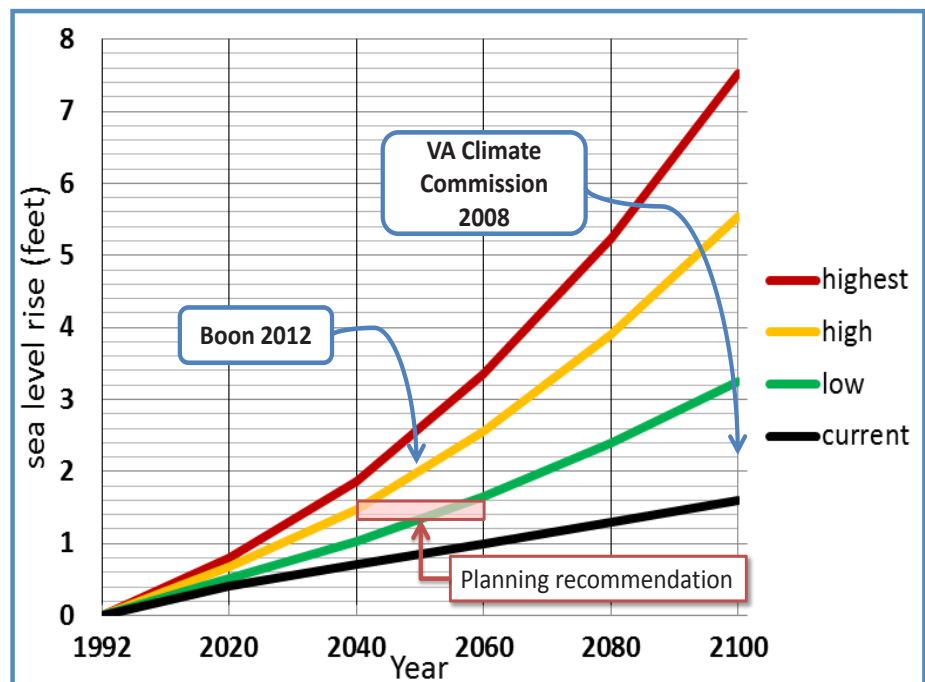
Predicted sea level rise chart from the Virginia Institute of Marine Science and the Center for Coastal Resource Management as presented in 2013.

SEA LEVEL RISE AND LAND SUBSIDENCE

Scientists predict that global sea levels will rise two to four feet in the next 80 years. Relative sea level rise in Norfolk will be among the highest in the United States due to post-glaciation settling, compaction from groundwater withdrawals, filling wetlands and the effects of an ancient meteor crater in the Chesapeake Bay. Flooding will range from nuisance flooding due to high tides to severe flooding due to hurricanes and nor'easters.

ADAPTING OUR INFRASTRUCTURE

Working with international and regional experts and residents, Norfolk is creating planning models to predict future shoreline conditions. The models will predict how local rates of sea level rise affect the construction of public buildings, shipyards, naval facilities, homes and other private development.



PLAN PROTECTING PROPERTY

PROTECTING NEIGHBORHOODS

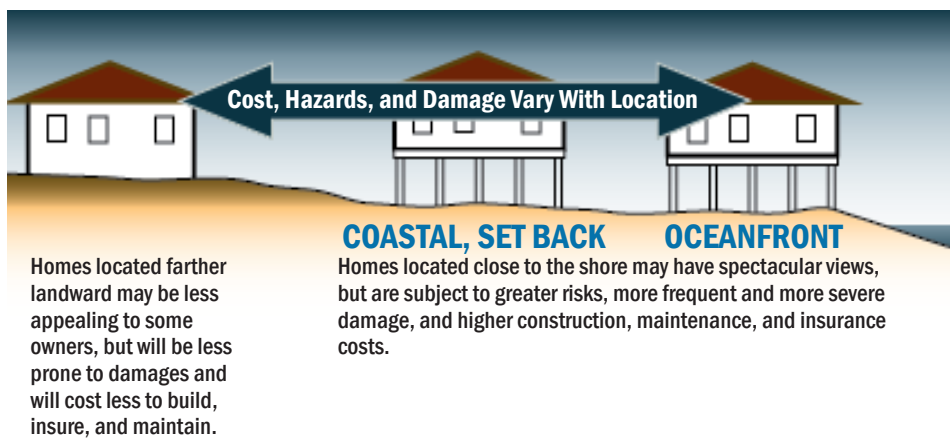
In 2007, Norfolk initiated a series of Coastal Flooding and Precipitation Flooding studies to analyze the City, watershed-by-watershed and provide solutions tailored to local conditions and neighborhoods. From these studies, planning and building codes were adapted to make homes less vulnerable to flooding.

For instance, starting in 2014, Norfolk building codes required the lowest floor of a building to be built no lower than three feet above the predicted level that water will rise in a flood. The new codes protect homes and possessions while also providing reduced flood insurance rates.

Residents can help reduce flooding impacts by:

- Restoring wetlands and natural shorelines to preserve flood buffers
- Planting trees
- Installing rain barrels
- Incorporating landscape techniques such as rain gardens

Public flood protection projects include flood walls, flood gates, pump stations and man-made berms. The downtown flood wall was constructed in the 1970's for \$5 million and now protects hundreds of millions of dollars in downtown development.



By raising a property three feet above the base flood elevation, insurance rates will decrease.



In order to reduce flooding, a section of westbound Brambleton Avenue between Colley Avenue and the Brambleton Bridge has been widened and elevated. The increase in elevation has decreased the impact of flooding during high tide events which has improved access to the region's medical complex.



Rain gardens are a great way to slow down, spread out and soak in water.



Students at Campostella Elementary School planted a Living Legacy Grove to protect the adjacent wetland.

PREPARE RESOURCES TO PROTECT RESIDENTS



Citizen Emergency Response Training (CERT) empowers residents to make a difference during emergency events.



Norfolk has elevated several homes with funds from the Hazard Mitigation Assistance Grant Program to prevent future flooding.

FEMA

Norfolk participates in the National Flood Insurance Program (NFIP) of the Federal Emergency Management Agency (FEMA). Norfolk requires higher elevations for new construction and major renovation. These new building requirements allow FEMA to offer Norfolk residents improved flood insurance rates.

EMERGENCY MANAGEMENT

Norfolk's Emergency Management staff are trained and prepared to respond to natural and man-made disasters in the region. Strengthening national and local response, coordinating resources and providing real-time impact analysis enhance our community's preparedness.

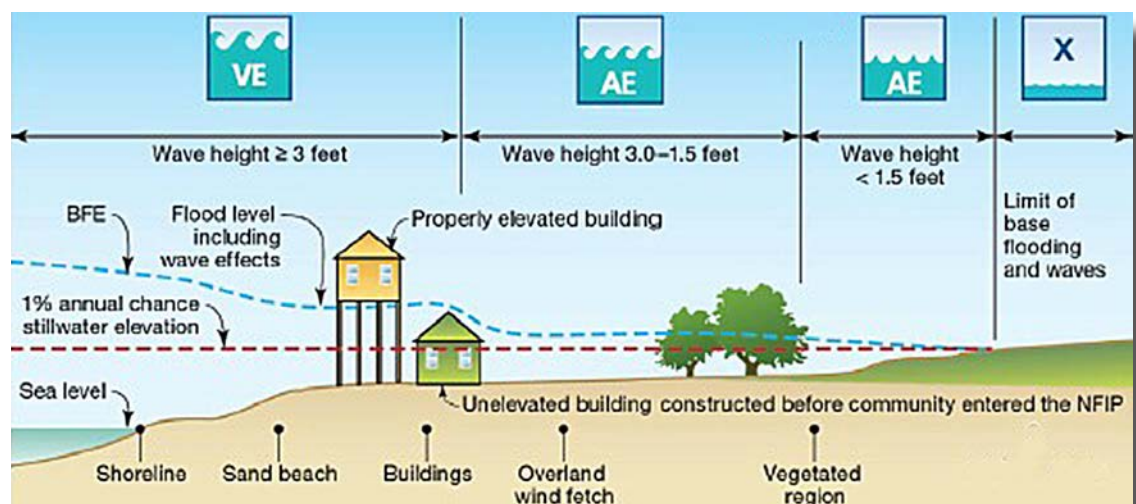
REGIONAL COOPERATION

Norfolk partners with all 16 Hampton Roads localities to ensure successful regional preparedness and recovery. "Ready Hampton Roads" helps residents get prepared and stay prepared. readyhamptonroads.org.

RESIDENT INVOLVEMENT

Coastal residents should know the elevation of their homes and purchase flood insurance if needed. Elevate the furnace, water heater, and electric panel in your home above expected floodwaters.

FEMA uses insurance risk zones such as VE, AE and X to determine flood insurance rates.



PREPARE DEVELOPING STRATEGIC PARTNERSHIPS

TEAM NORFOLK

Norfolk has built critical relationships in all sectors: public, private, not-for-profit, higher education, faith community and military. These relationships support a true comprehensive, community-wide approach to preparedness. Team Norfolk's goal is a secure and resilient city with the capability to prevent, protect, mitigate, respond and recover from various threats and hazards.

Residents can volunteer for the Local Emergency Planning Committee, the Community Emergency Response Team, the Medical Reserve Corp and Skywarn™.

A SECURE COMMONWEALTH

Norfolk participates in the Secure Commonwealth Panel, established by the Code of Virginia and located in the executive branch of state government. The panel includes policy leaders, and technical and operational experts from federal, state and regional agencies, academia and local levels. The goal is a comprehensive strategy to protect residents and property.



Norfolk's working waterfront supports industry and recreation.



Norfolk's neighborhood trees help absorb stormwater runoff.



Norfolk's downtown combines commercial and residential development with open green spaces.



Brick walkways and similar pervious surfaces absorb rain water.



Norfolk's Better Block projects inspire eco-friendly development.

MITIGATE BUILDING INFRASTRUCTURE

STRUCTURAL PROJECTS

Norfolk is home to a variety of industries that impact the global economy and national security. Norfolk invests in infrastructure to protect land and buildings from flooding. Our downtown boasts a half-mile long floodwall, with five tide gates and a pump station for draining runoff. The \$2.4 million road project at Brambleton Avenue raised the road, allowing for improved access to the nearby medical complex. Other potential structural projects include floodwalls, earthen berms, gates, pumps and elevating structures. Project costs range from \$10 million to \$306 million.

ARMY CORPS OF ENGINEERS

Norfolk is partnering with the Army Corps of Engineers for technical guidance and funding to assist with Norfolk's flooding plan. The Corps recently completed a study for the Ocean View beaches. The result is the City's first "engineered beach". Estimated construction cost is \$18.4 million with a City share of \$5.5 million. Related studies of Pretty Lake and the Hague are nearly complete. Such studies are valuable because large design and construction projects cannot be funded without the federal government underwriting between 75 and 90 percent of costs.



Norfolk's downtown is protected by a floodwall and several gates. Floodgates and walls can provide protection while becoming part of a natural urban landscape.



Dunes along Norfolk's seven miles of beaches protect properties from storms and tides. Thriving dunes are our first line of defense.



Norfolk is home to a variety of industries that impact the global economy and national security.



Stormwater culverts manage the flow of water from roadways and neighborhoods.

MITIGATE RECLAIMING NATURAL DEFENSES

SHORELINE PROJECTS

Norfolk recognizes that resilient infrastructure depends on healthy shoreline ecosystems. Norfolk is developing shoreline buffer projects to provide the first line of defense against large storm surges and high tides. These defenses create a natural barrier and slow the velocity of incoming water. Additionally, building living shorelines for shoreline erosion protection in lieu of hardened structures such as bulkheads, along with planting naturalized buffers will further protect the shoreline and add extra filtration of pollutants.

RECLAIMING FORMER WATERWAYS

Parts of Norfolk are built on the sites of former creeks and inlets that were filled in decades ago. These former waterways now experience frequent flooding during both high tides and hard rainfall. Norfolk has reclaimed and reconstructed filled wetlands throughout the city. Studies are underway to identify other areas where these former creeks and streams may be restored to improve both pollutant treatment and storm water flow.



The image is Norfolk's current downtown area. The yellow area indicates Norfolk's original 50 acres. This photo shows how Norfolk has grown and been filled in where water once flowed.



Old Dominion University students help restore the Colley Bay wetland.



Colley Bay wetland project after planting.



Hermitage Museum wetland restoration and nature walkway.

Recent Colley Bay and Hermitage Museum wetland restoration projects provide habitat, citizen engagement and water quality improvements in the Lafayette River.

COMMUNICATE RESIDENTS & EXPERTS



Community rain barrels are a great way to get neighbors talking while providing captured rainwater for landscape plants at the Ingleside Recreational Center.



Listening to residents helps City planners develop resiliency plans.

Norfolk's Flood Awareness website has something for everyone. Visit it today at norfolk.gov/flooding.

TALKING WITH EXPERTS

Norfolk is fortunate to work closely with experts throughout the region from academic institutions, corporate headquarters, defense commands, and medical systems. These partnerships provide access to research tools and opportunities for collaborative decision making about flooding.

TALKING WITH RESIDENTS

Input from residents and community partners that are knowledgeable about local situations is sought so that all views are represented. Community meetings where residents and leading experts interact to examine data, studies and plans help everyone prepare.

COMMUNICATION TOOLS

Norfolk has a flood awareness website developed with citizen, professional and expert input. The web page is easy to find on Norfolk's home page or at www.norfolk.gov/flooding. Norfolk uses social media and tools such as email blasts, Nixle, TV 48, local TV and radio, print media, presentations to business and civic groups, and interactive maps to connect residents to flood information.



COMMUNICATE PARTNERSHIP & COLLABORATION

100 RESILIENT CITIES CHALLENGE

In 2013, the Rockefeller Foundation announced the 100 Resilient Cities Challenge, an initiative supporting 100 cities across the globe in their efforts to build resilience. Norfolk was honored to be among the first cities included in this initiative which will provide support for a Chief Resilience Officer, leverage to unlock private financing for resilient infrastructure and inclusion in a global network of cities to share ideas.

RE.INVEST

Norfolk is one of eight cities selected for the Rockefeller national RE.Invest Initiative. The initiative helps cities attract private investment and use public resources more efficiently to upgrade their infrastructure. This project will improve drainage, reduce flooding and help prevent damage during future severe weather events like Superstorm Sandy. Nature-based infrastructure projects also beautify the City; make Norfolk more resilient to extreme weather, more attractive to businesses and investors and save significant taxpayer money.

Norfolk leads the way in coastal city management through close collaboration with its partners.

Bon Secours Medical Center
Central Planning Bureau
of the Netherlands
Children's Hospital
of the King's Daughters
College of William and Mary
Commonwealth of Virginia
Cox Communications
Dominion Virginia Power
Downtown Norfolk Council
Independence Center
Eastern Virginia Medical School
Faith Community
Federal and State Legislators
Hampton Roads Cities
Hampton Roads Planning
District Commission
Hampton Roads Sanitation District
Hampton Roads Transit
Local and Regional
Watershed Groups
Mayor's Committee for
People with Disabilities
National Institute for
Coastal and Harbor Infrastructure
National Aeronautical and
Space Administration

National Oceanic and
Atmospheric Administration
Norfolk Airport Authority
Norfolk City Departments
Norfolk Public Health
Norfolk Public Schools
Norfolk Residents
Norfolk State University
Old Dominion University
WHRO Public Media
Red Cross
Sentara
Southeastern Public Service Authority
Tidewater Community College
U.S. Army Corps of Engineers
U.S. Coast Guard
U.S. Department of Homeland
Security
U.S. National Guard
U.S. Navy
Verizon
Virginia Department of
Emergency Management
Virginia Department of
Transportation
Virginia Institute for Marine Science
Virginia Port Authority



Waterways are the veins of a city. Through it flows life with possibilities for everyone to enjoy.

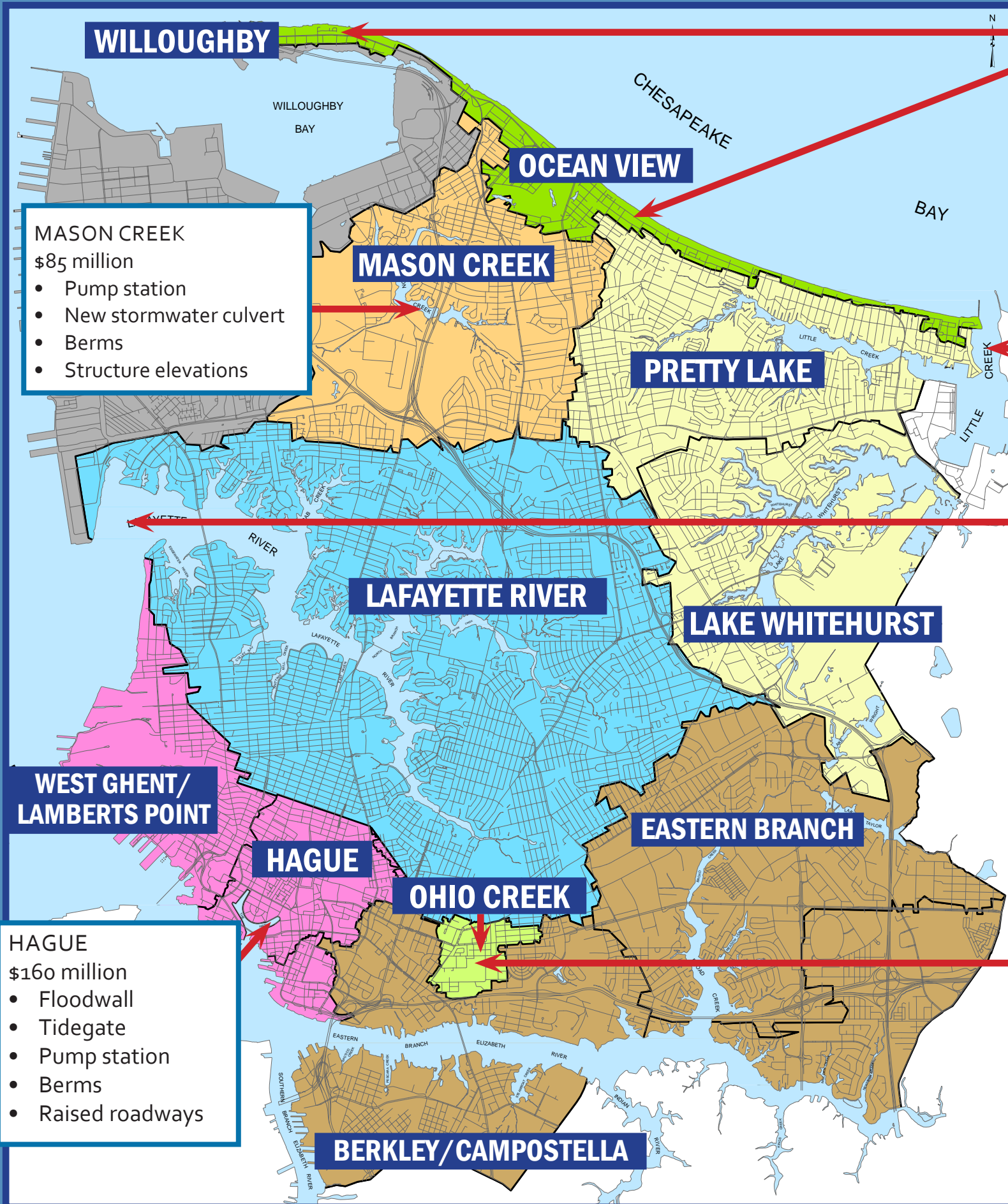


Norfolk visitors and residents enjoy both power and sail boating.



The Virginia Port Authority's sustainability program has been recognized by the Governor's Environmental Excellence Awards.

City-Wide Potential P



Projects By Watershed

Project Element Descriptions:

WILLOUGHBY/OCEAN VIEW \$21 million

- Dune & sand replenishment
- Structure elevations
- Outfall improvements
- Drainage improvements



Berms are engineered landscaping techniques that create a permanent flood wall from natural materials.

PRETTY LAKE \$100 million

- Floodwall
- Tidegate
- Pump station
- Raised roadways
- Drainage improvements



Floodgates and tidegates are man-made gates for shutting out, admitting, or releasing a body of water.



Floodwalls are man-made barriers that prevent tidal waters from accessing the protected area.

LAFAYETTE \$615 million

- Floodwalls/Floodgates
- Berms
- Structure elevations
- Drainage improvements



Outfalls are the large pipes that carry stormwater runoff to a natural waterway. Improving these structures improves runoff capacity.



Raised roadways increase the rise along a section of a roadway to assist with recurrent nuisance flooding.

OHIO CREEK \$70 million

- Pump station
- New stormwater culvert



Stormwater culverts are drains or pipes that allow water to flow under roads or structures. By improving these culverts, we can increase runoff capacity thereby assisting with nuisance flooding.



Structure elevations raise buildings above the base flood elevation, based on FEMA's Flood Insurance Rate Maps.



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