VIRGINIA

Coastal Resilience

MASTER PLAN

PHASE II

DRAFT FOR PUBLIC COMMENT

May 2026

DCR
Virginia Department of Conservation & Recreation

VIRGINIA COASTAL RESILIENCE MASTER PLAN


Newport News Shipbuilding

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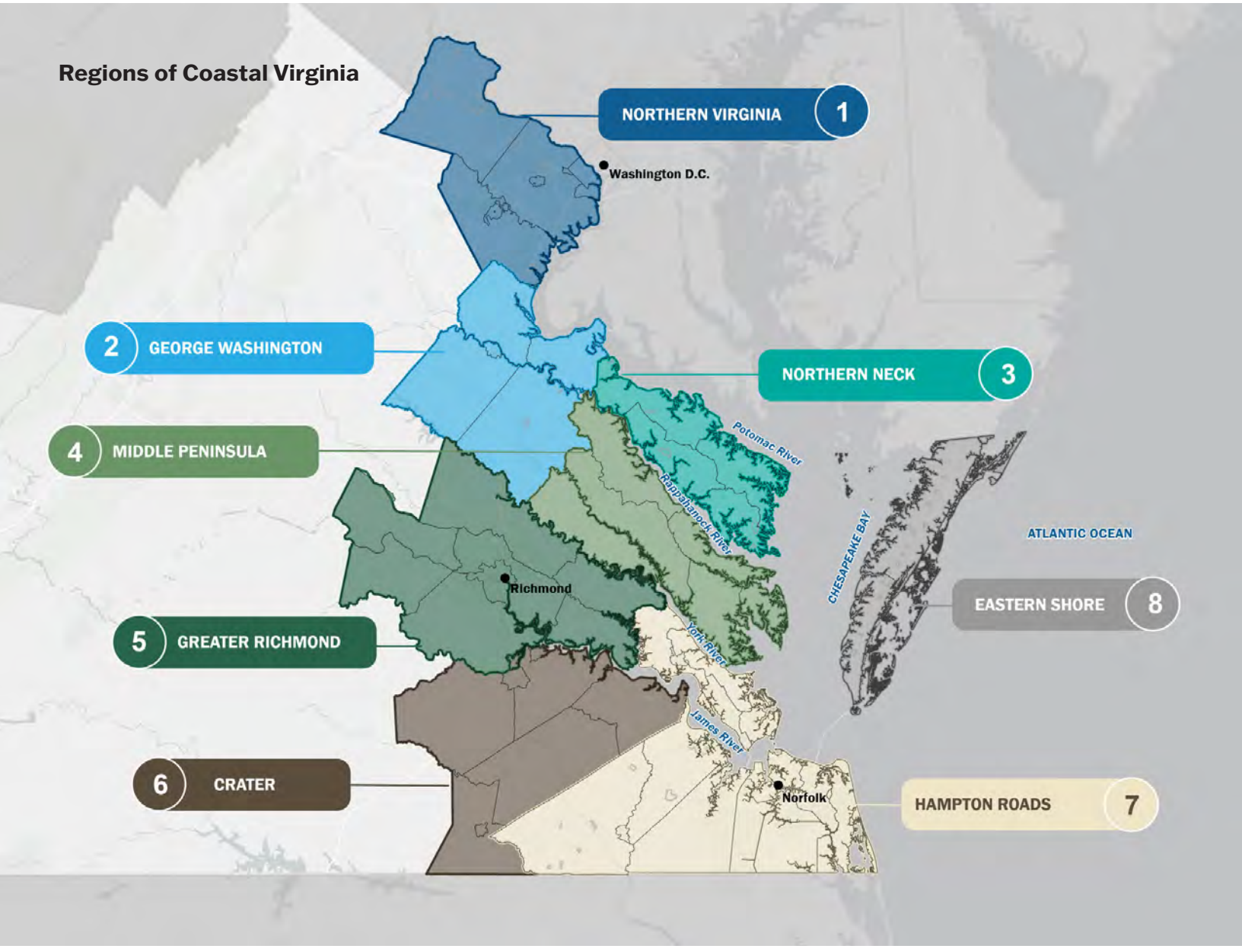
EXECUTIVE SUMMARY

This Phase II plan represents the culmination of significant effort over the past three years to incorporate all major flood hazard sources into a regionwide, forward-looking analysis of flood risk. This plan and its products use the best available data related to coastal Virginia's major flood hazard sources to inform decision makers on the risks and opportunities to address.

Why This Plan Matters

With over six million residents—73% of the state's population—living in coastal Virginia, it is crucial for the Commonwealth to understand the flood impacts we are facing.[1] Impacts of flooding vary across the region, influenced by each community's unique geographic, socio-economic, and historical context. While some communities are better prepared for flooding, others lack the resources and capacity to address evolving challenges. Often the communities with the fewest resources are hardest hit by flooding impacts.

This Coastal Resilience Master Plan (CRMP) is designed to be a trusted resource to support evidence-based decision making to mitigate severe and repetitive flooding. Phase I of the plan, released in 2021, was an important first step in the planning process, focused on the impacts of sea level rise and coastal flooding across the region. The Phase I Plan acknowledged the gaps in flood data and presented a path to address this limitation. This Phase II plan represents the culmination of significant effort over the past few years to incorporate all major flood hazard sources into a regionwide, forward-looking analysis of flood risk. Phase II builds upon previous efforts, providing the first ever regionwide rainfall-driven flood modeling data which incorporates projected impacts of changing precipitation.



To ensure that coastal Virginia will thrive for generations to come, we must address the impacts of flooding with forward-looking, informed and coordinated action. State-led support plays an important role in aligning resources, policies, and actions to achieve flood resilience. This plan's comprehensive approach is grounded in coordination and collaboration across different levels of government.

Phase II of the CRMP provides a thorough assessment of flood risk, leveraging the best available scientific data, mapping tools, and risk assessments. The goal of this plan is to promote informed decision across multiple levels of government to safeguard people, homes, businesses, infrastructure, and ecosystems. This plan provides stakeholders with a deeper understanding of flood exposure and its effects on local communities through the end of the century. It highlights the challenges, opportunities, and gaps in establishing a flood resilient future for coastal communities.

Who This Plan is For

The CRMP is designed to meet the needs of practitioners who play key roles in flood resilience through local action in coastal Virginia. In particular, the plan is catered to meet the needs of government decision makers.

This plan also offers valuable resources and information which can be used by community groups, non-profit organizations, employers, and individuals engaged in flood resilience efforts.

THE COMMONWEALTH'S ROLE IN ADVANCING FLOOD RESILIENCE

Effectively tackling the challenges ahead will require the collective efforts of state agencies, federal partners, regional planners, local governments, communities, and other stakeholders. In its leadership role, the Commonwealth of Virginia intends to support flood resilience efforts in the following ways:

- **Lead by example** by integrating flood resilience principles into decision-making processes.
- **Provide high-quality, accessible data and information** to support and guide stakeholders in making informed decisions.
- **Provide capacity-building support** to municipal governments to help them develop and implement localized flood resilience strategies.
- **Fill gaps in flood resilience actions** in areas where significant flood risks remain unaddressed through technical assistance, resources, and funding.

Stakeholder engagement throughout the development of this plan captured diverse perspectives from state agency staff, local and regional officials, federal agencies, the business and economic development community, non-profit organizations, residents, and others across Virginia's coastal communities. Through engagement:

- 500+ flood resilience activities were added to the projects and initiatives inventory by local and regional practitioners.
- 200+ people participated in webinars, meetings, and workshops on resilience and flooding in coastal Virginia.
- 50+ primary stakeholders provided direct input to inform the plan through a survey designed to collect feedback from the plan's intended end users.

This plan aligns with ongoing state programs and policies, serving as a framework that identifies new opportunities to improve flood resilience. The plan also provides foundational data to guide future efforts, setting the stage for ongoing coordination with local governments and other partners.

What this Plan Accomplishes

This plan and its products provide the best available data related to coastal Virginia's major flood hazard sources to inform decision makers on the region's unique risks that must be addressed. The information presented here will assist these actors in planning and implementing effective flood mitigation strategies. The Phase II plan focuses on two central topics: an analysis of flooding in coastal Virginia (Chapter 2) and solutions for flood resilience (Chapter 3).

OBJECTIVES OF THE COASTAL RESILIENCE MASTER PLAN

1. **Provide a unified baseline analysis of the threat of increasing flood exposure and impacts in coastal Virginia.** The plan provides a localized analysis of the changing threats from all sources of flooding to better equip diverse regions to tackle the challenges of the future. It quantifies projected flood impacts over multiple planning horizons and communicates findings to direct attention toward areas of need. Because the methods for data production are consistent regionwide, findings can be compared across the region's geographies.

2. **Identify opportunities to create impactful flood resilience solutions.** The plan includes an inventory of government-led or supported projects and initiatives across coastal Virginia, which is used to identify opportunities to fill gaps in action and enhance coordination. Additionally, the plan highlights 20 recommendations identified by key stakeholders on the Coastal Resilience Technical Advisory Committee (TAC) to address flood risk and resilience over the next five years.

In addition, the plan is designed to meet statutory requirements related to its development as established by the Code of Virginia § 10.1-658 and § 10.1-602.

COMMONWEALTH'S PRINCIPLES FOR FLOOD RESILIENCE

This plan is built on the five key principles for flood resilience that were established by the Coastal Resilience Master Planning Framework and codified in statute[2]. They are:

I Base decision making on the best-available science;

II Identify and address socioeconomic inequities and strive to enhance equity through the adaptation and protection measures by considering all areas of recurrent flooding;

III Recognize the importance of protecting and enhancing natural infrastructure and nature-based approaches to flood mitigation, when possible;

IV Utilize community and regional scale planning to the maximum extent possible, seeking region-specific approaches tailored to the needs of individual communities; and

V Include an understanding of fiscal realities and focus on cost-effective solutions for the protection and adaptation of communities, businesses, and critical infrastructure.

These principles value long-term effectiveness and ecological co-benefits while prioritizing strategies that meet community needs and adapt to new realities and risks.

ADVANCEMENTS IN THE PHASE II PLAN

The Phase II plan builds upon the foundation established during Phase I, utilizing the data, models, and information developed in that initial effort. Phase II now adds several critical elements:

- Enhanced flood hazard exposure models that include all forms of flooding—coastal, rainfall-driven, and riverine—to understand where flooding is likely to occur and its impacts on our residents and visitors, built environment, and natural resources.
- Advanced impact and risk assessment metrics.
- An updated inventory of resilience projects and initiatives currently underway in coastal Virginia, as well as funding opportunities to support these efforts.
- Recommended actions for flood resilience over the next five years from the Coastal Resilience TAC.
- Strengthened stakeholder engagement that considers the whole community of stakeholders in coastal Virginia.

Coastal Flooding – Occurs when tidal or storm surge waters exceed the typical shoreline and inundate upland areas. Coastal flooding includes both repetitive tidal flooding and severe storm surge.

Rainfall-Driven Flooding – Also known as "pluvial" flooding, occurs when intense or prolonged rainfall exceeds the land's ability to drain or absorb water, leading to inundation. This type of flooding occurs independently of existing water bodies and is sometimes excluded from traditional flood risk maps.

Riverine Flooding – Occurs when a river or stream overflows its banks and inundates the surrounding area. Riverine flooding can be caused by various factors, but in Virginia, it is often the result of heavy rainfall upstream. Many rivers in coastal Virginia are tidally influenced, meaning rising sea levels and other coastal flood factors can increase water levels and amplify flood risks.

IMPORTANT LIMITATIONS

The analysis presented in this plan is designed to provide context to inform flood resilience decision making. Important limitations exist for the flood hazards and flood impacts presented. Readers should take note of these limitations before using the data. Limitations are explored on page 23.

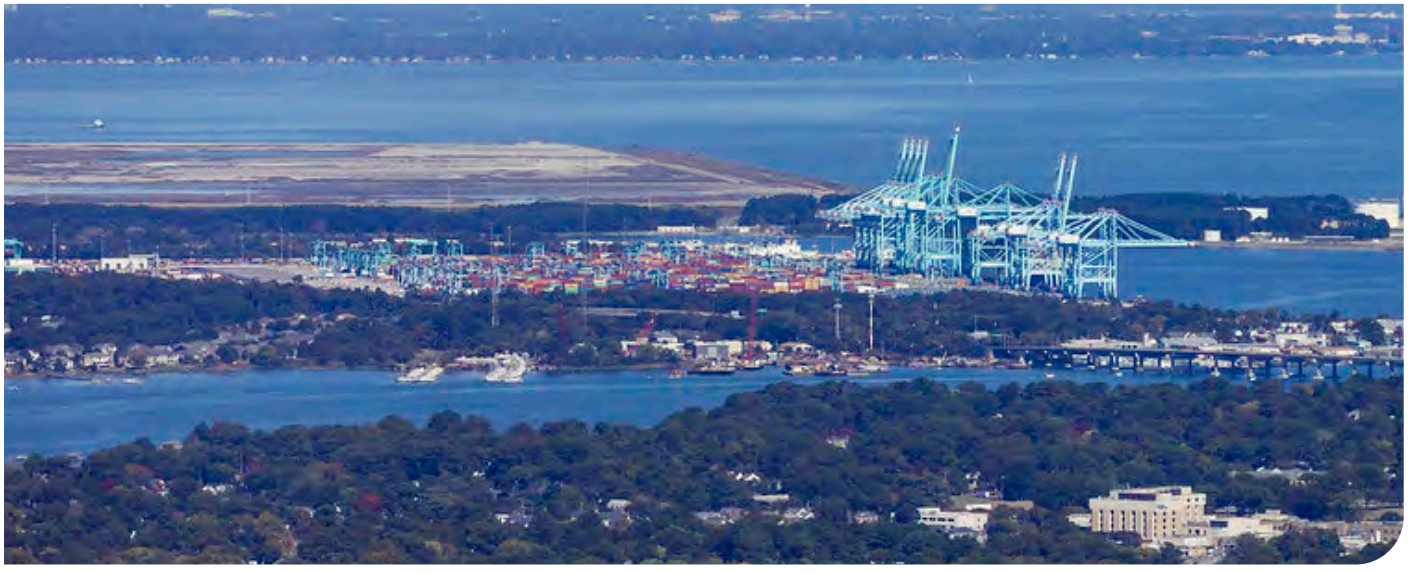
Flooding in Coastal Virginia

Flood hazards have the potential to affect many aspects of life in coastal Virginia, including the region's residents, visitors, and physical and natural resources. The plan explores where flooding is likely to occur and the impacts flooding may cause, positioning communities to build resilience to flooding for decades to come.

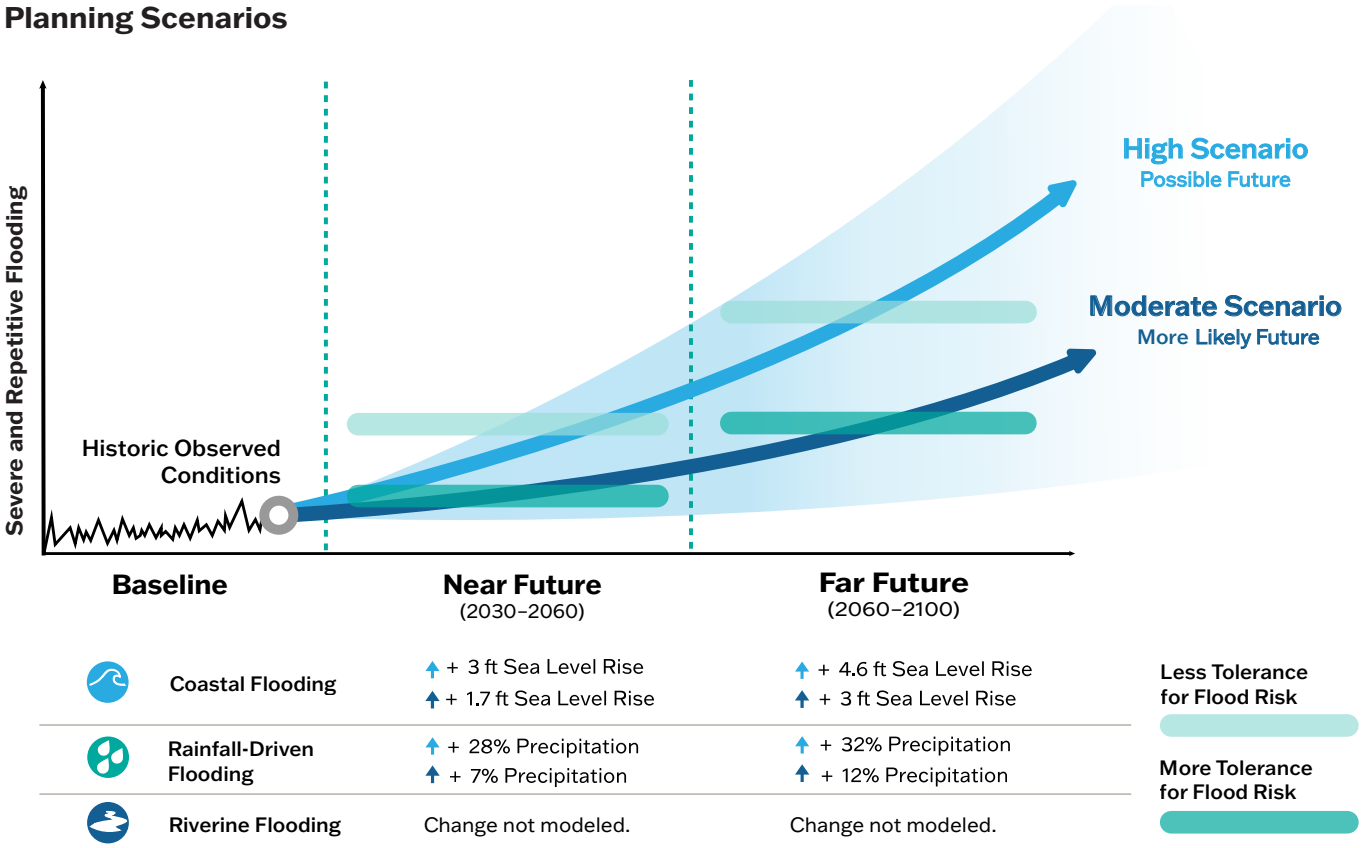
This plan presents results from modeling of coastal, rainfall-driven, and riverine flooding based on the best available data. Throughout, flood hazards are presented using five different planning scenarios which include both climate projection ranges and time horizons.

Within each planning scenario, the flood hazards were generated using modeling of a wide range of potential flood magnitudes, each paired with a corresponding probability of being equaled or exceeded, expressed as the annual exceedance probability (AEP). The AEPs represent the percent chance that a given flood magnitude may occur in any given year. To simplify the presentation of this flood data, the plan uses five reference flood conditions: tidal flooding (mean high water, relevant only for coastal data), chronic flooding (20% AEP), moderate flooding (4% AEP), major flooding (1% AEP), and extreme flooding (0.2% AEP).

Together, the five planning scenarios and the five reference flood conditions can be used to assess the changes in asset exposure and vulnerability over time and inform planning.



Planning Scenarios



Note: Sea level rise and precipitation increases are presented as averages but vary regionally. Climate change effects on riverine flooding were not available.

Flood Conditions Modeled and Referenced in the CRMP Phase II

Reference Flood Condition	Description (Likelihood)	Average Return Interval (Frequency)	Chance of occurring in...		
			5 years	10 years	30 years
Tidal (Coastal Only)	Mean Low Water	Always Inundated	100%	100%	100%
	Mean High Water *	Inundated Daily	100%	100%	100%
Chronic	50% AEP	2 years	97%	100%	100%
	20% AEP *	5 years	67%	89%	100%
Moderate	10% AEP	10 years	41%	65%	96%
	4% AEP *	25 years	18%	34%	71%
Major	2% AEP	50 years	10%	18%	45%
	1% AEP*	100 years	5%	10%	26%
Extreme	0.2% AEP	500 years	1%	2%	6%

*For purposes of this report only, the less frequent Annual Exceedance Probability (AEP) is used to summarize findings.

FLOOD HAZARDS

Coastal, rainfall-driven, and riverine flooding affect different parts of coastal Virginia, and many areas are subject to flooding from multiple sources. In the baseline scenario, about two million acres of land in coastal Virginia—approximately 27% of the region's land area—could be exposed to major flooding from any source, whether coastal, rainfall-driven, or riverine. About a quarter of that land area could be exposed to more than one source of major flooding.

Coastal Flooding

Virginia has a long history of major storms which have resulted in widespread coastal flooding. Today, 470,000 acres of coastal Virginia could be exposed to major coastal flooding. In general, where it occurs, major coastal flooding is expected to be deeper than major rainfall-driven flooding and may cause more severe damage. Hampton Roads and the Eastern Shore are the regions most exposed to major coastal flooding in both current and future scenarios.

Coastal Virginia, particularly the Hampton Roads region, has the highest rate of relative sea level rise on the U.S. East Coast.[3,4] In the past century, 18 inches of relative sea level rise has been observed in Hampton Roads.[5] Sea level rise influences storm surge flooding by increasing depths and allowing greater wave heights to reach farther inland. Between the baseline and far future scenarios, the land area that could be exposed to extreme coastal flooding may increase between 160,000 to 260,000 acres, nearly a 30-50% increase.

For low-lying areas of coastal Virginia located along tidal waterways, expanded tidal flooding is already a reality. By the end of the century, the region may see an additional 4.5 feet of sea level rise. Regionwide, 4% of the current land area in coastal Virginia could experience tidal flooding in the near future moderate scenario.

Rainfall-Driven Flooding

Severe rainfall events can result in significant flood impacts. Coastal Virginia has recently seen several isolated rainfall-driven flash-flooding events, including on July 8, 2019, when more than three inches of rain fell in parts of Northern Virginia over a 60-minute period.[6] Regionwide, rainfall-driven flooding poses a more extensive threat than coastal flooding, with the potential to expose approximately three times more land area in major flooding conditions.

Virginia is also experiencing an increase in the frequency and severity of heavy precipitation events. According to the Fifth National Climate Assessment, the southeastern United States has seen a 37% increase in the number of extreme precipitation days (defined as the top 1% of heaviest precipitation events) since the mid-20th century.[7] In coastal Virginia, the land area that could be exposed to rainfall-driven flooding may increase across all reference flood conditions and planning scenarios.

Increases in chronic rainfall-driven flooding are exacerbated in tidal regions that face both increases in precipitation and rising tidal water levels. Over time, communities in the Eastern Shore, Hampton Roads and the Middle Peninsula regions may see significant changes in the land area susceptible to chronic rainfall-driven flooding.

Riverine Flooding

There are four major rivers located in coastal Virginia: the Potomac, Rappahannock, York and James Rivers. When these rivers flood, they can impact the populations that rely on them. For example, historically the James River repeatedly flooded the City of Richmond and surrounding areas, resulting in damage to buildings and infrastructure and loss of life.

Across coastal Virginia, 548,000 acres—7% of the total land area—could be exposed to major riverine flooding in the baseline scenario. Crater, Hampton Roads, and Greater Richmond are the regions most likely to experience riverine flooding.

For most of coastal Virginia, riverine flood hazard data is only available for the baseline major flood condition as defined by FEMA's Special Flood Hazard Area (SFHA) (1% AEP). The lack of data about other reference flood conditions contributes to underrecognizing and under-communicating the risk of riverine flooding. Expanding riverine flood data and exploring the overlap between riverine and rainfall-driven flood hazard extents and impacts could help to improve understanding of risk.

FLOOD IMPACTS

Community Resources

This plan explores the impacts of flooding on people and their homes, and the resources that are important to communities' cultures. Nearly 1.5 million coastal Virginians—25% of the region's population—live in areas that could be exposed to major flooding today. Rainfall-driven flooding is the flood hazard most likely to impact coastal Virginia's residents at home, both for baseline and future conditions. However, the number of people that could be exposed to coastal flooding at home could rise significantly over the coming decades. Today, more than 3% of coastal Virginia's population—about 200,000 people—live in homes that could be exposed to major coastal flooding. The far future scenarios suggest that 7% to 11% of residents—equivalent to approximately 500,000 to 730,000 people—could be impacted.

Built and Human Infrastructure

This plan evaluates flood impacts on the systems of man-made or modified structures and related essential services that we rely on in our daily lives, ranging from energy systems to educational institutions.

Over time, more infrastructure will be at risk of direct damage or disruption from flooding. For example, public water treatment and distribution facilities provide access to clean drinking water across coastal Virginia. It is crucial that these systems are resilient to flooding to avoid disruptions to the essential services they provide. Regionwide, about 16% of water and wastewater assets could be exposed to rainfall-driven flooding, and about 8% could be exposed to major coastal flooding.

Natural Infrastructure

This plan explores how a range of conserved, working, and undeveloped lands and aquatic areas, including parks, may be vulnerable to changing flood conditions.

Agricultural lands along tidal water bodies, whether rivers and estuaries or open water bodies, may experience harmful impacts from coastal flooding. The Eastern Shore is especially vulnerable. Today, more than 6% of its agricultural lands could be exposed to chronic flooding. In the near future scenarios, this could rise between 8% to 12%.

About 9% of coastal Virginia is currently protected from human development as permanently conserved land.[8] Far-future scenarios indicate that 58,000–78,000 acres of conserved lands could become newly exposed to tidal flooding, creating conditions that could support the inland migration of wetlands.

Advancing Flood Resilience

In the face of flooding threats, many stakeholders are actively developing solutions. By establishing the Commonwealth's comprehensive inventory of flood resilience projects and initiatives, this plan presents a unified summary of actions underway across coastal Virginia. Actions are summarized by their potential costs, as well as their location, purpose, and other key information. Additionally, key stakeholders and technical experts across coastal Virginia collaborated to develop 20 recommendations for flood resilience actors across the region to advance in the next five years.

Projects are flood resilience activities that will lead to a place-based reduction of flood risk to people, property, or the environment through physical protection, adaptation, or avoidance measures. Project phases can include site assessments, conceptual or preliminary designs, permitting, final design and construction. Where possible, project should incorporate natural and nature-based approaches.

Initiatives are the resources needed to understand the flood risks and take concrete actions to protect their residents and assets from the threats posed by flood hazards. Initiatives include studies, data tools, programs, plans, policies, and technical assistance.

IMPORTANT LIMITATIONS

The analysis presented in this plan is designed to provide context to inform flood resilience decision making. Important limitations exist for the projects and initiatives findings presented. Readers should take note of these limitations before using the data. Limitations of the projects and initiatives inventory are located on page 60.

PROJECTS & INITIATIVES

- Since 2022, **more than 500** new resilience projects and capacity-building and planning initiatives were submitted to the plan's inventory.
- There are **nearly 950** projects and initiatives in the inventory. **Over 80%** of projects and initiatives are owned by local governments.
- Structural improvements to public facilities and infrastructure are by far the most common type of project. Specifically, this includes drainage improvements, road elevations, bridge elevations, and utility retrofits and upgrades.
- **Over 20%** of projects address multiple types of flooding. For projects with multiple hazards addressed, the most common grouping of hazards is storm surge flooding, stormwater flooding, and tidal flooding.
- **More than 10%** of all projects inventoried have been completed, at a total cost of **$241 million**.

FUNDING OPPORTUNITIES

- DCR's Community Flood Preparedness Fund (CFPF) grant program made **169 awards** in coastal Virginia between 2021 and 2025, amounting to **$237 million** of awarded funds.
- Relatively few initiatives in the inventory are intended to develop an organization's capacity to acquire funding for flood resilience efforts. During stakeholder engagement, local governments stated that funding—and the capacity to acquire funding—is one of the most prevalent challenges to advancing flood resilience efforts.
- Many localities view grants as the primary or exclusive method for funding resilience actions. However, additional mechanisms are available and being utilized for flood resilience action, such as bonds, taxes, and loans.

RECOMMENDATIONS OF THE COASTAL RESILIENCE TAC

The Coastal Resilience Technical Advisory Committee (TAC) was a codified public body responsible for assisting DCR with developing, updating, and implementing the CRMP. In addition to providing guidance to DCR on the plan's development, the TAC was divided into four subcommittees that were each tasked with developing recommendations designed to leverage the knowledge and expertise of practitioners to inform future resilience planning efforts.

- The 20 recommendations provide steps for implementation before the next planning phase and propose planning process improvements to help mitigate severe and repetitive flooding in coastal Virginia.
- Each subcommittee focused their efforts on specific objectives to enhance resilience planning through research, data, and innovation, project prioritization, funding strategies, and outreach and coordination.
- The recommendations highlight the need for a unified approach to advance flood resilience in coastal Virginia. Key themes that emerged include collaboration and coordination of information sharing, obtaining best available science and making data-driven decisions, community engagement and local resilience, financial understanding and sustainable funding.
- Recommendations are mostly aimed at the DCR Office of Resilience Planning, the Chief Resilience Officer (CRO) of the Commonwealth, and state agencies.

View the Virginia Coastal Resilience Web Explorer: dcr.virginia.gov/crmp/ResilienceExplorer

Next Steps

The CRMP is designed to evolve and grow every five years, with the next update scheduled for release in 2031. The Department of Conservation and Recreation's Office of Resilience Planning will continue to coordinate with key flood resilience actors in coastal Virginia to advance the use of this plan and the opportunities it captures. The next steps for the Office of Resilience Planning include:

- Encourage and support the use of flood resilience data through the promotion of the CRMP, the **Coastal Resilience Web Explorer (CRWE)**, and the Open Data Portal.
- Develop and implement an adaptive management plan to advance the TAC recommendations and other opportunities.
- Collect and monitor feedback from target audiences and the public to help inform future updates to this plan.

The Virginia Flood Protection Master Plan (VFPMP) is under development. Unlike the CRMP, the VFPMP will address flood challenges across the entire Commonwealth. The VFPMP will draw from key findings from this Phase II plan relevant to state policy, identifying opportunities which can be scaled beyond the coastal Virginia to address challenges in other parts of the state.

HOW TO USE THIS PLAN AND ITS PRODUCTS

To complement this plan, additional tools and resources were developed to communicate its findings in interactive and accessible formats:

The **CRWE** allows users to visualize flood hazards and impacts using maps and dashboards. The CRWE also provides access to information on resilience projects, capacity-building initiatives, and potential funding opportunities.

The **User Portal** allows stakeholders to submit and share information on their flood resilience efforts to the CRWE. This fosters collaboration and supports planning at the state, regional, and local levels.

The **Open Data Portal** provides a centralized repository for data presented in the plan, ensuring stakeholders have access to the most current information.

These resources can be used to better understand local and regional flooding challenges, develop comprehensive plans or hazard mitigation strategies, advance flood resilience actions, make informed decisions, secure funding and political support, and educate public audiences.

KEY TERMS

The following section provides definitions of key terms frequently referenced in this plan.

Key Terms

Our Planning Areas

- **Coastal Virginia** – The geographic area bounded by the eight easternmost Planning District Commissions (PDCs) of Virginia. The area encompasses all cities and counties within these PDCs, between the Atlantic Ocean and Virginia's fall line. Coastal Virginia represents the geographic area of focus for this plan.
- **Regions** – Eight geographic areas defined by the boundaries of each PDC within coastal Virginia. The regions are: Northern Virginia, George Washington, Northern Neck, Middle Peninsula, Greater Richmond, Crater, Hampton Roads and the Eastern Shore.

Flood Resilience Actors and Advisors

- **Coastal Resilience Technical Advisory Committee (TAC)** – A codified public body responsible for assisting the Department of Conservation and Recreation (DCR) with developing, updating, and implementing the CRMP. The TAC was chaired by the Director of DCR. Member organizations represented many of the plan's primary intended end users and key stakeholders, including state agencies, PDCs, university research programs, environmental non-profit organizations, and industry organizations. The TAC sunset in February 2025.
- **Flood Resilience Advisory Committee** – A codified public body responsible for advising DCR on the Virginia Flood Protection Master Plan (VFPMP), as well as the Department's other efforts to implement the Commonwealth's flood resilience, preparedness, prevention, and protection programs. The Committee was established in February 2025 and includes representatives from state agencies and other key stakeholders addressing flood resilience statewide.
- **Interagency Resilience Management Team** – A codified group convened by the Commonwealth's Chief Resilience Officer (CRO) to support coordination of planning and implementation for all-hazards resilience. The body will consist of state agency staff designated to represent their agency as a "resilience coordinator."
- **Local Government** – The systems of public administration that govern Virginia's cities, counties and towns. Local governments are sometimes also referred to as "localities" in the plan.
- **Planning District Commission (PDC) –** Political subdivisions of the Commonwealth which are defined by state law and consists of groups of localities. PDCs provide a collaborative forum for local governments to discuss planning, development, and management of resources within a geographic area. For the purposes of this plan, we use PDC to represent both PDCs and regional commissions.

Flooding Types and Factors

- **Annual Exceedance Probability (AEP)** – The likelihood of a given flood magnitude to be equaled or exceeded in any given year, presented as a percentage. This plan uses multiple terms to represent various AEP flood conditions, described in Chapter 2.
- **Coastal Flooding** – Occurs when tidal waters exceed the typical shoreline and inundate upland areas. Coastal flooding includes both repetitive tidal flooding and severe storm surge.
  - **Mean High Water** – The average of all tidal high-water heights observed over a standardized 19-year period.[1]
  - **Tidal Flooding** – Occurs when ordinarily dry land is temporarily inundated during daily high tides. Tidal flood elevations fluctuate each month and throughout the year. As sea levels rise, high tide waters generally extend farther inland.
  - **Storm Surge** – A rise in the normal water level along a shore that is caused by strong onshore winds and/or reduced atmospheric pressure associated with a storm event.[2] Sea level rise increases storm surge depths, allowing greater wave heights to reach farther inland.
- **Compound Flooding** – Occurs when multiple factors that cause flooding – such as high tide fluctuations, heavy rainfall, and strong onshore winds – take place simultaneously or in close succession. When multiple types of flooding converge in a single location, the resulting flooding is more severe than from any single source. Compound flooding is not specifically addressed in this plan.
- **Planning Scenario** – Five planning scenarios in this plan present findings from the flood hazard analysis and impact assessment across different climate projection ranges and timeframes. They convey recommended future conditions to use in long-range planning for flood hazards while recognizing the uncertainty that exists in climate forecasts.
- **Rainfall-Driven Flooding** – Also known as "pluvial" flooding, occurs when intense or prolonged rainfall exceeds the land's ability to drain or absorb water, leading to inundation. This type of flooding occurs independently of existing water bodies and is not always included in traditional flood risk maps.
- **Relative Sea Level Rise** – The localized rise in sea level as measured from a static point on land. This includes the effects of any local sediment compaction or subsidence – the sinking of land – as well as the global change in sea level.[3]
- **Riverine Flooding** – Occurs when a river or stream overflows its banks and inundates the surrounding area. Riverine flooding can be caused by a variety of factors, but in Virginia, it is often the result of heavy rainfall upstream. Many rivers in coastal Virginia are tidally influenced, meaning rising sea levels and other coastal flood factors can increase water levels and amplify flood risks.
- **Sea Level Rise** – The increase in the average level of the world's oceans due to factors like the melting of glaciers and polar ice caps and the thermal expansion of seawater as it warms.[4]
- **Shoreline Erosion** – The process by which local wave action, currents, and flooding wear down or carry away rocks, soils, and sands along shorelines and banks of water bodies.

Describing Flood Risk

- **Asset** – Physical components or resources of value that may be directly affected by hazards. In this plan, assets are organized into four major categories:
  - **Built Infrastructure** – The man-made or modified structures that we rely on in our daily lives. This includes the distribution systems that provide us with water and electricity, and the roads, bridges, and transportation systems we use to get from place to place.

- **Community Resources** – Include people and their homes, as well as assets which are important to communities' cultures, such as historic resources and religious buildings.
- **Human Infrastructure** – Includes the facilities and systems that provide critical services to the population to support the well-being of citizens. Unlike built infrastructure, these assets typically center around service provision, such as hospitals, educational facilities, and police stations
- **Natural Infrastructure** – Infrastructure that uses, restores, or emulates natural ecological processes, and is created through the action of natural physical, geological, biological, and chemical processes over time; is created by human design, engineering, and construction to emulate or act in concert with natural processes; or involves the use of plants, soils, and other natural features including through the creation, restoration, or preservation of vegetated areas using regionally suitable materials to manage stormwater and runoff, to attenuate flooding and storm surges, and for other related purposes.[5]

- **Ecosystem Services** – Direct or indirect contributions that ecosystems make to the environment and human populations.
- **Exposure** – The likelihood and degree to which an asset, population, or system will be physically affected by flooding. Flood exposure for a given asset is a factor of the magnitude of the hazard present at its location.
- **Hazard** – The potential occurrence of a physical event or trend that may threaten people, systems, or assets.
- **Impact** – Expected consequences to physical and social environments due to the interaction of assets with a hazard (such as tidal and coastal floods).
- **Risk** – The expected value of direct and indirect consequences associated with the potential damages and/or disruption of the asset or system. Quantifying risk to an asset requires considering the probability a hazard event will occur and the associated consequences of that event to the asset. Such consequences include the direct structural and functional losses, as well as indirect social, environmental, and economic losses.
- **Vulnerability** – The degree to which an asset, population, or system associated with the asset is likely to be adversely affected by the hazard. Vulnerability can be physical or social. It encompasses an array of concepts, including exposure, sensitivity, and adaptive capacity. Vulnerability is measured in a variety of ways in this plan.

Flood Solutions

- **Adaptation** – Adaptation strategies allow existing assets to endure increased or amplified flooding. Rather than block floodwaters, these strategies adapt existing built or natural systems in ways that decrease their susceptibility to flooding hazards. Adaptation strategies include restoration projects that allow natural infrastructure to withstand higher sea levels and site-level projects that enable existing built structures to withstand a certain magnitude of flooding.
- **Flood Resilience** – The capability to anticipate, prepare for, respond to, and recover from flood hazards with minimal damage to social well-being, health, the economy, and the environment.[6]
- **Living Shoreline** – A shoreline management practice that provides erosion control and water quality benefits; protects, restores or enhances shoreline habitat; and maintains coastal processes through the strategic placement of plants, stone, sand fill, and other structural and organic materials.[7]

- **Nature-Based Solutions** – Nature-based solution means an approach that reduces the impacts of flood and storm events through the use of environmental processes and natural systems. A nature-based solution may provide additional benefits beyond flood control, such as recreational opportunities and improved water quality.[8]
- **Protection** – Where adaptation is impractical, protection strategies can maintain the functions and benefits of existing infrastructure by absorbing or diverting floodwaters. They include defensive engineered structures and systems that have the potential to protect large areas from a wide variety of flood conditions but they are often costly to design, construct, and maintain.

Understanding Community Context

- **Social Vulnerability** – The susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood.[9] Socially vulnerable populations are especially at risk during public health emergencies because of factors like socioeconomic status, household characteristics, racial and ethnic minority status or housing type and transportation.
- **Whole Community Approach** – A strategy that involves engaging all members of the community, including individuals, businesses, non-profits, and government agencies, in addressing hazards.[10] Although traditionally a strategy for emergency management—particularly disaster response and recovery—DCR has adapted and embraced the approach for its flood resilience planning outreach and engagement framework.

See the Community Outreach and Engagement Plan for more details.

- https://www.dcr.virginia.gov/dam-safety-and-floodplains/document/DCR-COEP.pdf

CHAPTER 1

INTRODUCTION

Coastal Virginia, home to millions of Virginians, thriving economies, and robust natural systems, is at increasing risk from flooding. Over the past decade, the Commonwealth of Virginia has taken an increasing role in coordinating planning processes to develop a regionwide flood resilience strategy, including the development of this Coastal Resilience Master Plan. This chapter sets the stage for the remainder of the plan, exploring the planning area, plan purpose and approach, as well as outlining a brief history of how the work this plan captures has evolved.

Our Coastal Home

Coastal Virginia is home to over six million people, or 73% of the state's population.[1] Extending from the Eastern Shore to the fall line and from the North Carolina border to Northern Virginia, the area is defined by its stunning natural beauty, deep historical roots, robust economies, and cultural significance.

Coastal Virginia encompasses 120 diverse towns, cities, and counties from the bustling urban waterfront streets of Old Town Alexandria to the quiet, rural farmlands spanning the Eastern Shore. These localities have their own unique neighborhoods, businesses, critical infrastructure, natural resources, and institutions that shape their economy and culture.

Across the region, waterways and water bodies are a foundational element of coastal Virginia's way of life. The area is defined by its proximity to the Chesapeake Bay, the largest estuary in the United States. The bay and its extensive networks of rivers, channels, and creeks—including the Potomac, Rappahannock, York, and James Rivers and their watersheds—not only provide stunning landscapes but also sustain a diverse range of ecosystems. The Chesapeake Bay and its watershed are home to thousands of plants, fish, and wildlife species, making it one of the most biologically vibrant areas in the country.

These waters and their abundant resources also drive large sectors of coastal Virginia's economy, such as the Port of Virginia and the Naval Station Norfolk, which together support more than 695,000 jobs in Virginia and 12% of Virginia's gross state product.[2,3] However, this vital network of water bodies also presents significant flood risks to nearby communities and resources.

Flooding has long affected coastal Virginia, but climate change is escalating these risks. Factors such as growing development, rising relative sea levels (including land subsidence), and increasingly frequent and severe storms threaten economic stability, infrastructure, and ways of life.

In coastal Virginia, rapid human development has reduced the land's ability to absorb heavy rainfall, leading to more frequent flooding. Urban infrastructure struggles to manage the growing stormwater runoff, exacerbating the situation.

Coastal Virginia is experiencing the highest rate of relative sea-level rise along the entire U.S. Atlantic coast, with an increase of more than 14 inches since 1930.[4] Climate change is also intensifying storm frequency and severity, driven by rising sea surface temperatures and altered atmospheric conditions. The combination of factors increases storm surge risks and flooding challenges.

As a result, coastal communities and ecosystems are increasingly vulnerable. Flooding poses significant risks to the health and well-being of Virginians, leading to property and economic loss, damage to cultural resources, and potential loss of life.

The responsibility to act to address these challenges and build flood resilience rests with many different actors: local governments, PDCs, state agencies, the federal government, neighborhood groups, environmental non-profits, the business community, and beyond. Ultimately, the whole community must come together to build resilience to flooding.

Strategies to adapt, protect, and voluntarily relocate people and assets out of harm's way are already underway across coastal Virginia. However, more action is needed to address the challenge at hand.

What is a Planning District Commission?

A Planning District Commission (PDC) —also sometimes called a "Regional Commission"—is a political subdivision of the Commonwealth chartered through the Regional Cooperation Act and created through agreements between local governments.[5] PDCs aim to encourage and facilitate cooperation among local governments and between state and local government to address regional problems. They serve as liaisons between localities and state agencies and conduct strategic planning for the region. Their roles may include studying problems of regional significance, identifying cost-saving opportunities through coordinated governmental efforts, and providing technical assistance and implementing services upon request of member localities, among other duties.

Several PDCs include member localities of an adjoining commission for planning continuity purposes. This structure exists between PlanRVA and the Crater PDC for Chesterfield County and Charles City County; between the Middle Peninsula PDC and the Hampton Roads PDC for Gloucester County; and between the Crater PDC and the Hampton Roads PDC for Surry County.

The Planning Area and Planning Regions

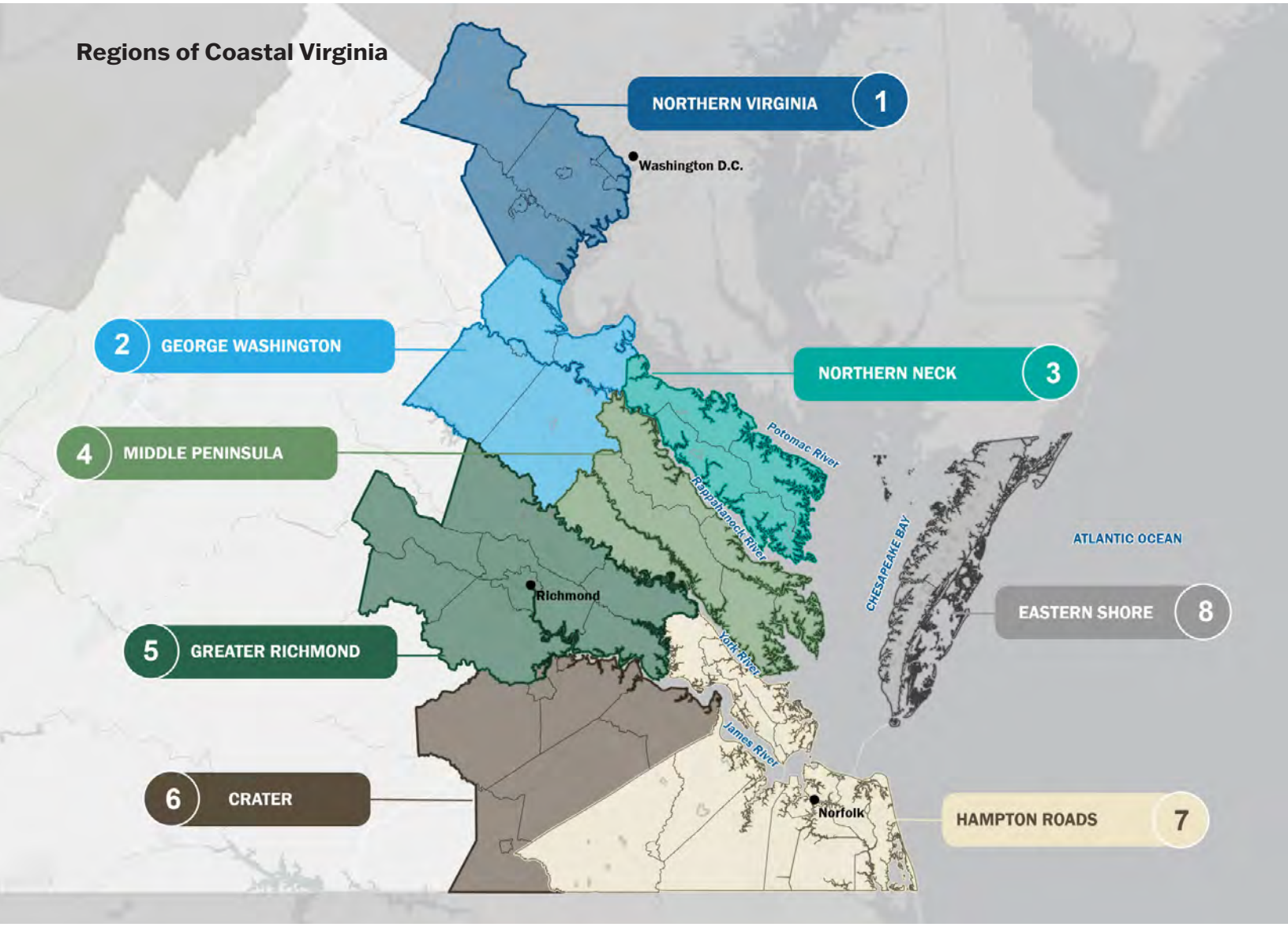
For the CRMP, "coastal Virginia" is defined as the entire area covered by the eight eastern-most PDCs in the Commonwealth. This is the geographic area of focus for this plan. This part of the state consists of distinctive communities defined by unique geographies, development patterns, economies, and cultures.

With these variations in mind, the Commonwealth has recognized that there is no "one-size-fits-all" approach to understanding flooding challenges and embracing solutions.

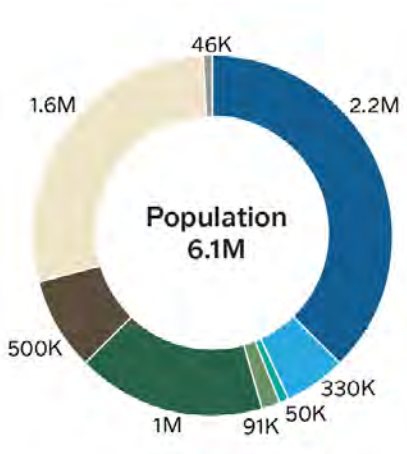
Aligning with our flood resilience guiding principle to utilize regional scale planning, this plan summarizes findings at a smaller scale than the entirety of coastal Virginia by summarizing impacts and opportunities by "regions" which are consistent with the eight PDCs. PDCs were selected as the geographic scale by which to organize the content. Additional political and watershed-based scales of reporting are available to explore in the Coastal Resilience Web Explorer (CRWE) and Open Data Portal.

1. **Northern Virginia region** (Northern Virginia Regional Commission): Counties of Arlington, Fairfax, Loudoun, and Prince William; Cities of Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park; Towns of Clifton, Dumfries, Hamilton, Haymarket, Herndon, Hillsboro, Leesburg, Lovettsville, Middleburg, Occoquan, Purcellville, Quantico, Round Hill, and Vienna.
2. **George Washington region** (George Washington Regional Commission): Counties of Caroline, King George, Spotsylvania, and Stafford; City of Fredericksburg; Towns of Bowling Green and Port Royal.
3. **Northern Neck region** (Northern Neck PDC): Counties of Lancaster, Northumberland, Richmond, and Westmoreland; Towns of Colonial Beach, Irvington, Kilmarnock, Montross, Warsaw, and White Stone.
4. **Middle Peninsula region** (Middle Peninsula PDC): Counties of Essex, Gloucester, King and Queen, King William, Mathews, and Middlesex; Towns of Tappahannock, Urbanna, and West Point
5. **Greater Richmond region** (PlanRVA): Counties of Charles City, Chesterfield, Goochland, Hanover, Henrico, New Kent, and Powhatan; City of Richmond; Town of Ashland.
6. **Crater region** (Crater PDC): Counties of Dinwiddie, Greensville, Prince George, Surry, and Sussex; Cities of Colonial Heights, Emporia, Hopewell, and Petersburg; Towns of Claremont, Dendron, Jarratt, McKenney, Stony Creek, Surry, Wakefield, and Waverly.
7. **Hampton Roads region** (Hampton Roads PDC): Counties of Isle of Wight, James City, Southampton, and York; Cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg; Towns of Boykins, Branchville, Capron, Courtland, Ivor, Newsoms, Smithfield, and Windsor.
8. **Eastern Shore region** (Accomack-Northampton PDC): Counties of Accomack and Northampton; Towns of Accomack, Belle Haven, Bloxom, Cape Charles, Cheriton, Chincoteague, Eastville, Exmore, Hallwood, Keller, Melfa, Nassawadox, Onancock, Onley, Painter, Parksley, Saxis, Tangier, and Wachapreague.

Regions of Coastal Virginia



Population, Land Area, and GDP of Coastal Virginia's Regions



Purpose of the Coastal Resilience Master Plan

The CRMP is designed to be a trusted resource to support evidence-based decision making to mitigate severe and repetitive flooding.

State-level action is a critical element of coastal Virginia's mission to become flood resilient. As the whole community of actors works toward flood resilience in coastal Virginia, a coordinated response can help to maximize the impact of efforts and resources. The state has a role to play in aligning resources, policies, and actions for flood resilience among multiple levels of government: from federal, to state, to local. Without a unified approach, flood mitigation efforts can become fragmented, leaving under-resourced local governments and vulnerable communities behind.

The CRMP provides foundational data to guide flood resilience efforts by presenting a consistent picture of flood risks and opportunities across the region. This sets the stage for ongoing coordination with local governments and other partners, serving as a framework that identifies opportunities to improve flood resilience. The plan integrates this data with information about ongoing efforts from flood resilience practitioners—particularly at the local government level—in a summary appropriate for coordinated decision-making at multiple scales.

OBJECTIVES OF THE COASTAL RESILIENCE MASTER PLAN:

1. **Provide a unified analysis of the threat of increasing flood exposure and impacts in coastal Virginia.** The plan provides a localized analysis of the changing threats from all sources of flooding to better equip diverse regions to tackle the challenges of the future. It quantifies projected flood impacts over multiple planning horizons and communicates findings to direct attention toward areas of need. Because the methods for data production are consistent regionwide, findings can be compared across the region's geographies.

2. **Identify opportunities to create impactful flood resilience solutions.** The plan includes an inventory of government-led or supported projects and initiatives across coastal Virginia, which is used to identify opportunities to fill gaps in action and enhance coordination. Additionally, the plan highlights 20 recommendations identified by key stakeholders on the Coastal Resilience TAC to address flood risk and resilience over the next five years.

The CRMP serves as a centralized resource for data and information for state, regional and local governments as they work to safeguard Virginia's coastal communities, economies, and natural resources for future generations.

Evolution of a Regionwide Flood Resilience Strategy

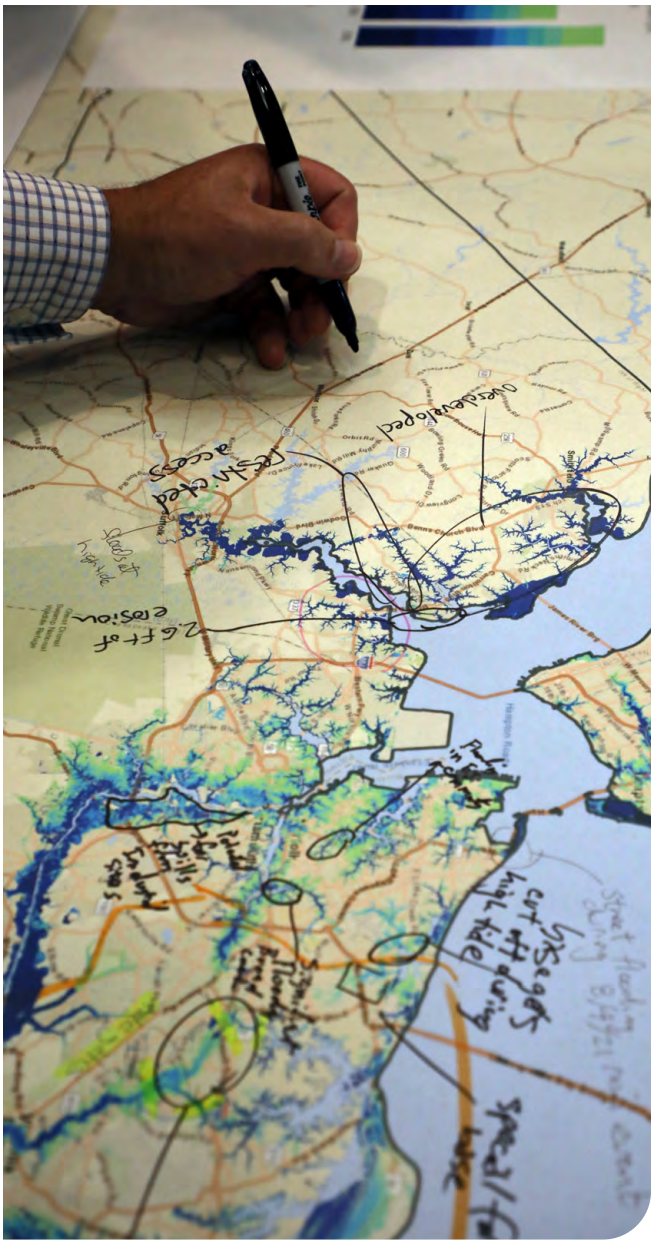
Addressing the impacts of flooding requires forward-looking, informed, and coordinated action so that coastal Virginia continues to thrive for generations to come. Over the past decade, the Commonwealth of Virginia has taken an increasing role in coordinating planning processes to develop a regionwide flood resilience strategy.[6] Establishing and developing the CRMP is one of many actions that have occurred at the state level to advance and coordinate flood resilience.

In its leadership role, the Commonwealth of Virginia intends to support flood resilience efforts in the following ways:

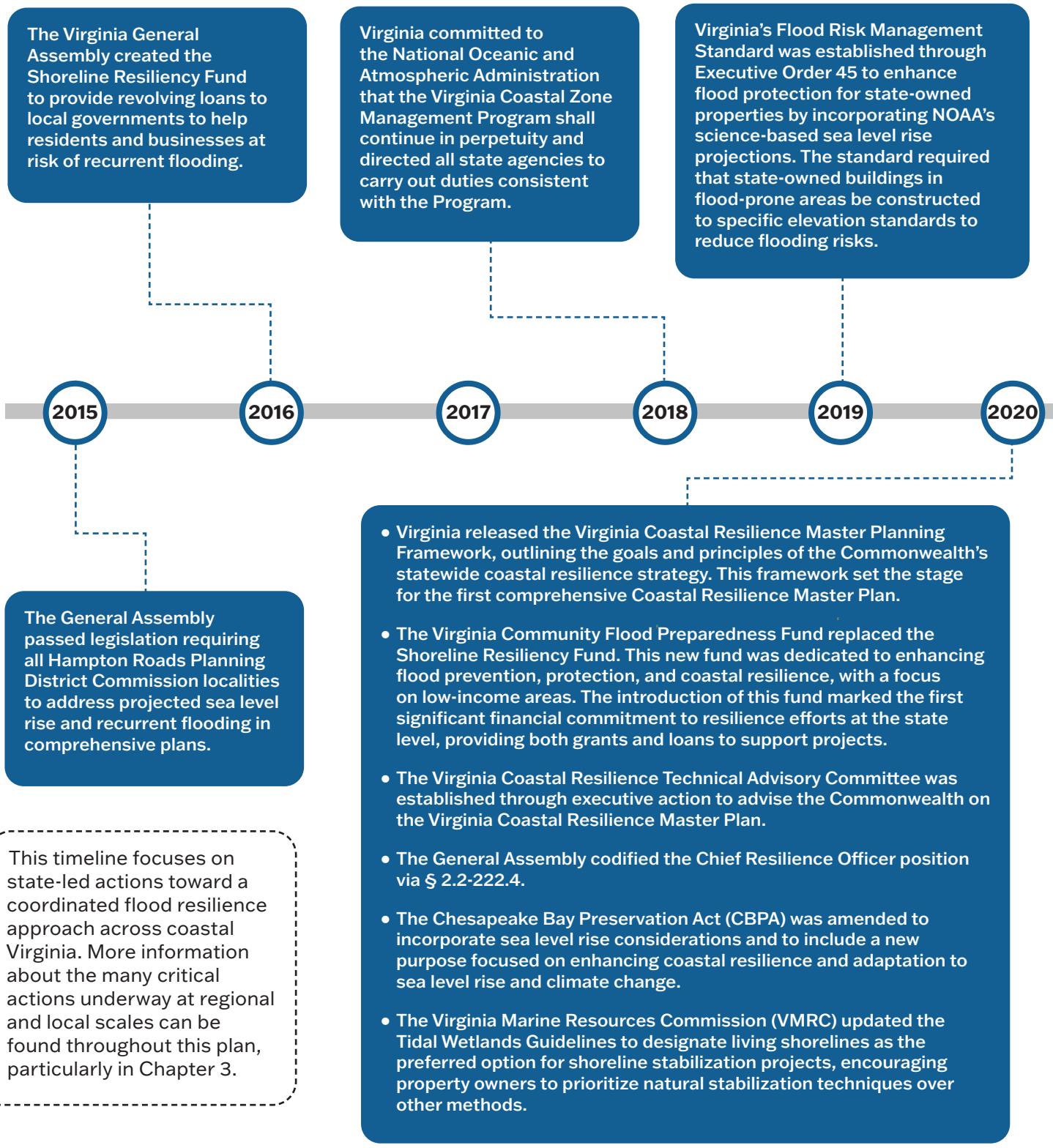
- **Lead by example** by integrating flood resilience principles into decision-making processes.
- **Provide high-quality, accessible data and information** to support and guide stakeholders in making informed decisions.
- **Provide capacity building support** to local governments to help them develop and implement local and regional flood resilience strategies.
- **Fill gaps in flood resilience actions in areas** where significant flood risks remain unaddressed through technical assistance, resources, and funding.

Creating a unified state approach to filling emerging and unmet flood resilience needs is an ongoing effort. Following the release of this plan, DCR will continue to coordinate with its partners in coastal Virginia to build upon the Commonwealth's accomplishments to date and address opportunities to further flood resilience.

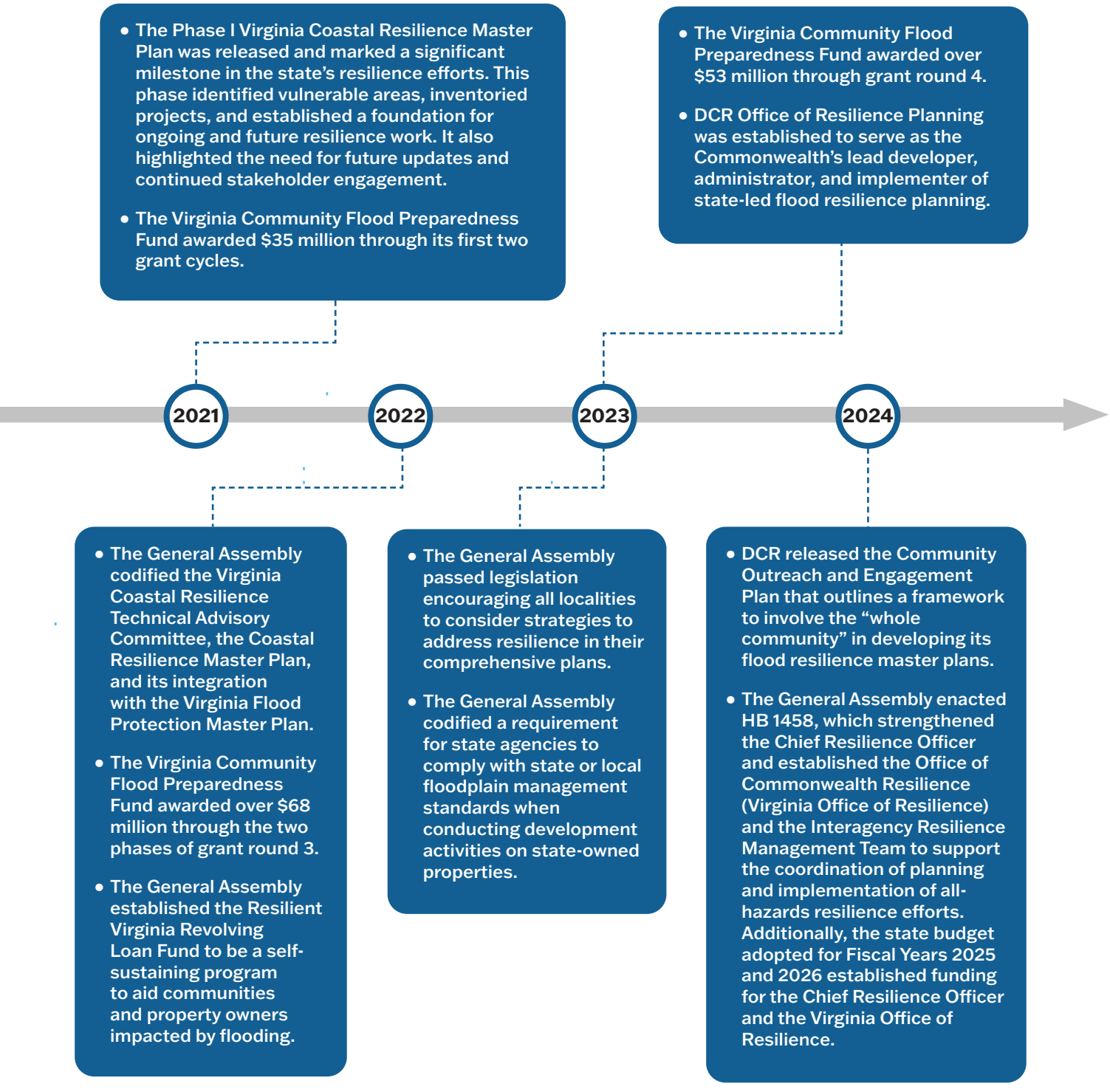
Additionally, future efforts—such as the Virginia Flood Protection Master Plan (VFPMP)—will incorporate actions to coordinate flood resilience statewide, ensuring flood resilience efforts benefit all areas of the state.



Major Milestones in the Commonwealth's Coastal Flood Resilience Strategy in the Past Decade



This timeline focuses on state-led actions toward a coordinated flood resilience approach across coastal Virginia. More information about the many critical actions underway at regional and local scales can be found throughout this plan, particularly in Chapter 3.



Indigenous Tribes Addressing Coastal Flood Resilience

The Indigenous Tribes of Virginia have a long tradition of stewardship over their ancestral lands, employing traditional ecological knowledge and practices to enhance the flood resilience of coastal lands. Today, these Tribes engage in projects and initiatives that continue this tradition in the face of modern coastal land development and a changing climate. Their stewardship is historically rooted in a deep understanding of the land, waters, and ecosystems.

Currently, 11 indigenous Tribal nations are recognized in Virginia, seven of which hold federal recognition. Most of these Tribal nations are concentrated in coastal Virginia, and particularly the Middle Peninsula and western Hampton Roads. Advancing projects and policies that address flooding impacts while actively improving the health of these waterways is crucial to the livelihoods of Tribal communities present in coastal Virginia. Federally recognized Tribes maintain a government-to-government relationship with the federal government, granting them direct access to federal grant programs and services for Tribal members within their service area.

Virginia's Indian Tribes are an important part of coastal Virginia's communities. The knowledge and approaches of Tribal leadership to address growing flood challenges offer deep value to the future resilience of our coastal communities. Just a few of the many ongoing Tribal flood resilience projects include:

- The Upper Mattaponi Indian Tribe acquired 853 acres of culturally significant ancestral territory and began habitat restoration along the Mattaponi River with support from the National Oceanic and Atmospheric Administration (NOAA) "Return to the River" program.
- In 2022, the Chickahominy Tribe developed its own Hazard Mitigation Plan (HMP). This became the first Tribal HMP to be approved by the Federal Emergency Management Agency (FEMA) Region III, positioning the Tribe to take advantage of mitigation funds and work directly with FEMA.[7]
- The Nansemond Indian Nation, along with other federally recognized Tribes, receives funding for its environmental programs from EPA's Indian Environmental General Assistance Program. Nansemond environmental programming emphasizes improvements to water quality and coastal resilience through the restoration of oysters in the Chesapeake Bay and the removal of invasive plant species along with the re-planting of native plant species.
- In 2022, the Rappahannock Tribe secured 465 acres of ancestral Tribal land along the Rappahannock River, which was placed in a conservation easement with the U.S. Fish and Wildlife Service (USFWS). Reacquisition of the land allows the Tribe to implement conservation measures designed to protect the shoreline.

Following legislation passed by the Virginia General Assembly in its 2025 session, Tribes with Federal or State recognition are eligible to receive funding through the Community Flood Preparedness Fund.

History of the Coastal Resilience Master Plan

COASTAL RESILIENCE MASTER PLANNING FRAMEWORK

The Virginia Coastal Resilience Master Planning Framework was developed in 2020 to lay out the Commonwealth's approach to coastal protection and adaptation. Through collaboration across state agencies, local and regional partners, and other stakeholders, the framework established goals, objectives, guiding principles, and key actions that helped to drive the development of the first iteration of the CRMP (Phase I).

COASTAL RESILIENCE MASTER PLAN, PHASE I

The Phase I CRMP was developed and released in 2021. The plan established a strong foundation for ongoing and future flood resilience efforts, addressing both immediate and long-term challenges. It achieved the following objectives:

- **Comprehensive Flood Hazard and Vulnerability Assessment:** The assessment determined current and future land exposure to coastal flooding hazards and identified anticipated changes in flood frequency across the Commonwealth. This assessment also highlighted areas with high social vulnerability and coastal flood hazard exposure, pinpointing regions with the greatest potential needs and risks.
- **Impact Analysis and Stakeholder Engagement**: The planning team used coastal flood hazard models to estimate flood impacts on community resources, critical sectors, and natural infrastructure. The planning effort included conducting workshops with PDCs, localities, and communities to refine these assessments using local knowledge and understanding.
- **Development of Resilience Tools:** Phase I included the release of the original CRWE, which provided access to view data on coastal flood hazards, impacts, projects and initiatives, and funding sources to support resilience efforts at the state, regional, and local levels. The funding element of the CRWE was created to support owners of projects and initiatives in the inventory to access information about relevant grant and loan programs.
- **Project Evaluation:** Together with the Coastal Resilience TAC, the planning team explored establishing a data-driven approach for evaluating and prioritizing identified projects and initiatives in alignment with the Commonwealth's flood resilience principles. While ultimately the plan did not prioritize projects due to limitations of time and capacity, it established an initial prioritization framework which can be revisited by future efforts.

While Phase I was an important step forward, it was acknowledged as a foundational effort with known limitations. For example, the Phase I plan did not include all major sources of flooding—coastal, riverine, and rainfall-driven—instead only examining coastal flooding from tides and storm surge and its increases due to relative sea level rise. The planning process and its outcomes were designed to evolve over time, incorporating the latest science, policy developments, and knowledge to ensure it remained relevant and effective.

LEGISLATIVE ACTION TO IMPLEMENT THE COASTAL RESILIENCE MASTER PLAN

In 2022, the General Assembly passed legislation to codify the requirement to complete the Coastal Resilience Master Plan and the Coastal Resilience Technical Advisory Committee. As a result, DCR is responsible for developing and updating the plan every five years, as well as administering the plan and leading efforts to act on plan recommendations. DCR is also responsible for developing and updating a statewide plan for flood resilience—the VFPMP—and ensuring that the two master plans are integrated.

Included in the legislation was a requirement for DCR to produce an out-of-cycle update to the CRMP which led to the development of this Phase II plan. The update was required to incorporate: all major flood hazards, including precipitation-driven flooding; a list of all projects considered and an update of the status of all projects previously implemented; and a comprehensive risk assessment of critical human and natural infrastructure. The Phase II plan is designed to fulfill these codified requirements.

The CRMP is built upon five guiding principles for flood resilience that are codified in statute[8] and adapted from the Coastal Resilience Master Planning Framework.

Our Approach

ADVANCEMENTS IN THE PHASE II PLAN

Phase II of the CRMP continues the work initiated in Phase I, building on the foundation already established. Because this plan update was developed only a few years after the Phase I plan's release, much of the same data and information collected and analyzed was utilized, from the coastal flood hazard data models to the stakeholder engagement findings. However, several critical elements of the plan were enhanced to address known limitations in the Phase I plan.

Enhancing Flood Exposure Modeling

Phase II incorporates findings from forward-looking rainfall-driven flood models developed for the plan to address legislative requirements and provide a more comprehensive picture of flood risk in coastal Virginia. Combined with existing coastal flood hazard data, and riverine flood hazard data from FEMA, this iteration of the plan includes all major sources of flooding in coastal Virginia: coastal, rainfall-driven, and riverine. The plan's broadened analysis includes both the locations and impacts of coastal and rainfall-driven flooding, more completely capturing and describing the challenges and opportunities related to addressing flood risk in the region.

Adopting Planning Scenarios

The Phase II plan incorporates forecasted flood hazard data through the end of the century for both coastal and rainfall-driven flood hazards based on multiple climate models and sources of hazard data. To provide a unified approach which allows comparison of flood hazards while acknowledging uncertainty in the data, the Phase II plan adopts five planning scenarios. These scenarios are designed to provide a straightforward comparison of the different flood hazard and impact findings.

Updating the Projects, Initiatives and Funding Inventory

The CRWE includes an updated inventory of resilience projects and capacity-building initiatives in coastal Virginia, providing a clearer understanding of current priorities in coastal communities. The CRWE also contains updates to potential funding opportunities to support these endeavors. The updated inventory allowed for analysis on the trends and themes seen across efforts and opportunities to address potential gaps in actions. Additionally, the inventory was updated to be a living resource and can continue to evolve independently from the plan to provide up-to-date information on the opportunities for building flood resilience.

Recommending Actions for Flood Resilience

Over the course of the Phase II planning process, representatives from state agencies, PDCs, university research programs, environmental non-profit organizations, and industry organizations came together as the Coastal Resilience Technical Advisory Committee (TAC). The Committee developed recommendations aimed at advancing flood resilience efforts across the Commonwealth. These recommendations focus on specific objectives related to research, data, and innovation, project prioritization, funding, and outreach and coordination. They are designed to guide resilience planning efforts over the next five years.

Strengthening Stakeholder Engagement

The process for developing Phase II of the CRMP strengthened stakeholder engagement by building on the lessons learned from the 2021 Phase I plan. For Phase II, DCR implemented an outreach and engagement strategy that mapped the whole community of stakeholders in coastal Virginia according to the degree to which they are impacted by flooding and their level of influence on flood resilience action across the region. Taking the findings from this analysis, alongside established goals for outreach and engagement, the strategy developed activities to collect feedback from state agencies, PDCs, and local governments to inform plan development while establishing regular touch points with other stakeholders to provide updates on the plan.

Embracing a Regional Perspective

Feedback on the Phase I plan included a desire for a more nuanced perspective of the unique characteristics, challenges, and opportunities across coastal Virginia. In response, this Phase II plan focuses on smaller geographic regions to summarize flood risks and resilience opportunities. Following the release of Phase II, DCR will coordinate with external stakeholders, including the eight coastal Planning District Commissions, to present data and information from the plan tailored to provide further regionally relevant information on impacts, challenges and opportunities.

PLANNING PROCESS

The process for developing the Phase II plan consisted of five steps: modeling flood hazards, assessing their impacts, identifying and analyzing resilience actions, quantifying financial needs and opportunities, and developing recommendations for future action. These steps were carried out as part of the overall cycle of master plan development, implementation, and review.

This approach integrated the best available data with advanced climate science and asset-specific information to model current and future flood hazards. The resulting detailed flood hazard projections were then applied to identify impacts on physical assets and resources. To evaluate these impacts, data was categorized based on exposure, vulnerability, and risk, enabling a comprehensive assessment of how various assets—such as landscapes, community resources, and infrastructure—could be affected by flooding now and into the future. Although the best available data was used, datasets varied in quality and completeness. Despite these inherent limitations, this analysis provides a clearer understanding of potential flood risks and their impacts across coastal Virginia. Limitations of the data are further explored on page 23.

Updating the projects and initiatives inventory by identifying and analyzing existing flood resilience actions across coastal Virginia required extensive collaboration with regional partners and stakeholders. DCR updated the inventory in coordination with stakeholders, including multiple broad data calls and subsequent direct follow-up correspondence with action owners. While this inventory offers a thorough overview of current resilience actions, given the dynamic nature of these initiatives and the availability of data, the picture is still incomplete. Limitations of the inventory are further explored on page 60.

Each step in the plan development process involved stakeholder outreach and engagement to inform the plan's approach or content. The approach and results from stakeholder engagement are explored on page 14 and in Appendix C.

COASTAL RESILIENCE TECHNICAL ADVISORY COMMITTEE

The Coastal Resilience Technical Advisory Committee (TAC) was a codified public body responsible for assisting DCR with developing, updating, and implementing the CRMP. The TAC was chaired by the Director of DCR. The 35 member organizations that participated between 2022 and 2025 represent many of the plan's primary intended end users and key stakeholders, including state agencies, PDCs, university research programs, environmental non-profit organizations, and industry organizations.

The TAC played a central role in advising DCR on both the Phase I and Phase II CRMP. Regularly engaging with the TAC to gather detailed input on planning decisions was a critical element of DCR's stakeholder engagement strategy. Following legislation by the General Assembly in 2022, appointed and invited members of the newly codified TAC convened in September 2022 to initiate efforts in support of the Phase II plan. The committee met quarterly, convening as a full public body on nine occasions. During these meetings, the TAC received updates from DCR and provided input on the planning effort.

Commonwealth's Principles for Flood Resilience

This plan was developed in alignment with five key principles for flood resilience that were established by the Coastal Resilience Master Planning Framework and codified in statute[8]. They are:

I Base decision making on the best-available science;

II Identify and address socioeconomic inequities and strive to enhance equity through the adaptation and protection measures by considering all areas of recurrent flooding;

III Recognize the importance of protecting and enhancing natural infrastructure and nature-based approaches to flood mitigation, when possible;

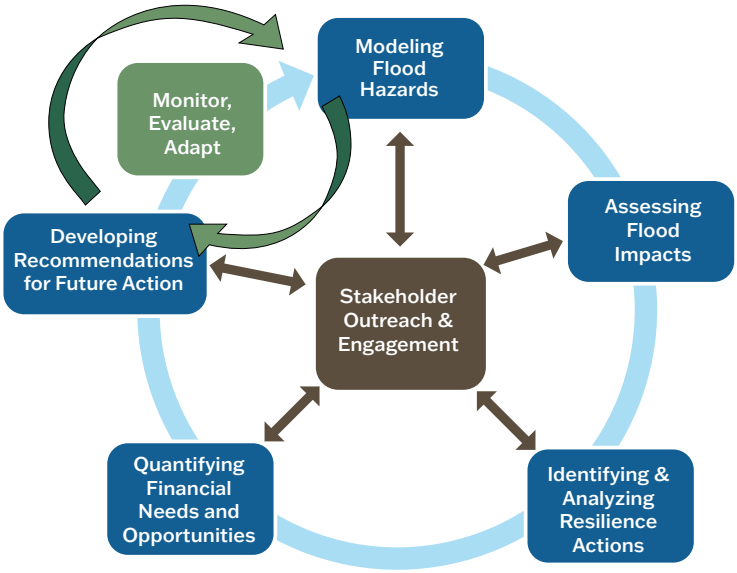
IV Utilize community and regional scale planning to the maximum extent possible, seeking region-specific approaches tailored to the needs of individual communities; and

V Include an understanding of fiscal realities and focus on cost-effective solutions for the protection and adaptation of communities, businesses, and critical infrastructure.

In addition to meeting as a full body, the TAC convened in four subcommittees at the direction of the chair. These subcommittees began meeting in mid-2023 and convened six times prior to the plan's release. Each subcommittee established objectives for their work in support of the plan.

In addition to providing guidance to DCR on the plan's development, each subcommittee was tasked with developing recommendations aligned with their specific objectives. These recommendations were designed to inform future resilience planning efforts. Through interactive and collaborative meetings, the subcommittees each identified five priority recommendations, for a total of 20 TAC recommendations. For detailed information on these recommendations, refer to Chapter 3.

Five-Year Planning Process Cycle



Subcommittees of the Technical Advisory Committee

Charges of the Technical Advisory Committee:

- Assist with developing, updating, and implementing the CRMP
- Ensure that risk evaluations and project prioritization protocols are regularly updated and are informed by the best applicable scientific and technical data
- Ensure that statewide and regional needs are addressed using the best applicable science and long-term resilience approaches
- Ensure that the Virginia Coastal Resilience Master Planning Framework is adhered to in the development and updating of the Virginia CRMP

Research, Data, and Innovation

- Inform development of the flood hazard exposure model.
- Inform inputs to flood hazard risk assessment.

Project Prioritization

- Inform and support the flood hazard risk assessment.
- Inform and support the identification of planned resilience actions.

Funding

- Inform quantification of financial needs for flood resilience.
- Identify and examine financial tools and processes that are suited and/or needed to implement flood resilience.
- Identify challenges and opportunities to implement financial tools.

Outreach and Coordination

- Inform and support outreach and engagement for Phase II of the plan.
- Strengthen relationships with key stakeholders identified as critical to engaging in Phase II of the master plan.

Organizational Members of the Coastal Resilience Technical Advisory Committee

September 2022 - February 2025

- Virginia Department of Conservation and Recreation (Chair)
- Chief Resilience Officer/Secretary of Natural and Historic Resources (Vice Chair)
- Accomack-Northampton PDC
- American Flood Coalition
- Crater PDC
- Fort Monroe Authority
- George Washington Regional Commission
- Hampton Roads PDC
- Middle Peninsula PDC
- Nansemond Indian Nation
- Navy Region Mid-Atlantic (Advisor)
- Northern Neck PDC
- Northern Virginia Regional Commission
- Office of Data Governance and Analytics (Project Prioritization Subcommittee Chair)
- Office of Diversity, Opportunity and Inclusion (Outreach & Coordination Subcommittee Chair)
- Old Dominion University
- PlanRVA
- The Nature Conservancy
- University of Virginia
- Upper Mattaponi Indian Nation
- U.S. Army Corps of Engineers, Norfolk District
- Virginia Chamber of Commerce
- Virginia Department of Emergency Management
- Virginia Department of Environmental Quality (Reseach, Data and Innovation Subcommittee Chair)
- Virginia Department of Housing and Community Development
- Virginia Department of Transportation
- Virginia Farm Bureau
- Virginia Institute of Marine Science
- Virginia Manufacturers Association
- Virginia Marine Resources Commission
- Virginia Port Authority
- Virginia Resources Authority (Funding Subcommittee Chair)
- Virginia Sea Grant
- Virginia Tech
- Virginia Transportation Research Council
- Wetlands Watch
- William & Mary

Note: Additional organizations were invited but did not participate in the TAC.

ADDITIONAL OUTREACH AND ENGAGEMENT ACTIVITIES

Engagement with stakeholders and the public was central to the development of the Phase II plan to ensure that decisions incorporated the priorities of end users and coastal communities. The planning team for this CRMP developed and implemented a comprehensive outreach and engagement strategy which followed DCR's Community Outreach and Engagement Plan stakeholder engagement framework.

The plan's strategy prioritized involvement from a diverse range of key stakeholders throughout the development of the plan. This approach reflects DCR's commitment to engaging the "whole community" of actors who have a shared responsibility for flood resilience, including all levels of government, private and non-profit sectors, and communities.

A central tenet of this strategy was to leverage existing networks and pathways to collaborate across flood resilience planning efforts. In particular, the planning team took care to coordinate with PDCs and local governments for stakeholder engagement. This approach helped to create alignment and eliminate duplication or confusion between roles and responsibilities at state, regional, and local levels.

DCR continues to keep stakeholders informed about how their input has influenced the plan and about future opportunities for feedback, which fosters ongoing engagement and support for implementation.

For a comprehensive overview of all Phase II engagement activities and outcomes, please refer to Appendix C.

Outreach and Engagement Goals

Four goals were established to guide Phase II outreach and engagement activities:

- **Understand end user needs.** Understand how the updated impact assessment and other products can be used by local governments, PDCs, state agencies, and other key stakeholders to help them build coastal flood resilience.
- **Understand lived experiences with flooding.** Provide more context for the plan's content by including information on lived experience with flood impacts.
- **Understand existing flood resilience efforts.** Include information about planned and ongoing activities to address flood risk in the planning area.
- **Drive awareness.** Encourage whole community action toward coastal flood resilience.

Engagement with Primary Stakeholders

Primary stakeholders included state agencies, PDCs, local governments, and other actors directly implementing flood resilience actions, such as tribal governments, public universities, environmental non-profit organizations, federal partners, and others. Primary stakeholders played a crucial role in developing and refining the Phase II plan, providing valuable feedback and insights. Many primary stakeholders were engaged on an ongoing basis through the Coastal Resilience TAC. In addition, DCR led a variety of other engagement efforts during 2024.

As a result of these efforts, between Phase I and Phase II, all PDCs and 82% of city and county governments in coastal Virginia were engaged in the planning processes.

- **End-user survey:** this survey gathered feedback from 49 primary stakeholders about how they have used the Phase I CRMP, as well as barriers and opportunities for enhancing flood resilience. The planning team used the results to inform the presentation of data in the plan and presented findings to the Coastal Resilience TAC to inform recommendations development.
- **Projects and initiatives data call:** More than 70 primary stakeholders provided direct input to the plan by submitting their projects and initiatives to the CRWE database. Stakeholders were reached via meetings, events, webinars, and electronic communications to both general and targeted audiences.
- **Asset data and impact metrics coordination:** The planning team communicated with more than 20 primary stakeholders to gather their feedback on the asset data leveraged for the plan, as well as the metrics presented to quantify impacts. For example, DCR presented the asset data catalog to the VDEM Critical Infrastructure Program Working Group to gather feedback on datasets to be leveraged for the plan, and met with the federally-recognized tribes of Virginia at their monthly

Regional Tribal Operations Committee meeting to request feedback on incorporating flood impacts on tribal resources in the plan.

- **Local government meetings:** In May and June 2024, the planning team met with more than 40 staff from local governments and PDCs, and their key flood resilience partners. These meetings focused on reaching localities in coastal Virginia with relatively high flood risk and low participation rates during Phase I from the Hampton Roads, Crater, and Greater Richmond regions. During the meetings, the planning team shared information about the Phase II plan, and engaged with participants to better understand their local flood challenges and needs. Additionally, the planning team gathered information on projects and initiatives to incorporate into the CRWE.

Engagement with Public Stakeholders

Public stakeholders include business owners, community organizations, individual Virginians, and other organizations who are impacted by flooding or have an interest in flood resilience. This group was engaged to ensure their voices, experiences, and priorities were reflected in the planning process, and to build awareness about the plan and its findings. The Phase II outreach and engagement strategy included both broad public outreach and focused engagement efforts for public audiences.

- **Public webinars** (September 2024) reached 85 individuals with information about the plan and its findings.
- **Monthly outreach and engagement coordination meetings** with more than ten non-governmental organizations throughout the development of the Phase II plan.
- **Community meetings** (September 2024) engaged 62 people in the Middle Peninsula PDC, Northern Neck PDC, Hampton Roads PDC, and PlanRVA regions.
- **Business, industry, and economic development webinar** (October 2024). Fifty-four representatives from business, industry, and economic development sectors involved or interested in flood resilience attended a webinar to learn more about the plan.
- **Federal facilities meeting** (October 2024). Thirty federal partners representing ten different facilities took part in a collaborative forum, providing valuable feedback and insights.

In addition, DCR leveraged comments provided by members of the public received during the development of the Phase I plan. By combining these broad and focused strategies, DCR ensured that the diverse perspectives and needs of coastal communities were represented and incorporated into the development of the Phase II plan.

A Plan in Action

TARGET AUDIENCES

The CRMP is designed to meet the needs of practitioners who play key roles in flood resilience through local action in coastal Virginia. In particular, the plan is designed to meet the needs of government decision makers.

The plan and its tools also serve as a valuable resource for the whole community – including community groups, non-profit organizations, and individuals – to guide action toward coordinated, informed, and effective responses to the challenge of increasing flooding.

COMPLEMENTARY TOOLS AND RESOURCES

In addition to this plan document, DCR has produced a variety of other products and resources to communicate elements and findings in user-friendly formats. By leveraging the plan's tools, data, and insights, stakeholders can develop strategies that protect communities, address gaps, and build a more resilient future. These resources are accessible through DCR's website.

Explore the resources.

Coastal Resilience Web Explorer:
dcr.virginia.gov/crmp/ResilienceExplorer

Flood Resilience Open Data Portal:
https://floodplan-vdcr.hub.arcgis.com/

User Portal:
dcr.virginia.gov/crmp/user-portal

Coastal Resilience Web Explorer and User Portal

The CRWE is a publicly accessible online tool that presents findings from the plan in an interactive format. It allows users to visualize modeled flood hazards and impacts at a variety of geographic scales using maps and dashboards.

The CRWE also includes access to an inventory of ongoing and planned resilience projects, initiatives, and funding opportunities. This inventory is a "living" resource that will be updated independently from the plan to provide timely information on opportunities for building flood resilience. Through a companion user portal, stakeholders can submit and share information about their flood resilience projects, initiatives, and funding on an ongoing basis. Information submitted through the User Portal is automatically incorporated into the CRWE once approved by DCR staff.

Open Data Portal

Data developed for this plan is also directly available to view and download from DCR's Flood Resilience Open Data Portal. This database is maintained and updated by DCR, providing a valuable resource for decision makers looking to use data products directly to identify findings, adapt models to local applications, or otherwise leverage the data in ways unique to their flood resilience needs. The database ensures transparency in the planning products. It gives stakeholders access to the most current information to help inform risk assessment, project creation and grant applications.

HOW TO USE THIS PLAN AND ITS PRODUCTS

There are many ways in which government decision makers and other stakeholders can use this plan and the complementary products to enhance flood resilience. As you engage with the plan, DCR encourages you to consider the following opportunities to apply its findings.

- Understand challenges of increased flooding that may be relevant to your organization or geography of interest.
- Incorporate and adapt the forward-looking flood hazard and impact data into comprehensive plans, small area plans, hazard mitigation plans, and capital improvement plans.
- Identify opportunities to coordinate with others based on mutual needs and priorities.
- Fill flood resilience gaps in areas where flood risks exist and identified projects or initiatives are insufficient to build resilience.
- Incorporate flood resilience information into regular business operations to support enhanced decision making on an ongoing basis.
- Inform efforts to seek public and policy-maker support to address flood risks and build resilience.
- Educate public audiences about flood risks and resilience using the CRWE and Open Data Portal.

Additional information about these use cases appears in Chapter 4.

CHAPTER 2

FLOODING IN COASTAL VIRGINIA

Coastal Virginia, home to millions of residents, thriving economies, and robust natural systems, is at growing risk from flooding. Understanding the various types of flood hazards and their future implications is an important first step in identifying strategies to prepare and adapt local communities for the impacts of these hazards. This chapter summarizes the flood conditions analyzed and explores the potential impacts of flooding on our natural ecosystems and built environments in terms of exposure, vulnerability and risk, highlighting key data trends within regions and across coastal Virginia. The information in this chapter aims to equip decision makers and stakeholders with the insights needed to build lasting flood resilience in Virginia's communities. However, this plan presents only a portion of the total data produced. Additional information about flood hazards and impacts is available to explore via the Coastal Resilience Web Explorer.

Modeling Changing Flood Conditions

Flooding is a natural and necessary process. It helps recharge groundwater, renew wetlands, and replenish agricultural lands. However, flood events – particularly those that are severe – can also overwhelm the capacity of natural and built infrastructure, causing harm to the systems on which we rely. These flood challenges are not new to coastal Virginia. Between 1995 and 2023, Virginia experienced 11 flood events that each resulted in $1 million or more in combined property and crop damages, including Hurricanes Isabel, Florence, Fran, and Floyd, Tropical Storm Michael, and several combined rainfall and snowmelt events.[1,2]

Coastal Virginia experiences multiple flood-related hazards which can generally be grouped into three major types: rainfall-driven, riverine, and coastal.

While coastal and riverine flooding occur along the edges of our coasts and rivers, rainfall-driven flooding can affect large portions of the region, including upland areas. Each of these three types of flooding is explored in further detail in this chapter.

These flood hazards each pose challenges on their own, but when they occur at the same time and in the same location, their potential to cause damage increases. This results in compound flooding, which can be much more widespread and dangerous than that from an individual flooding source.

While this plan incorporates normal tidal conditions into rainfall-driven flood models, the potential for multiple types of flood hazards to co-occur and cause compound flooding has not been systematically evaluated in this plan. Future phases of the study may address compound flooding impacts.

To understand the changing conditions of flooding across coastal Virginia, this plan presents results from modeling of coastal, rainfall-driven, and riverine flooding based on the best available data. While there is uncertainty in the forward-looking projections and science continues to evolve, the discussion and findings in this plan represent modeling based on current data and science for each flood type.

COASTAL FLOODING

This plan builds upon data developed during the technical study conducted for the Phase I CRMP to interpret probabilistic coastal flood risk and changing coastal flood conditions. The technical study modeled coastal flood hazard scenarios using publicly available science and datasets for topography, present-day tidal inundation and storm surge flooding, and sea level rise projections.

For the CRMP Phase I, The Commonwealth selected the 2017 NOAA intermediate-high sea level rise curve to model future flood hazards. In 2022, NOAA updated its sea level rise curves. DCR developed planning scenarios that utilize the existing data from Phase I to align with the updated projections, providing appropriate data for the intended planning purposes.

NOAA's sea level rise projections are not uniform across coastal Virginia due to differences in subsidence rates and oceanographic processes. A spatially varying coverage of sea level rise projections from NOAA was used rather than a single value, which varied across the region by up to 0.4 feet. These sea level rise scenarios were then combined with today's tidal and storm surge conditions to estimate flood extents, depths, and wave conditions for the planning scenarios. Refer to Appendix A of the CRMP Phase I for more information on the coastal flood hazard modeling approach.

RAINFALL-DRIVEN FLOODING

For rainfall-driven flooding, the plan presents findings from a modeling analysis conducted for this Phase II plan. The Commonwealth selected projections from the Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA) program. MARISA developed change factors that can be used to modify the National Oceanographic and Atmospheric Administration's (NOAA) intensity-duration-frequency (IDF) precipitation curves documented in Atlas-14 to model future precipitation conditions. The projections used are based on the Representative Concentration Pathway (RCP) 4.5 as described by the Intergovernmental Panel on Climate Change (IPCC), which is a climate scenario in which emissions peak around 2040 and then decline. Within the RCP 4.5 scenario, the 50th percentile (representing the median or "best estimate" projection) and 90th percentile (representing the high-end projection) were used across two time horizons: 2020-2070 and 2050-2100.

NOAA Atlas-14 rain gauge data and MARISA adjustments reflect the geographic variability in precipitation, which is caused by factors such as topography and proximity to water bodies. As a result, the projections are not uniform across Virginia. Accordingly, the data in this plan

incorporates spatial variability via locally-specific rainfall data. The analysis modeled rainfall-driven flooding scenarios within 1,800 small watershed subbasins of less than ten square miles across the study area using a rain-on-grid modeling approach. The results of the modeling are presented as flood depths, which are correlated to the MARISA precipitation data, and aligned with scenarios selected for this plan. Flood depths of less than six inches are removed from reported impacts to avoid over-reporting conditions of flooding. These shallow depths are widespread, short in duration, and produce limited impacts.

While the models incorporate major flow paths, they do not include the effects of stormwater infrastructure like pipes and culverts. Refer to Appendix A for more information on the rainfall-driven flood hazard modeling approach.

RIVERINE FLOODING

Riverine flooding is incorporated into the plan using the existing 1% annual exceedance probability (AEP) flood data from the Federal Emergency Management Agency (FEMA). This data represents present day hazards as understood based on historical flood conditions and does not represent future hazards. FEMA provides the best available riverine flood hazard data which is both consistent and available across the entire planning area. Models examining the future conditions of riverine flooding are not presently publicly available.[3]

OTHER FACTORS INFLUENCING FLOODING

How we experience flooding is influenced by a variety of external factors that alter the ways water moves through the landscape. Development of natural land results in more impervious surfaces, making the ground less absorptive of water and more susceptible to flood hazards. As communities develop, they build stormwater infrastructure to manage the resulting increases in runoff. While communities continue to build new stormwater infrastructure, much of the existing network is decades old. Many of these aging systems are no longer keeping pace with today's water management needs.

Another factor influencing the ability to absorb water is oversaturated terrain. Subsurface soils are saturated by water from a variety of sources, resulting in rising groundwater tables. When this water table rises, the ground loses capacity to absorb rainfall and flood waters, raising the risk for surface inundation. Higher groundwater levels can also overwhelm treatment plants and sewage lines, contaminating nearby environments and drinking water supplies.

While these external factors are not modeled for the plan, they are an important consideration for planning efforts and should be understood by local actors conducting site-specific interventions.

Important Limitations

The objective of this analysis is to provide context to forward-looking projections that show potential changes in flood conditions due to sea level rise and changing precipitation patterns. The analysis is based on the best available models and datasets, but, as with all models and forward-looking data, uncertainty and constraints exist.

Statements about future conditions and the data that underpin them reflect possible scenarios. Readers should use this information to guide their understanding of potential flood risk and incorporate that understanding into their decision-making along with other appropriate factors. Over time, as our understanding of climate science continues to evolve, it is likely that future projections will change.

Flood hazard models are simplified representations of complex and interconnected natural and manmade systems. For example, the data does not model existing stormwater infrastructure, and therefore represents a scenario in which this infrastructure does not exist, has failed, or is overwhelmed by a large-scale flood event. In addition to stormwater infrastructure, the following factors are not included in the flood hazard models: compound flooding, flood velocities and durations, erosion, groundwater levels and marsh accretion. Future conditions presented in this plan represent increased flooding, including sea level rise and precipitation changes, as well as subsidence across our current landscape. These future hazards are based on today's built, natural and social conditions. The analysis does not consider future population growth, increasing development patterns, or other changes in the physical landscape across time horizons. Additionally, the plan does not account for the reduction in flooding that can be achieved by projects planned and underway.

The impact assessment leveraged the best available asset datasets to present exposure, vulnerability, and risk. Additional information about the models and their limitations can be found in Appendix A and B.

Planning Scenario Flood Hazard Data Sources

Time Horizon	Baseline	Near Future 2030–2060		Far Future 2060–2100	
Projection		Moderate	High	Moderate	High
Coastal Sources	CRMP Phase I modeling, using NOAA and FEMA water level data and NOAA relative SLR (2017 Intermediate–High)				
	2020 Conditions	2040 Projections	2060 Projections	2060 Projections	2080 Projections
Rainfall-Driven Sources	CRMP Phase II modeling, using NOAA Atlas-14 precipitation estimates with MARISA precipitation change factors (RCP 4.5)				
	No Change Factor	2020–2070, 50th Percentile	2020–2070, 90th Percentile	2050–2100, 50th Percentile	2050–2100, 90th Percentile
Riverine Sources	FEMA National Flood Hazard Layer filtered to only riverine flooding				
	Future conditions not available				

PLANNING SCENARIOS

Throughout this plan, flood hazards are presented using five different planning scenarios that address both climate projection ranges and timeframes. These scenarios convey future conditions that DCR recommends for use in long-range planning for flood hazards while recognizing the uncertainty that exists in climate forecasts.

The planning scenarios were developed specifically for the CRMP with guidance from expert stakeholders, including members of the Research, Data and Innovation Subcommittee of the Coastal Resilience TAC, using widely accepted data sources. The planning scenarios are based on the best available data to forecast increasing coastal flood hazards and precipitation. They combine the three major flood hazard types by categorizing complex data forecasts into a unified set of future scenarios.

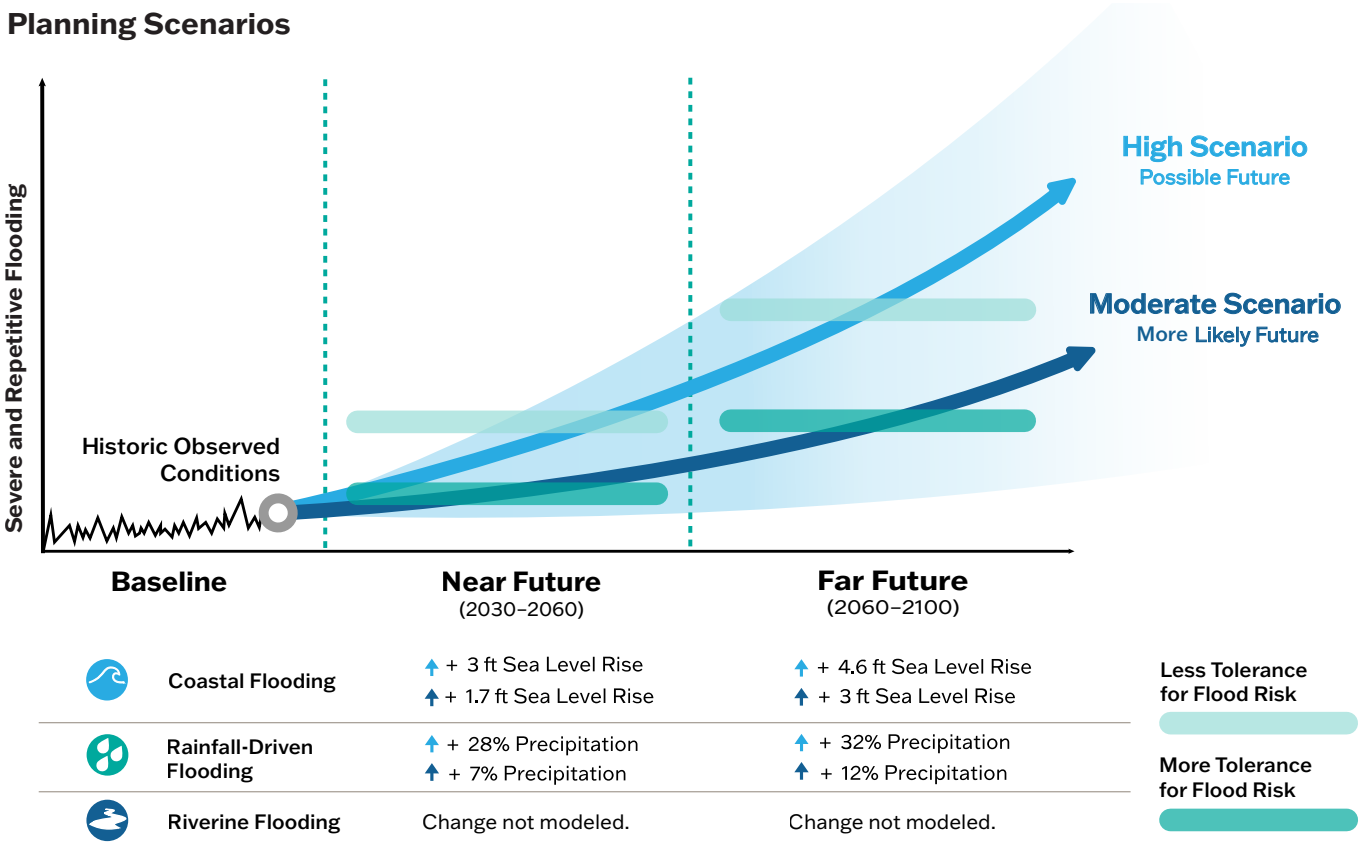
Each planning scenario includes two main components: a time horizon and a projection range. The time horizon describes the point in the future for which a decision is relevant. Because flooding conditions are projected to continue changing over time, the time horizon relevant for decision-making will vary. There are three time horizons contained in the scenarios:

- **Baseline** data is based on historical, observed data and does not incorporate anticipated future conditions. This data serves as a point of comparison for future conditions.
- **Near future** projections are suitable for mid-term planning and are based on climate data most relevant to the period between 2030 and 2060.
- **Far future** projections are suitable for long-term planning and are based on climate data most relevant to the period between 2060 and 2100.

There is inherent uncertainty in climate projections. For example, even when it is projected on a single climate scenario, sea level rise is presented as a range of possible future outcomes. The planning scenarios include two ranges for each time horizon to break down future projections based on their relative likelihood. The appropriate projection range to use for a given decision will depend on factors such as the level of risk and uncertainty a decision maker is willing to tolerate.

- **Moderate** projections indicate a more likely future. They represent a "best estimate" for future conditions, suitable for decisions where more risk is acceptable.
- **High** projections indicate a less likely but possible future with higher sea level rise and precipitation estimates. These projections may be favored for use in decisions for which the tolerance for risk is low.

Planning Scenarios



Note: Sea level rise and precipitation increases are presented as averages but vary regionally. Climate change effects on riverine flooding were not available.

REFERENCE FLOOD CONDITIONS

The flood hazard data used in the plan were generated using modeling of a wide range of potential flood magnitudes, each paired with a corresponding probability of being equaled or exceeded. This data is expressed as the annual exceedance probability (AEP), which is the percent chance that a given flood magnitude may occur in any given year.

AEPs convey the likelihood of flooding based on statistical analysis of many historical events. This approach does not model specific storms or individual flood events. Instead, it normalizes potential flood exposure over time to inform planning and decision making.

The riverine flood data used for the plan, sourced from FEMA, is provided only for the 1% AEP. In contrast, the coastal and rainfall-driven flood data includes seven AEPs representing a broader range of flood conditions, from frequent but shallow chronic flooding with a 50% chance of occurring in any given year, to rare but high-magnitude flooding with a 0.2% annual chance of occurring. In addition, the coastal data includes the water levels associated with daily tidal cycles: mean low water and mean high water.

To simplify the presentation of probabilistic flood data, this plan summarizes the AEPs using five reference flood conditions: **tidal** flooding (mean high water, relevant only for coastal data), **chronic** flooding (20% AEP), **moderate** flooding (4% AEP), **major** flooding (1% AEP), and **extreme** flooding (0.2% AEP).

Throughout the plan, these reference terms are used alongside the five planning scenarios to communicate projected impacts. While the scenarios are simplified for presentation in this document, the full set of flood hazard data produced can be accessed via DCR's Flood Resilience Open Data Portal.

AEPs can also be translated across longer time periods to convey the long-term likelihood of flood exposure. Such an approach accounts for the repeated annual likelihood of exposure to flooding over time. For example, a home located in an area that could be exposed to major coastal flooding has a 1% chance of experiencing a coastal flood event of that magnitude in any given year. However, over a typical 30-year mortgage duration, the chances that the home will experience at least one such flood event rise to 26%.

Flood Conditions Modeled and Referenced in the CRMP Phase II

Reference Flood Condition	Description (Likelihood)	Average Return Interval (Frequency)	Chance of occurring in...		
			5 years	10 years	30 years
Tidal (Coastal Only)	Mean Low Water	Always Inundated	100%	100%	100%
	Mean High Water *	Inundated Daily	100%	100%	100%
Chronic	50% AEP	2 years	97%	100%	100%
	20% AEP *	5 years	67%	89%	100%
Moderate	10% AEP	10 years	41%	65%	96%
	4% AEP *	25 years	18%	34%	71%
Major	2% AEP	50 years	10%	18%	45%
	1% AEP*	100 years	5%	10%	26%
Extreme	0.2% AEP	500 years	1%	2%	6%

*For purposes of this report only, the less frequent Annual Exceedance Probability (AEP) is used to summarize findings.

Flooding in Coastal Virginia

COASTAL FLOODING

Coastal flooding occurs when tidal waters exceed the typical shoreline and inundate upland areas. Coastal flooding includes both repetitive tidal flooding and severe storm surge.

Virginia has a long history of major storms, including hurricanes and nor'easters, which have resulted in widespread coastal flooding. One of the most notable storms in the region was Hurricane Isabel in 2003, which reached a highest tide of 7.9 feet above mean lower low water at Sewells Point and resulted in major coastal flooding from storm surge.[4] More recent events, like Hurricane Matthew and Tropical Storm Hermine in 2016, illustrate that coastal flooding poses on ongoing threat to the state. Today, 470,000 acres of coastal Virginia could be exposed to major coastal flooding.

Coastal Virginia, particularly the Hampton Roads region, has the highest rate of relative sea level rise on the U.S. East Coast.[5,6] This phenomenon threatens the integrity of the Chesapeake Bay, the largest and most productive North American estuary and a vital ecological and economic asset to the Commonwealth. Data collected from 1969 to 2017 indicates that relative sea level rise in Virginia is 5.14 mm per year, with an acceleration rate of 0.119 mm per year.[7] In the past century, 18 inches of relative sea level rise has been observed at the Sewell's Point tide gauge at Naval Station Norfolk.[8]

Sea level rise is influenced by rising average global temperatures, which lead to warming ocean temperatures and expanding seawater volumes, as well as melting glaciers and ice sheets that contribute more water to the ocean.[9] The rise in sea level at a specific location on land, known as relative sea level rise, is measured from a fixed point and considers land subsidence, which is the gradual sinking of land. Land subsidence can happen due to groundwater withdrawals and shifts in the continental plates. Land subsidence has historically accounted for nearly half of Virginia's relative sea level rise.[10]

In the Commonwealth, the groundwater aquifer system includes various layers, with the shallow Surficial Aquifer near the surface and the deeper Potomac Aquifer below. Coastal Virginia is experiencing land subsidence due to groundwater withdrawals from the Potomac Aquifer.[11]

Sea level rise influences storm surge flooding by increasing depths and allowing greater wave heights to reach farther inland. These higher waves elevate the risk of frequent and severe damage in low-lying regions while causing flood waters to penetrate deeper into inland communities. Between the baseline and far future scenarios, the land area that could be exposed to extreme coastal flooding may increase between 160,000 to 260,000 acres, nearly a 30-50% increase.

For low-lying areas of coastal Virginia located along tidal waterways, expanded tidal flooding is already a reality, regularly creating nuisances such as flooded roadways and parking decks, and stormwater system backflows. Scientists forecast that these trends will continue and, in many cases, worsen.[12,13] By the end of the century, the region may see an additional 4.5 feet of sea level rise. This will increase the frequency of flooding. Areas which are accustomed to nuisance tidal flooding today may become permanently inundated in the next fifty years. Regionwide, 4% of the current land area in coastal Virginia could experience tidal flooding in the near future moderate scenario.

RAINFALL-DRIVEN FLOODING

Rainfall-driven flooding occurs when intense or prolonged rainfall exceeds the land's ability to drain or absorb water, leading to inundation of normally dry lands. Rainfall-driven flooding can also be induced by frequently recurring events which can temporarily overwhelm drainage systems, particularly clogged and unmaintained stormwater systems.

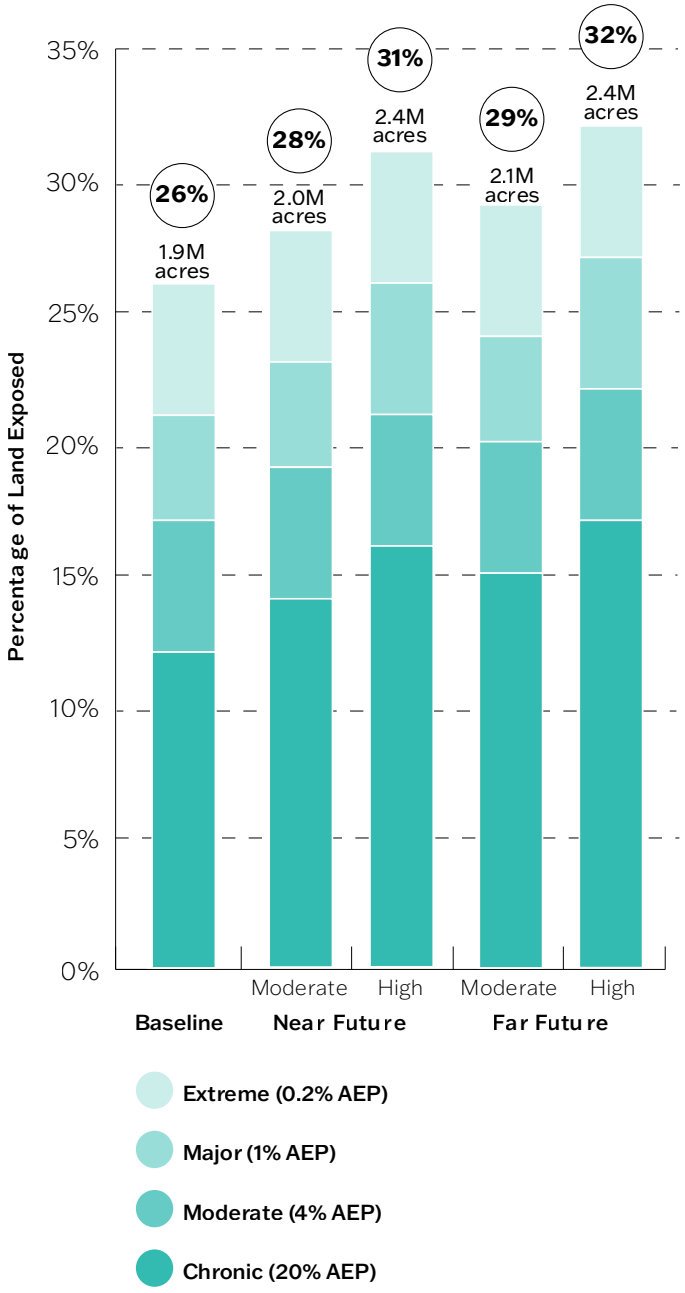
Severe rainfall events can result in significant flood impacts. Coastal Virginia has recently seen several isolated rainfall-driven flash-flooding events, including on July 8, 2019, when more than three inches of rain fell in parts of Northern Virginia over a 60-minute period. The burst of precipitation overwhelmed drainage systems. Sinkholes formed, damaging roadways, and drivers were stranded, requiring open water rescue.[14] Regionwide, rainfall-driven flooding poses a more extensive threat than coastal flooding. Approximately three times more land area in coastal Virginia could be exposed to major rainfall-driven flooding than to major coastal flooding.

Virginia is experiencing an increase in the frequency and severity of heavy precipitation events. **According to the Fifth National Climate Assessment, the southeastern United States has seen a 37% increase in the number of extreme precipitation days (defined as the top 1% of heaviest precipitation events) since the mid-20th century.**[15] Local and state-wide research has found similar trends. After experiencing the impacts of three severe precipitation events in 2016, the City of Virginia Beach completed an analysis and found a statistically significant trend of heavy rainfall increasing by 7% every decade since the 1950s.[16] Similarly, research conducted by the Virginia Transportation Research Council shows that rainfall volume and frequency has consistently increased at rainfall stations across the Commonwealth.[17] This trend of increasing precipitation is expected to persist over the coming decades.[18]

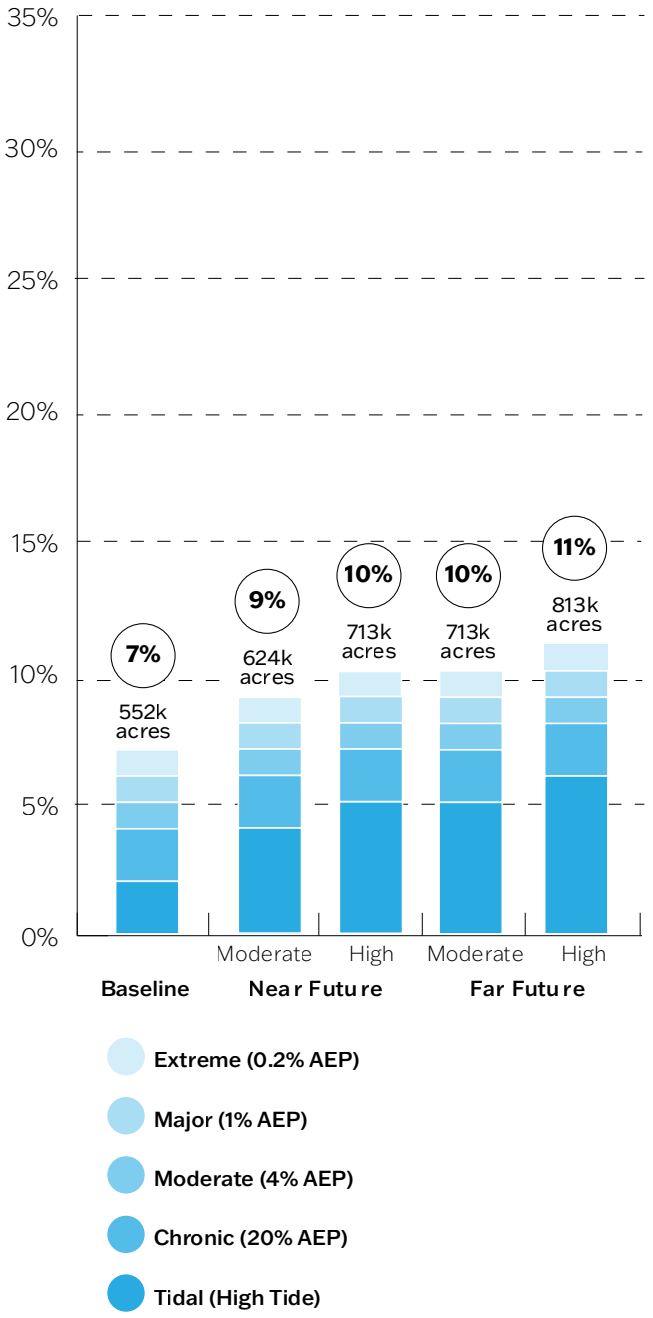
Increases in chronic rainfall-driven flooding are exacerbated in tidal regions that face both increases in precipitation and rising tidal water levels. Over time, communities in the Eastern Shore, Hampton Roads and the Middle Peninsula regions may see significant changes in the land area susceptible to chronic rainfall-driven flooding. On the Eastern Shore, the land area exposed to the far future, chronic rainfall-driven flooding scenarios could increase between 90,000 to 110,000 acres, nearly two to three times over the baseline conditions. Regionwide, the land area that could be exposed to rainfall-driven flooding may increase across all reference flood conditions and planning scenarios.

Historically, modeling of rainfall-driven flooding has primarily occurred for stormwater management purposes, usually to meet regulatory and storm-water system design requirements set at state and local levels. With precipitation on the rise and exacerbating the growing challenges of coastal flooding, practitioners in coastal Virginia are increasingly incorporating rainfall in their floodplain management strategies. Rainfall-driven flood models can indicate areas prone to rainfall-driven flooding that are not always reflected in the regulatory flood maps produced by FEMA. As communities continue to prepare for rainfall-driven flood events, it is especially important to consider the local context of potential impacts, including functionality of local stormwater management systems to reduce flooding and the depth of flooding expected. Flood depths significantly influence the effectiveness of different storm-water management, floodplain management, and adaptation strategies to protect people and assets.

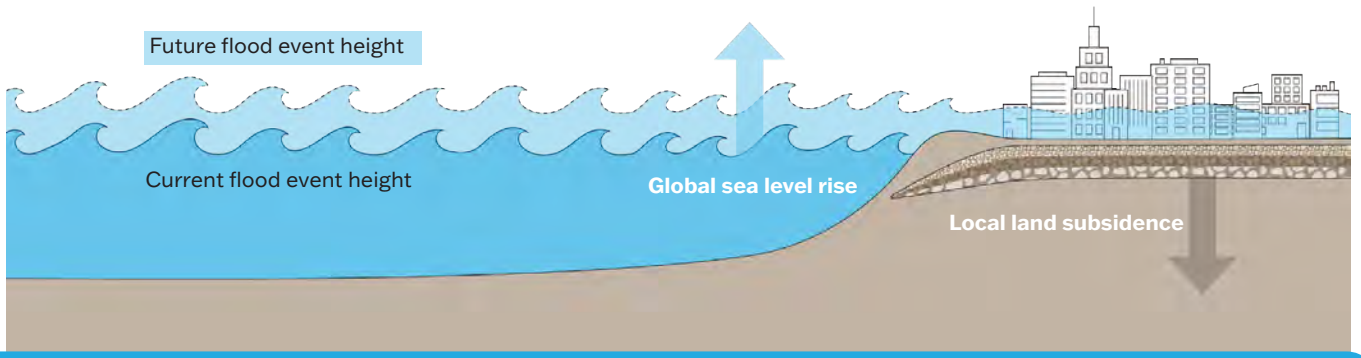
Land Exposure to Rainfall-Driven Flooding in Coastal Virginia



Land Exposure to Coastal Flooding in Coastal Virginia



Sea Level Rise and Local Land Subsidence



Mitigating Land Subsidence through HRSD's Sustainable Water Initiative for Tomorrow

While most flood resilience actions adapt to the projected effects of relative sea level rise, the Hampton Roads Sanitation District's (HRSD) Sustainable Water Initiative for Tomorrow (SWIFT) project seeks to help counteract one of its contributors: land subsidence.

Subsidence can occur for numerous reasons, including when too much groundwater is pumped from underground aquifers, reducing the aquifer's internal pressure, and allowing the ground to compact and sink. As pressures in the aquifer system decrease, the weight of the overlying sediment squeezes the clay layers within the system, causing them to dewater and compact. The compaction of these clays is irreversible and results in subsidence of the land surface, exacerbating relative sea level rise. At the same time, the coarser sediments in the aquifer system also rearrange and cause some compaction that can be reversed if pressure is restored.

Another result of excessive pumping is the migration of saltier water onto the freshwater portion of the aquifer system. Water quality transitions from fresh to brackish to saltwater moving from west to east across the aquifer system. This aligns with the natural flow of groundwater in the system. Excessive withdrawals can reduce the pressure in the aquifer around the withdrawal wells, causing a reversal of the flow direction from east to west. This flow reversal has the potential to cause saltwater to migrate to the freshwater areas of the aquifer and contaminate drinking water wellfields. These concerns become greater as a growing population must draw from a finite supply of water pumped from underground.

The Potomac Aquifer is the deepest aquifer in eastern Virginia and a primary drinking water source for nearly half of the state's population. Located in coastal Virginia, the aquifer spans across the majority of the Atlantic Coastal Plain Aquifer System, underlying the eastern United States from Georgia to New Jersey. The Virginia Department of Environmental Quality (DEQ) requires permitted groundwater users to report actual withdrawals from their wells. This data reports an average use of 59 million gallons (Mgal) per day between 2017 to 2021. The USGS estimates the unpermitted domestic withdrawals from the Potomac aquifer to be approximately 11.7 Mgal per day.[19] Therefore, withdrawals from the Potomac aquifer total approximately 71 Mgal per day. They account for 65% of all groundwater withdrawals in the Virginia Coastal Plain.

Through SWIFT, HRSD is providing measurable solutions to groundwater depletion and land subsidence through wastewater recycling. SWIFT treats wastewater to levels cleaner than those required by drinking water standards, and then recharges the treated water back into the Potomac Aquifer, where it was originally sourced.

When operations are fully scaled in 2030, SWIFT will pump more than 50 Mgal per day of water back into the aquifer, reducing stress on the aquifer and the potential for additional land subsidence. By cleaning wastewater and returning it to the aquifer, the program also helps to improve water quality by reducing the amount of nutrients entering the Chesapeake Bay.

Henrico County's Locally Mapped Community Flood Hazard Areas

Like many populations in coastal Virginia, residents of Henrico County have long been familiar with flood-prone areas in their community. However, many of these areas were not represented on FEMA's Flood Insurance Rate Maps (FIRMs) used to communicate and regulate risk. In response, in the early 2000s, the County went through a process to identify additional riverine floodplains—above and beyond those mapped by FEMA—to better protect and inform residents. The findings from this mapping effort were adopted by local officials in 2007 as Henrico's regulated Community Special Flood Hazard Areas (SFHAs).

Following the release of updated FEMA FIRMs in 2024, the County is updating its Community SFHA maps, which are planned for completion in 2026.[20] Once implemented, the updated community maps will incorporate new survey data, changes in land use, hydrology, and advancements in modeling technology, offering a more comprehensive view of flood risk in the County. These initiatives have enabled Henrico County to strengthen its protection against flood impacts, ensuring greater safety for community members.

Communities participating in the National Flood Insurance Program (NFIP) have the option to develop and adopt maps which regulate development in areas beyond those mapped by FEMA. This can be a useful tool to ensure that flood hazards from rainfall-driven flood impacts, as well as unmapped riverine flooding, are managed to reduce impacts. The rainfall-driven flood models developed for this plan may provide a useful starting point for communities interested in conducting a similar local mapping exercise.

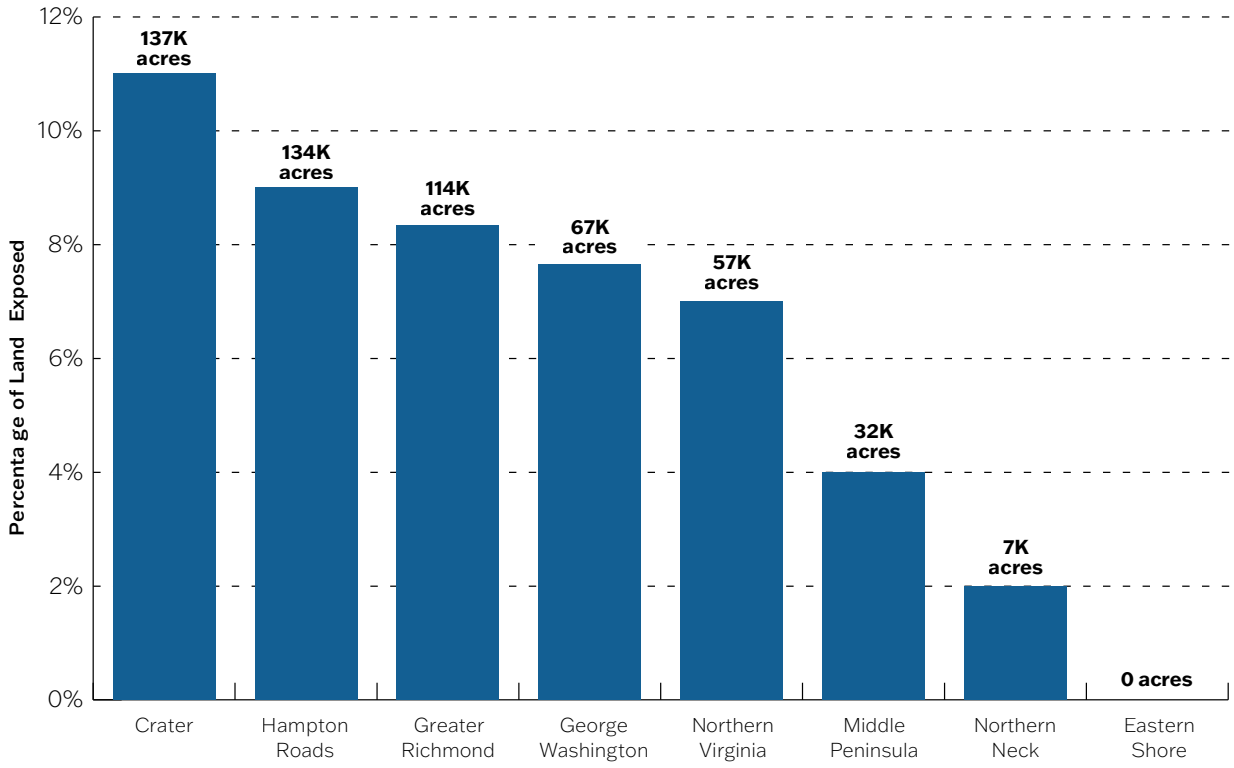
In addition to increasing flood hazard awareness in the County, Henrico's Community SFHA maps were instrumental in the County achieving a Class 5 in FEMA's Community Rating System (CRS) program, providing residents with a 25% discount on annual flood insurance premiums through the NFIP. Because the Community SFHAs are regulated the same as the FEMA SFHA, the County was able to utilize those areas when calculating impact points for various activities for determining their CRS class rating. Additionally, the County could be eligible for additional points for the engineering studies associated with the updated maps once complete.

RIVERINE FLOODING

There are four major rivers located in coastal Virginia: the Potomac, Rappahannock, York and James Rivers. These rivers, as well as many other smaller rivers and streams in coastal Virginia, are vital natural resources, supporting economies through agriculture, trade, tourism, and recreation. Throughout history, coastal Virginia's rivers have played an important role in their surrounding watersheds. However, when they flood, they can impact the populations that rely on them. For example, the James River has repeatedly flooded the City of Richmond and surrounding areas. These events have caused damage to buildings and infrastructure and loss of life, as experienced in the historic flood associated with rainfall from Hurricane Camille in 1969. That event, as well as other floods, had such a significant impact on Richmond that the city installed a protective floodwall, with construction beginning in 1986 and concluding in 1995.[21]

Across coastal Virginia, 548,000 acres—7% of the total land area—could be exposed to major riverine flooding in the baseline scenario. Crater, Hampton Roads, and the Greater Richmond area are the regions most likely to experience riverine flooding.

Land Exposure to Major (1% AEP) Riverine Flooding by Region



Multifrequency Riverine Flood Data

For most of coastal Virginia, riverine flood hazard data is only available for baseline major flooding as defined by FEMA's SFHA (1% AEP). However, in some limited locations, FEMA has published data for riverine flood extents and depths across five present-day flood conditions, ranging from the 10% AEP to the 0.2% AEP. The planning team used FEMA's enhanced riverine flood hazard data to conduct a case study analysis. The purpose of this case study was to better understand how improved riverine flood risk data might alter findings for flood impacts.

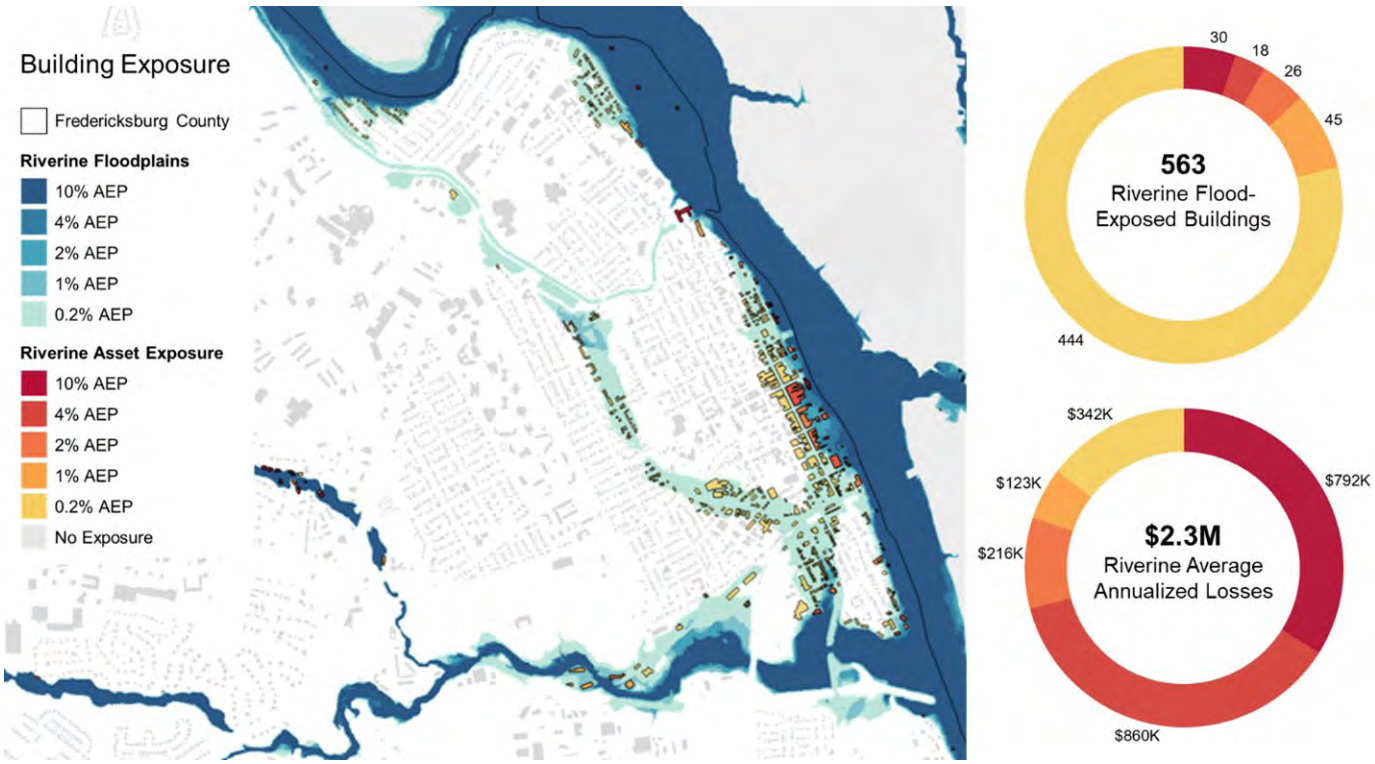
The case study area covered three watersheds that overlapped with the George Washington, Middle Peninsula, and Northern Neck regions. While the study area was primarily rural, it also included the City of Fredericksburg, which provided helpful context for differences in data results in an urban setting. Notable findings from this pilot include:

- **The likelihood of riverine flooding is underrecognized and under-communicated.** Riverine flood exposure is described in this plan using only the 1% AEP reference flood condition to indicate areas likely to be exposed to a "major" flood. This binary description of "in" or "out" of this area contributes to under-communicating the risk from riverine flooding. The study found that most buildings that could be exposed to a major flood have a much higher annual likelihood of flooding than 1%. Across the study area, 79% of buildings that could be exposed to major flooding have a 2% chance of flooding in any year. Nearly half could be exposed to moderate flooding, with a 10% chance of flooding every year. Similarly, compared to major flooding, about twice as many buildings could be exposed to extreme flooding.
- **Potential economic risk is underestimated.** Another downside of the lack of data on multiple flood conditions is less data for use in economic impact assessments. Although moderate and chronic flooding could impact fewer structures than major flooding, these higher-frequency return periods represent a large portion of total economic risks in annualized loss estimates. Also, while extreme flooding is relatively infrequent, the scale and damage associated with this level of flooding drive a notable portion of total economic risk. The case study found that annualized losses calculated using all five available flood extents were significantly higher than those calculated using major riverine flooding alone.
- **In coastal Virginia, riverine risk is still small compared to coastal and rainfall-driven flood risk.** Even with the inclusion of the extreme flood condition, the number of structures exposed to riverine flooding in the case study area was small when compared to coastal and rainfall-driven flood sources. Similarly, only a small fraction of developed land area is exposed to riverine flooding. This finding might reflect both the rural nature of the study area, as well as the effectiveness of decades of riverine floodplain mapping and management practices that have limited risky development within the regulatory floodplain.

The case study recommended **expanding multifrequency riverine flood modeling** with a matching suite of reference flood conditions, future scenarios, and data products to complement coastal and rainfall-driven flooding information.

Additionally, the study team recommended **exploring the overlap between riverine and rainfall-driven flood hazard extents and impacts**, noting that significant overlap likely exists. See Appendix B to read the full case study.

Building Exposure Across Baseline Riverine Flood Frequencies in Fredericksburg



COMBINED FLOODPLAIN

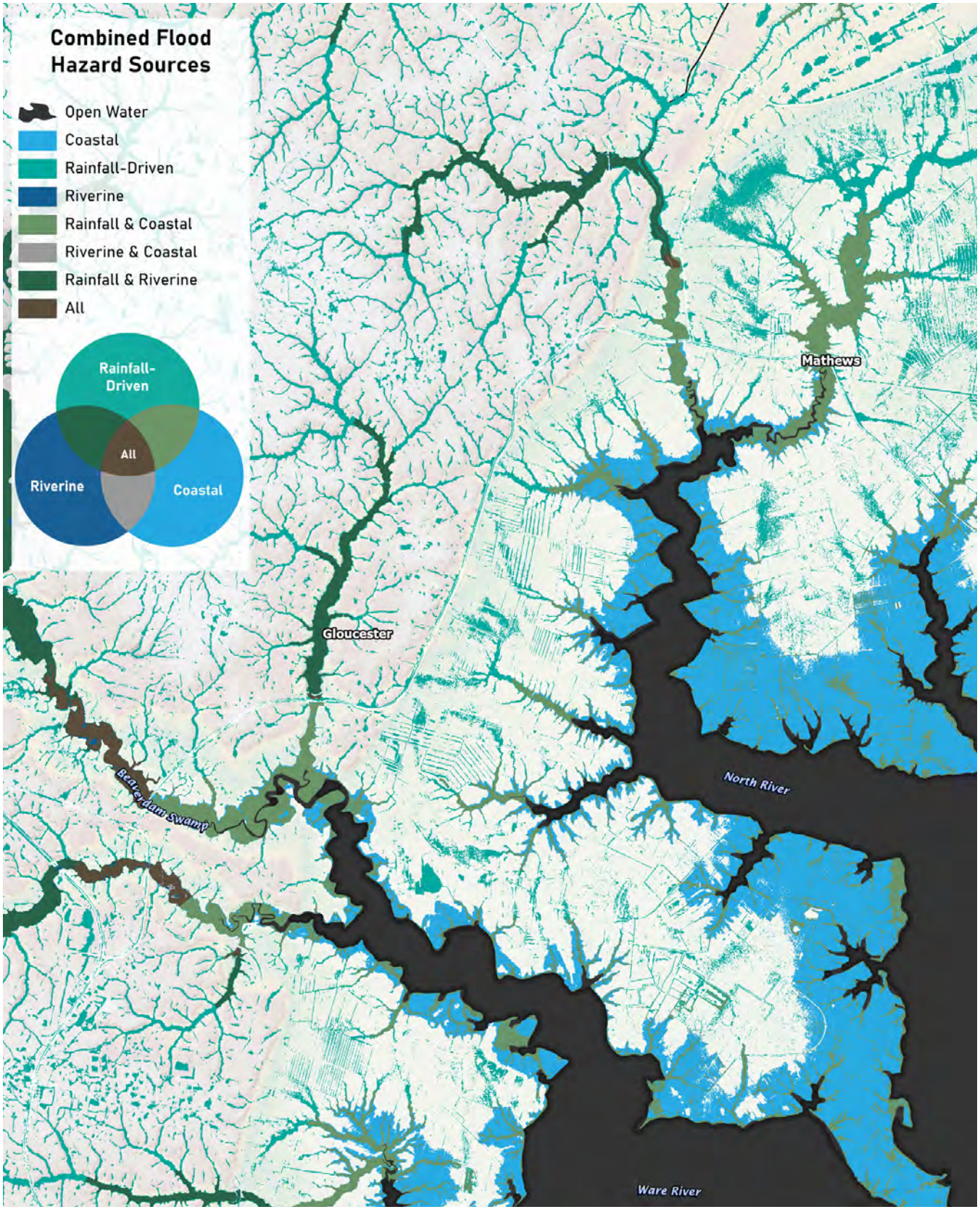
Coastal, rainfall-driven, and riverine flooding affect different parts of coastal Virginia, and many areas are subject to flooding from multiple sources.

Regional and local exposure to coastal and riverine hazards are controlled by local physical characteristics, such as length of shoreline, presence of rivers and streams, and extent of adjacent low-lying areas. Meanwhile, rain can fall anywhere, but rainfall-driven flooding only occurs where runoff accumulates and pools due to inadequate drainage.

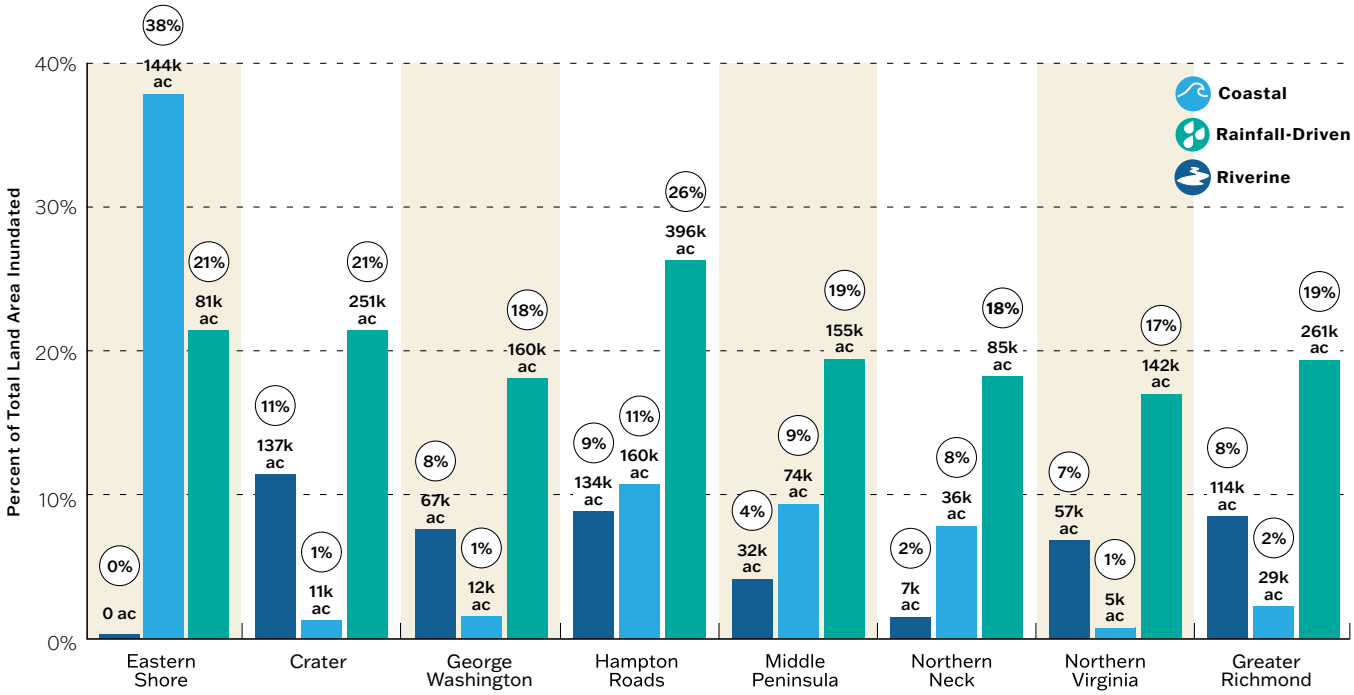
This plan presents a simplified comparison of the geographic extents and the likelihoods of the different types of flooding, which is represented by the "combined floodplain." This combined floodplain illustrates the geographic area likely to experience major flooding from any of the three flood types—coastal, rainfall-driven or riverine—when modeled independently of one another.

In the baseline scenario, **about two million acres of land in coastal Virginia—approximately 27% of the region's land area—could be exposed to major flooding from any source**, whether coastal, rainfall-driven, or riverine. About a quarter of that land area could be exposed to more than one type of major flooding. Rainfall contributes to the greatest extent of major flooding, followed by riverine and then coastal. However, although a larger geographic area may be exposed to major rainfall-driven flooding, that flooding is expected to be relatively shallow in depth. In contrast, major coastal flooding generally results in relatively less widespread exposure, but much greater flood depths that may cause more damage.

Combined Floodplain by Flood Hazard Presence in the Near Future Moderate Scenario



Percent of Coastal Virginia's Land Area Exposed to Major (1% AEP) Flooding in the Baseline Scenario



Flood Impacts

This section of the plan presents information about the consequences of all flooding types on people, assets, and resources located throughout coastal Virginia. By assessing not just where flooding is likely to occur but how it will affect our natural and built environments, we can better understand how to build flood resilience in our coastal communities in the decades to come.

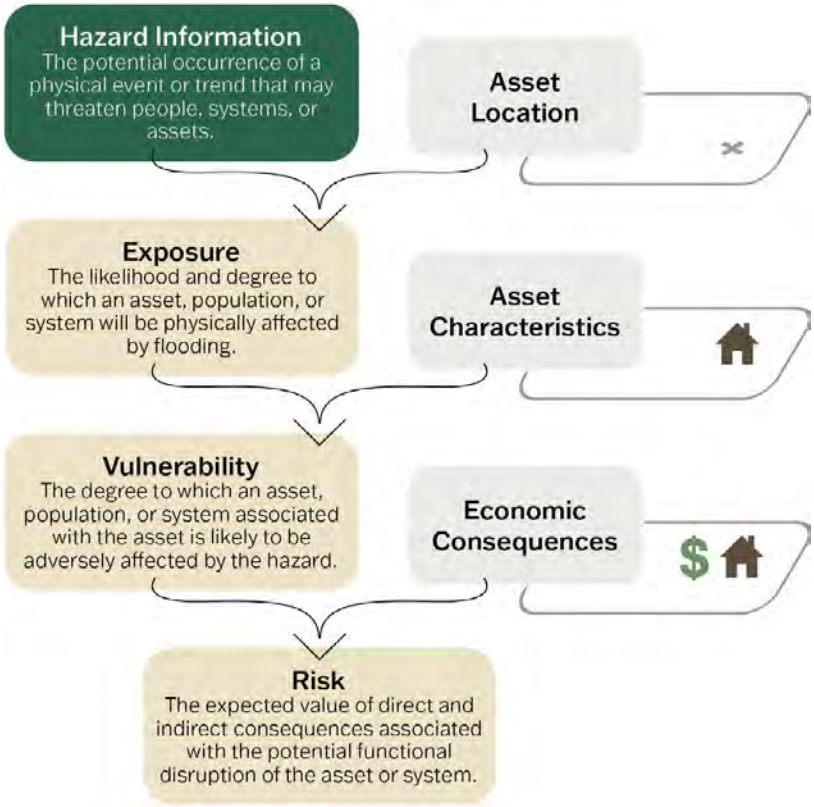
Impacts are explored using a variety of metrics. They range from exposure, which captures whether an asset is likely to experience flooding, to risk, which quantifies the potential costs of damages resulting from flooding. More information about the impact assessment methodology, including the catalog of asset datasets used for the analysis and all metrics produced, is available in Appendix B.

Impacts are grouped into four major categories to summarize findings thematically:

- **Community resources:** people and their homes, and the resources that are important to communities' cultures. These resources include historic resources and religious buildings.
- **Built infrastructure:** the systems of man-made or modified structures that we rely on in our daily lives. This includes distribution systems that provide communities with water, energy, electricity and communications, and the roads, bridges, and transportation networks used to get from place to place.
- **Human infrastructure:** essential services and systems that sustain the well-being, safety, and functioning of a society. These assets include emergency services, healthcare and public health services, government facilities, childcare and education, financial services, food and agriculture services, and solid waste management.
- **Natural infrastructure:** a range of conserved, working, and undeveloped lands and aquatic areas, including parks. The health of these environments and assets underpins the overall well-being of coastal Virginia.

Each category is presented independently. Economic impact findings are aggregated and presented across all categories at the conclusion of the chapter.

Flood Impacts Assessment



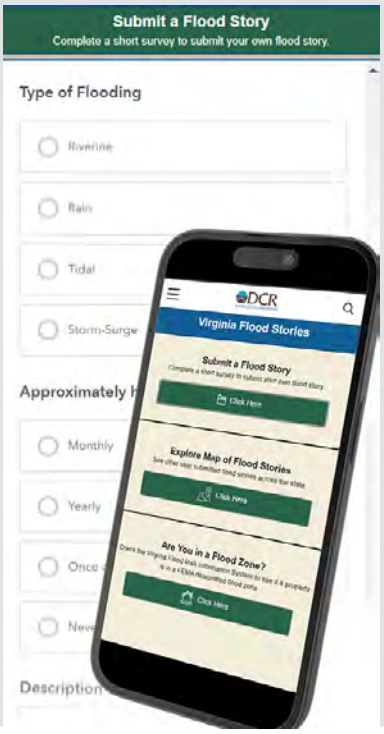
This document presents only a selection of flooding impacts analyzed when developing this plan. Additional data for other types of assets are available via the CRWE. The CRWE also allows users to explore findings across a variety of different geographic scales, all reference flood conditions, and all planning scenarios. The data is available to view via maps and graphs in the web application, as well as to download.

Access the Coastal Resilience Web Explorer:
dcr.virginia.gov/crmp/ResilienceExplorer

DCR Flood Stories

To determine future impacts, this plan focuses on anticipated flooding based on models and asset data gathered via remote desktop analysis.

DCR has developed the Flood Story tools to help us better understand real, on-the-ground impacts of flooding from those directly affected by flooding events. An online submission form and web viewer allow Virginians to share their personal flood experiences via photos and text description submitted. Stories are then published to the Virginia Flood Risk Information System (VFRIS), allowing DCR to gain additional context and insight about impacts, in addition to supplementing the quantitative models.



Submit your Flood Story

dcr.virginia.gov/floodstory

COMMUNITY RESOURCES

Population

Nearly 1.5 million coastal Virginians—25% of the region's population—live in areas that could be exposed to major flooding today. Rainfall-driven flooding is the flood hazard most likely to impact coastal Virginia's residents at home, both for baseline and future conditions. In the baseline scenario, nearly 20 times as many residents could be exposed to a chronic rainfall-driven flooding than chronic coastal flooding.

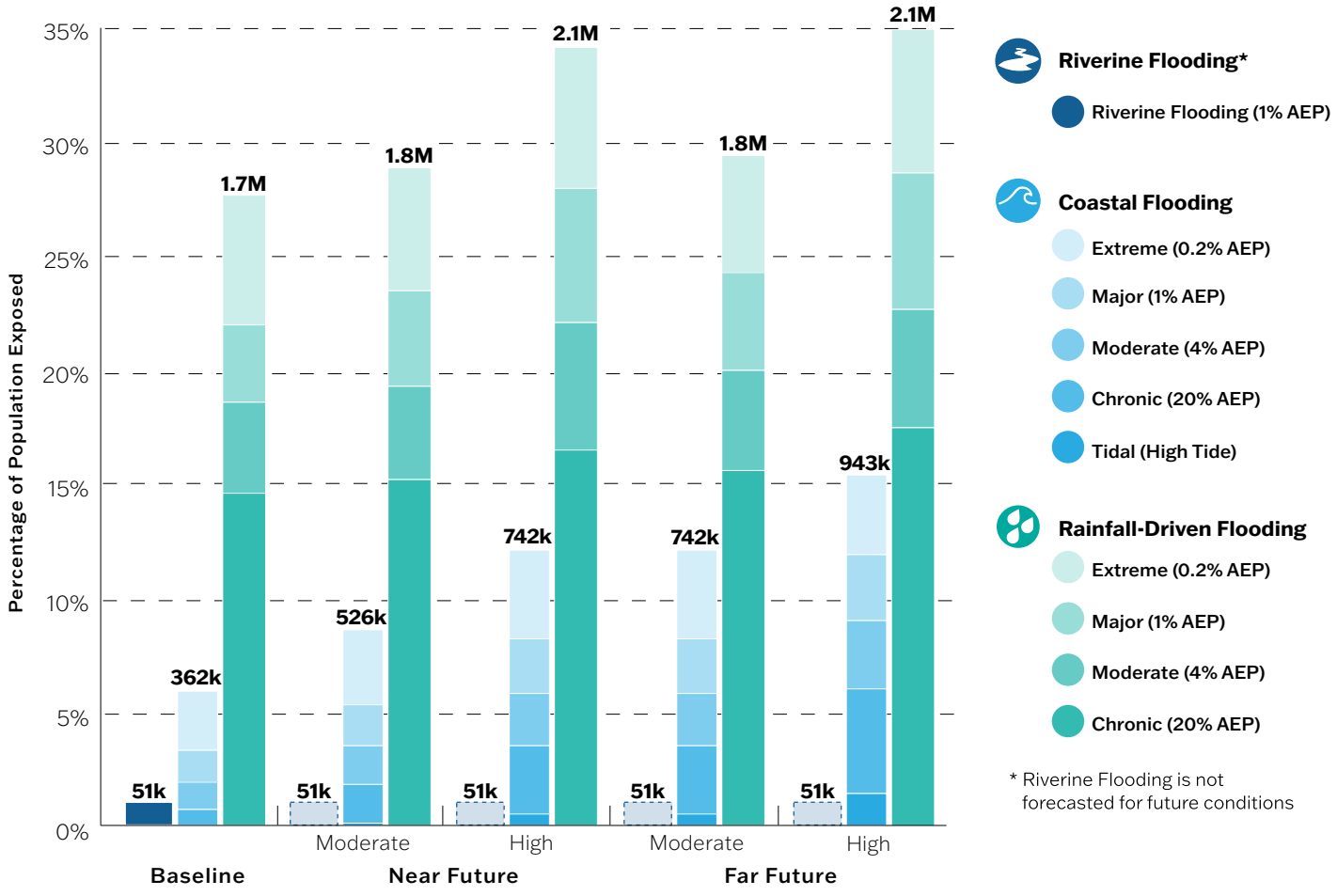
Today, approximately 22% of all residents of coastal Virginia—more than 1.3 million people—live in homes that could be exposed to major rainfall-driven flooding. While this number is likely to increase in future scenarios, these increases are modest and less certain when compared to increases in coastal flooding impacts.

Chronic coastal flooding impacts a limited number of coastal Virginians at home in baseline conditions, with about 47,000 people living in exposed areas. However, this number could rise significantly due to sea level rise. In the far future scenarios, the number of residents that could be exposed to chronic coastal flooding at home could increase between three to seven times. Most of these residents live in Hampton Roads.

Today, more than 3% of coastal Virginia's population—about 200,000 people—live in homes that could be exposed to major coastal flooding. The far future scenarios suggest that 7% to 11% of residents—equivalent to approximately 500,000 to 730,000 people—could be impacted.

Riverine flooding impacts a smaller population than the other two hazards. Today, about 51,000 residents live in homes that could be exposed to major riverine flooding, about the same as the number of people that could be exposed to chronic coastal flooding.

Population Exposure to Flooding In Coastal Virginia



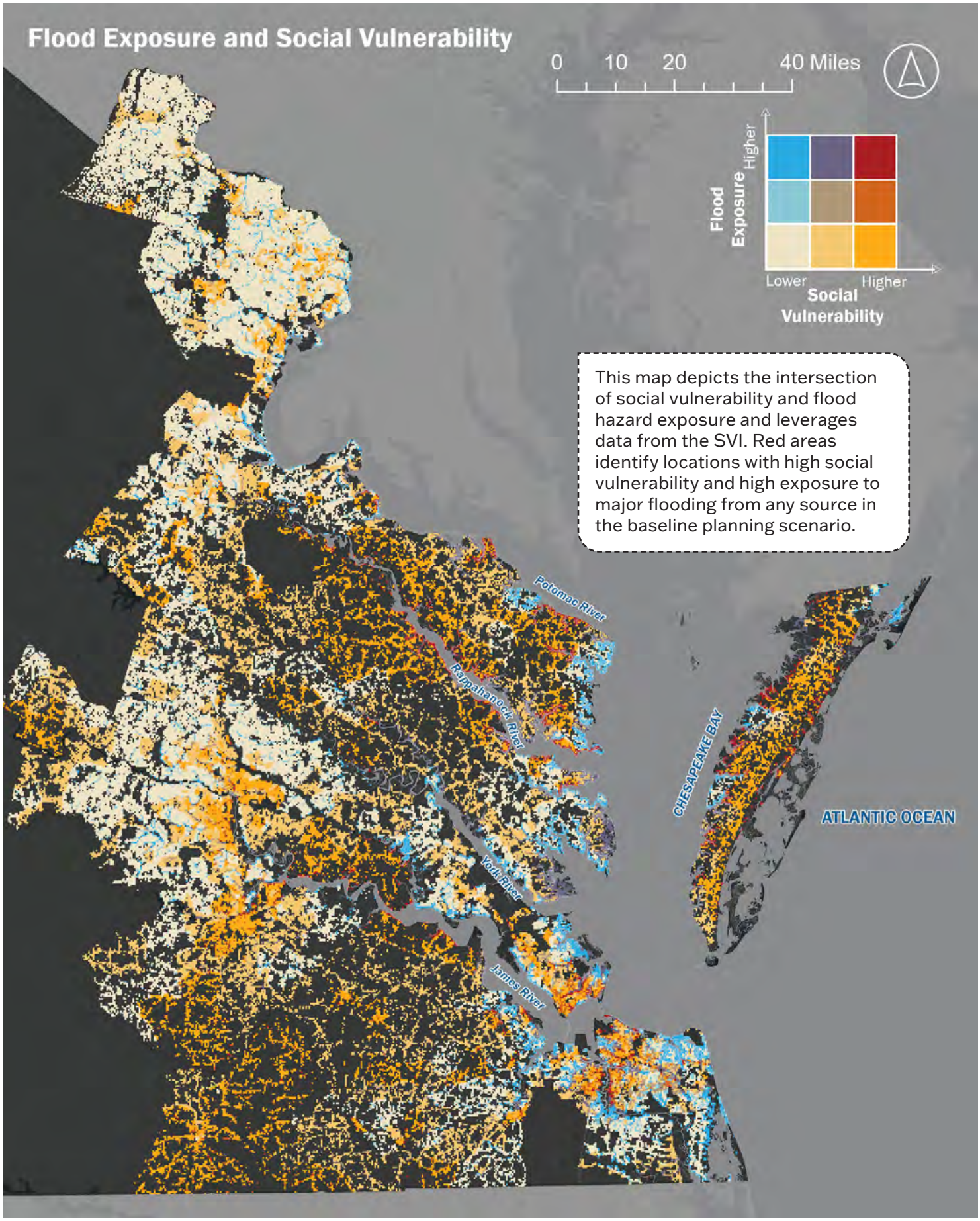
Social Vulnerability and Flood Risk

Populations within a community have varying degrees of access to personal and community-provided resources which affects their capacity to prepare for and adapt to flooding impacts. Flooding can limit access to vital community resources such as medical services and food supply. Additionally, these communities may have fewer resources to repair, rebuild or relocate after experiencing significant damages to their personal property.

Identifying the locations of socially vulnerable populations living in flood prone areas can help to ensure that the proper resources are allocated and available during and after a flood event, supporting community needs for both flood emergency response and long-term flood resilience. For example, agencies can focus and prioritize capacity building or sustained technical assistance efforts in socially vulnerable communities to help build long-term flood resilience.

One tool for identifying socially vulnerable populations is the Centers for Disease Control and the Agency for Toxic Substances and Disease Registry (CDC/ATSDR) Social Vulnerability Index (SVI).[22] The SVI was designed to identify communities experiencing social vulnerability that are likely to need support before, during, and after a public health emergency. The SVI uses 23 demographic variables related to socioeconomic status, housing type and transportation, racial and ethnic minority status, and household characteristics.

The national SVI is calculated at the census tract level (with each tract typically representing between 1,000 and 8,000 people). However, this plan presents social vulnerability data using a downscaled version of the index calculated at the census block group level (typically representing 600 to 3,000 people) to support more granular analysis and planning. Still, additional efforts by local governments to understand the variations in social vulnerability within small geographic areas through outreach and engagement with local communities can be important to enhancing flood resilience efforts.



Residential Buildings

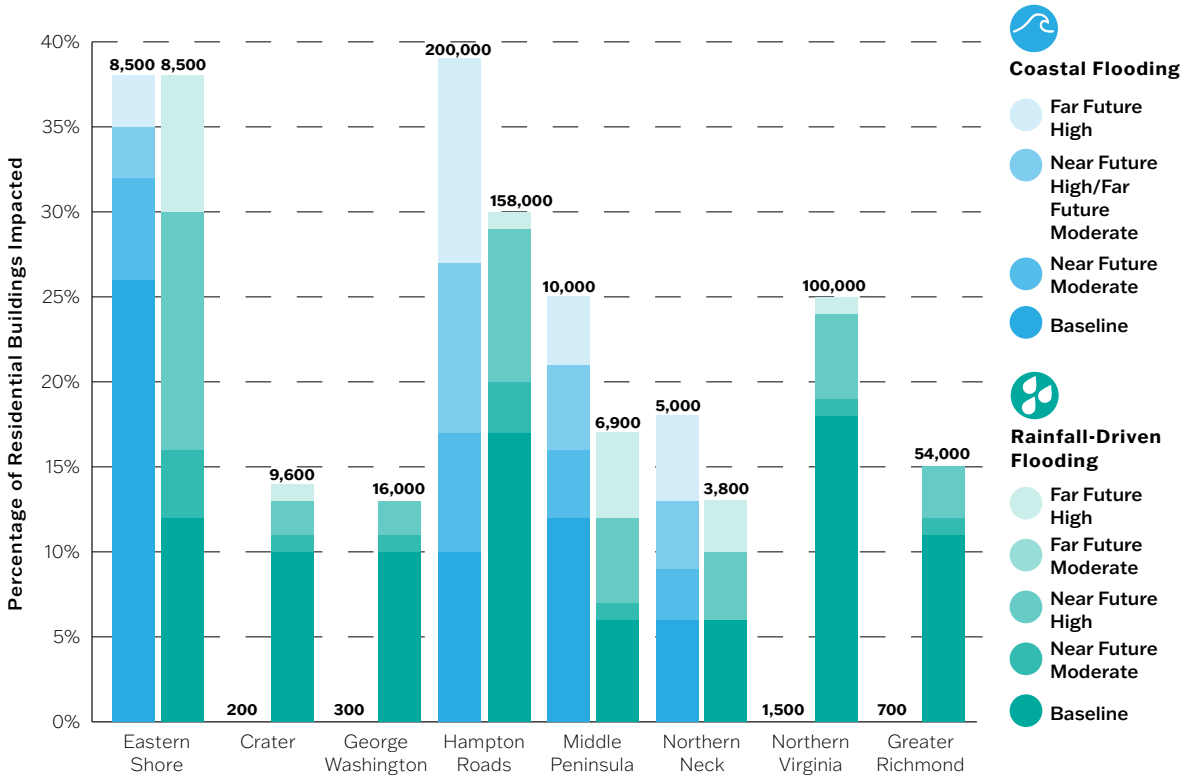
Residential buildings include all types of homes, from single-family houses to temporary lodging and nursing homes. Flooding poses a significant threat to these buildings and can cause direct and costly damages. The resulting impacts can affect residents' health, safety, and economic livelihoods.

The population exposure data presented in the prior section illustrates that the potential for rainfall-driven flooding to impact residential structures is widespread. Exposure in turn creates the potential for damages. For example, in the baseline scenario, 240,000 residential buildings could be exposed to major rainfall-driven flooding. The estimated value of structural and content damages associated with this magnitude of flooding is a combined $8.2 million. These numbers could rise between 260,000 and 340,000 buildings exposed and about $8.9 to $11 million in damages in the near future scenarios.

More than 85% of the residential buildings that could be exposed to this major rainfall-driven flooding are in the Hampton Roads, Northern Virginia, and Greater Richmond regions. Stormwater systems that effectively manage a certain degree of rainfall-driven flooding are comparatively prevalent in these more urbanized regions, and—where present and functional—will generally mitigate some of the potential for rainfall-driven flood damages. Because the data does not model for these stormwater systems their proper maintenance is clearly important..

While fewer residential buildings could be exposed to coastal flooding than rainfall-driven flooding, the resulting damages from coastal flooding have the potential to be significantly more severe. In the baseline scenario, about 65,000 buildings regionwide could be exposed to major coastal flooding. The associated estimated damages total about $5.4 million. In the near future moderate scenario, these numbers could rise to about 100,000 buildings and $11 million in damages. Residential buildings in low-lying areas of the Middle Peninsula, Hampton Roads and Eastern Shore are particularly vulnerable to both exposure to and damages from coastal flooding.

Residential Buildings Exposed to Major (1% AEP) Flooding in Coastal Virginia



Septic Vulnerability Research and Action in Coastal Virginia

Floodwaters and rising seas can introduce a number of issues to septic system treatment, ranging from the introduction of silt and debris into the systems, to loss of necessary soil buffers from groundwater. Across all of Virginia, there are approximately 1.1 million septic systems.[23] Many of those systems are located in coastal Virginia.

The Virginia Department of Health (VDH), together with the Virginia Institute of Marine Science (VIMS) and other partners, is working to improve the Commonwealth's understanding of septic system failures, including vulnerability of these systems to sea level rise. In 2020, VIMS released the Virginia Wastewater Data Viewer, an interactive online map designed to help understand patterns of septic system failure and forecast the effects of sea level rise on septic systems in Virginia. The viewer presents results from a VIMS research effort which analyzed data on permitted septic systems across Virginia and evaluated the causes for septic system failures. The study identified areas where septic systems are failing at the highest rates. Areas with a high density of failures are located throughout coastal Virginia, with notable concentrations on the Eastern Shore, lower Middle Peninsula, and Chesterfield County. VIMS is undergoing an effort to update the study and produce findings statewide to provide high quality data on septic system failures to VDH and other decision makers.

Since the data's release, VDH has successfully leveraged the findings, partnering with other organizations such as Virginia Housing, the Department of Housing and Community Development, and the non-profit organization SERCAP, to begin to address septic issues in coastal Virginia.

Ongoing efforts to address the impacts of sea level rise on septic systems are coordinated via the Wastewater Infrastructure Policy Working Group, a state advisory board originally established in 2019 which continually assesses wastewater infrastructure needs in the Commonwealth and develops policy recommendations.

Historic Resources

Historic buildings, districts, cemeteries, battlefields, and archaeological sites connect Virginians to history, contribute to vibrant communities, and create economic sustainability across the Commonwealth. These irreplaceable historic resources are often located along waterways, increasing their exposure to both flooding and erosion. As a result, compared to other types of assets, historic resources see greater potential for flood exposure to riverine flooding, in addition to significant exposure to rainfall-driven and coastal flooding.

Regionwide, in the baseline scenario, 20% of all historic resource assets could be exposed to major riverine flooding. About 56% of historic resource assets could be exposed to major rainfall-driven flooding, and 11% to major coastal flooding.

The City of Richmond and Arlington County are the localities with the most historic resources that could be exposed to major rainfall-driven flooding. In Richmond, more than 11,000 assets could be exposed. Examples of vulnerable resources include the Shockoe Valley and Tobacco Row Historic District, as well as the Shockoe Hill Burying Ground. In Arlington, there are more than 8,000 vulnerable assets, such as the Marcey Creek Ware and Fort CF Smith.

Historic resources in Hampton Roads are particularly vulnerable to coastal flooding. This includes both major historical sites—like the Colonial National Historical Park—and individual homes and historic districts. Today, more than 7,900 assets located on about 49,00 acres in Hampton Roads could be exposed to major coastal flooding. Between 36,000 and 53,000 acres of historic resources are projected to become exposed to tidal flooding under the near-future scenarios.

These findings were developed using the best available asset data on known historic resources from the Virginia Department of Historic Resources. For a variety of reasons, some localities have been more intensely surveyed than others. Jurisdictions found to have relatively low exposure of these assets to flood risk may contain equally significant historic resources that have not yet been identified or evaluated.

When Historic Jamestown flooded in October 2024 after Hurricane Helene, access to the museum was blocked. Groundwater rose up through the bottom of excavation units, impacting ongoing archaeological investigations.

Flood Resilience for Historic Resources in Jamestown, Virginia

Jamestown—the first English settlement in America—is a globally significant historical resource widely recognized to be at extreme risk from sea level rise. The site, located on the James River, has long experienced flooding and has seen significant changes in sea levels and shoreline erosion since its initial settlement more than four hundred years ago. Over time, these changes have washed away elements of the site, including a significant amount of the original fort. The site experiences flooding of the landscape, pathways, and below surface archaeological resources.

To address erosion and flood risk at Jamestown, the U.S. Army Corps of Engineers (USACE) built a concrete block seawall between 1901 and 1906. By the early 1980s, the sea wall began to fail, and repairs were made every few years. Additional past efforts prioritized shoreline protection in select locations where threats to archaeological sites were greatest. Recently, approximately 96,000 tons of armor stone was placed in front and halfway up the sea wall. USACE anticipates that these additions will help neutralize wave action along the shoreline for the next 50 to 75 years. However, the sea wall alone is insufficient to address the challenge of sea level rise and flood inundation on site.

As conditions of flooding continue to change in the decades to come, the historic resources at Jamestown will face even more severe levels of flood risk which threaten their integrity. According to studies conducted by the Jamestown Rediscovery Foundation, a private nonprofit that funds research and operations at the original site of James Fort, 14 acres surrounding the 1607 James Fort and Statehouse Ridge could be inundated with water within the next 50 years.[24] Beyond regular inundation, risks include rising and falling groundwater levels, which can damage or destroy previously dry archaeological resources.

Flood resilience plans and a large fundraising campaign are underway to raise buildings, pathways, and landscapes, as well as to improve infrastructure, increase the height of the marsh sills, and install flood berms, flood gates and a pump station in the most critical areas. The Jamestown Rediscovery Foundation has emphasized that the next five years are critical to mitigate flood impacts to historic resources at Jamestown, which will become increasingly difficult to manage if left unchecked.[25]

BUILT INFRASTRUCTURE

Water Supply and Wastewater Facilities

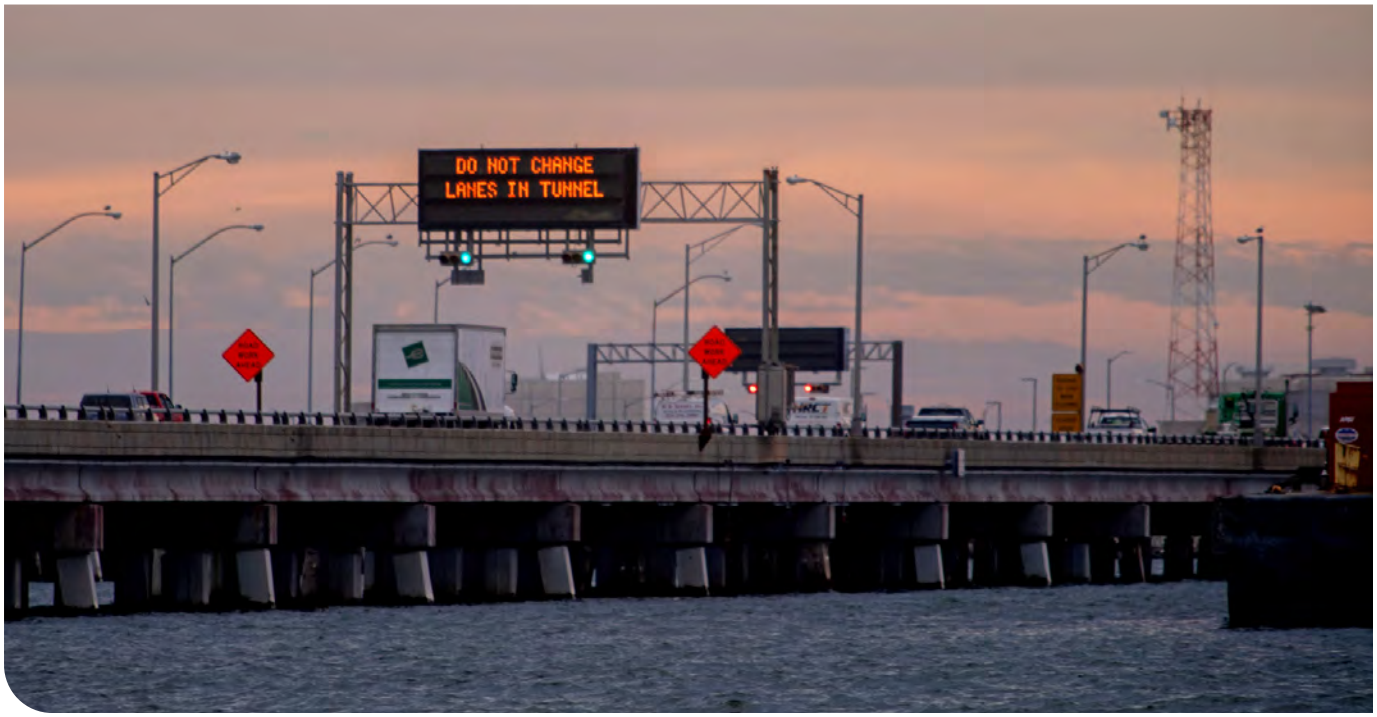
Public water treatment and distribution facilities provide access to clean drinking water across coastal Virginia. If floodwaters infiltrate water treatment plants and distribution systems, they can contaminate drinking water supplies and lead to service disruptions, posing serious risks to public health and safety. Wastewater treatment facilities also serve as critical infrastructure, protecting the health of people and ecosystems by removing pollutants from wastewater before returning it to the environment. It is crucial that these systems are resilient to flooding to avoid disruptions to the essential services they provide. These facilities are often located near water bodies due to the nature of their functions.

Regionwide, about 16% of water and wastewater assets could be exposed to rainfall-driven flooding, and about 8% could be exposed to major coastal flooding. Coastal flood vulnerabilities are most pronounced in Hampton Roads and the Middle Peninsula, where respectively 26% and 16% of facilities could be exposed to major coastal flooding. It is unlikely that a significant number of additional water and wastewater facilities will be exposed to flooding in the near future, however, flood depths at facilities exposed may increase in the decades to come.

In the City of Chesapeake, flooding of the Northwest River Water Treatment Plant in the spring of 2021 prompted local officials to place priority on resilience efforts in that area. Upwards of $91,000 was awarded in grant funds to assess flood risk and develop potential adaptation strategies to protect the water treatment plant.[26] Other drinking water and wastewater facility operators throughout the region, including the Hampton Roads Sanitation District, are also analyzing and addressing the impacts of changing flood risk on their infrastructure.

Roadways

Already, some communities experience regular roadway inundation that disrupts residents' lives, business supply chains, and essential services. Because individual roadways are part of the larger transportation network, when one part of a road is impassable due to floodwaters, it can result in entire routes of roadways becoming unusable. Even temporary road closures have the potential to disrupt the larger transportation network. This is particularly concerning in rural areas, where alternative routes are limited, as it can restrict access to essential services like healthcare, emergency response, and food supplies. Secondary impacts resulting from loss of access and mobility due to roadway disruptions are important considerations for flood resilience planning but are not quantified in this plan.



More than 30% of roadway mileage—more than 8,000 linear miles—could be exposed to major rainfall-driven flooding in the baseline scenario. In the near future scenarios, there could be an additional 600 to 2,000 linear miles of impacts. Roadways in low-lying areas adjacent to tidal water bodies are particularly vulnerable to rainfall-driven flooding. Stormwater infrastructure that is not accounted for in this data may help to offset rainfall-driven flooding on roadways. However, in general, the existing infrastructure is not large enough to manage the amount of stormwater that results in major and extreme flooding, especially in areas where tidal backflow into the systems is increasing.

About 3.5% of roadway mileage—1,500 linear miles—could be exposed to major coastal flooding. In the near future scenarios, there could be an additional 700 to 1,900 linear miles of impacts. As with rainfall-driven flooding, low lying areas adjacent to tidal water bodies are especially vulnerable.

In contrast, only about 1% of roadway mileage could be exposed to major riverine flooding in the baseline scenario. However, this vulnerability is concentrated in different parts of the region, for example, inland communities in the Crater, Greater Richmond and Northern Virginia regions.

VDOT Resilience Plan

The Virginia Department of Transportation (VDOT) released its first Resilience Plan in November 2022 to formalize the incorporation of resilience to flooding and other inundation-related impacts across its areas of work, including asset management.

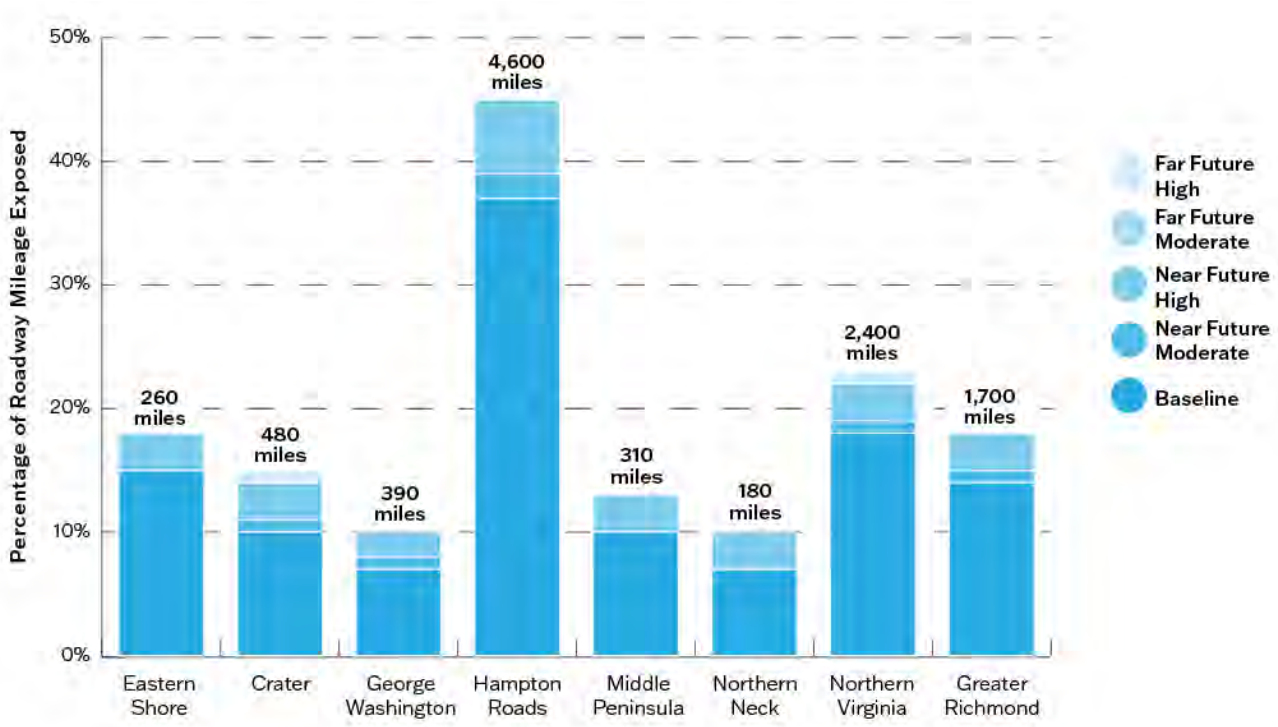
To implement the strategies outlined in its plan, VDOT is developing an At-Risk Infrastructure Visualization Tool to measure the vulnerability of VDOT assets to flooding and related hazards.

The tool will help VDOT to make informed decisions for both system-level and project-level planning based on factors including the assets' level of exposure, criticality, and sensitivity.

Access the plan on VDOT's website:

vdot.virginia.gov/doing-business/technical-guidance-and-support/environmental/

Roadway Exposure to Major (1% AEP) Rainfall-Driven Flooding in Coastal Virginia



Real-time Roadway Flood Monitoring Systems

While flood modeling and analysis is invaluable for planning purposes, it does not represent observed conditions. Real-time monitoring of water conditions, such as precipitation and water depths, provides another important tool to understand and mitigate flood risks. This real-time data can be essential to support more informed, location-specific planning for future flood events, as well as to alerting citizens of active flood events. It can be particularly useful for conducting flood monitoring and response for roadway infrastructure.

The VDEM Flood Intel Unit provides publicly available, real-time flood monitoring data to the National Weather Service through the Virginia Flood Monitoring System (VFMS).[27] The VFMS is a modernized network consisting of 151 water level gauges, rain gauges and meteorological stations located statewide. Using this real-time data, public safety and water resource officials can issue timely alerts for road closures, as well as other flood-related alerts, such as flash flooding and evacuations. The establishment of this network in 2024 has significantly expanded the geographic coverage of the Commonwealth's ability to monitor potential and real-time flooding and complements existing networks from NOAA, USGS, fellow state agencies and local governments. In addition to VDEM's statewide monitoring efforts, other government entities across coastal Virginia are employing real-time flood monitoring equipment to identify when water levels are hazardous to motorists and implement quicker road closures.

VDOT has been selected to receive $5.4 million in federal funding for its Modernizing Operations for Virginia's Evacuation Resilience (MOVER) program to advance strategies aligned with the VDOT Resilience Plan. MOVER is a pilot effort working toward statewide integrated technology to ensure efficient traffic flow on critical routes during emergency weather events. The pilot program will focus on the Virginia Tidewater and Chesapeake evacuation areas that collectively serve over 3.6 million people, spanning eastern Virginia and the Outer Banks of North Carolina. Through MOVER, VDOT will purchase and install technology such as flood sensors, stream gauges, traffic cameras, and other traffic monitoring and control devices to monitor weather and traffic on key transportation corridors during flooding and evacuation management. The technology will be located on designated evacuation routes and other key transportation facilities in areas vulnerable to flooding to facilitate emergency evacuations due to extreme weather events. Funding will also support developing a data integration process within VDOT's existing traffic operations network to help minimize disruption of travel.

In Norfolk, the City partnered with FloodMapp and Waze to provide real-time information to motorists about flooded road conditions.[28] FloodMapp develops a real-time flood inundation model to predict locations of flooded roads that updates every 15 minutes based on tidal riverine and rainfall data. Waze then provides alerts about the current flood conditions and suggests alternative routes to motorists. A feedback loop employed by Waze allows drivers to confirm the presence of the flooded roadway, increasing the accuracy of the alerts.

At locations across Hampton Roads, the PDC has installed flood sensors to provide real-time monitoring of the depth of water on roadways. Once the water on the roadway reaches a pre-defined depth, the monitor provides an alert to Waze, which then provides alternate routes to motorists.[29]

In Richmond, the City has installed high water detection systems at two flood prone locations that monitor the flood conditions. The systems activate flashing beacons, message signs, and automatic road barrier gates to prevent motorists from accessing the roads during flood conditions once conditions are unsafe for motorists.[30]

In Prince William County, the County's Flooded Roadway Traffic Gate Project will prevent motorists from accessing flooded roadways by using real-time monitoring of flood conditions to trigger gates to close roads when road conditions become unsafe for travel. High-water detection equipment and rain gauges will be installed at the most vulnerable locations within the County. The software package used will allow real-time monitoring and notification of rainfall summary, stream summary, thresholds for displays and alarms, and a detailed dashboard showing data for County public safety situational awareness and potential resource needs.

HUMAN INFRASTRUCTURE

Educational Institutions

Educational institutions provide learning opportunities that support the intellectual, social, and civic development of young people in a community. For many families, schools also serve as critical childcare providers. When educational institutions are temporarily out of operation, the community and especially vulnerable populations—such as low-income families—may lack alternative childcare options. This can make it difficult for parents to return to work, further exacerbating economic hardships.

Rainfall-driven flooding is already likely to impact educational institutions. About 340 assets—7% of the region's total—could be exposed to major rainfall-driven flooding in the baseline scenario. This vulnerability is most notable in Northern Virginia, which accounts for more than 40% of assets exposed. Assets in Hampton Roads and the Greater Richmond region are also comparatively more vulnerable to rainfall-driven flooding.

Regionwide, about 2% of educational facilities could be exposed to major coastal flooding. In general, facilities on the southside of Hampton Roads and on the Eastern Shore are most vulnerable to coastal flooding. Today, four of the Eastern Shore's 50 educational assets could experience chronic coastal flooding.

Manufacturing Facilities

Manufacturing facilities are privately-owned sites that make biological, chemical, pharmaceutical, and other products. While Virginia's economic landscape is diverse, manufacturing is one of the top three producing industries, with annual value of sales, shipments, or revenue upwards of $100 billion.[31] Flooding of these facilities could lead to direct economic losses and supply shortages, both locally and regionally.

About 19% of manufacturing sector assets across the region could experience rainfall-driven flooding in the baseline scenario. In comparison, about 3% could be exposed to coastal flooding, and about 2% to riverine flooding. Rainfall-driven vulnerability is dispersed across coastal Virginia, with concentrations around larger metro areas. Coastal vulnerability is geographically concentrated in Hampton Roads, which accounts for more than 90% of all manufacturing facilities exposed to coastal flooding. Riverine vulnerability is notable in Northern Virginia and the Greater Richmond regions.

Within the manufacturing sector, some facilities use materials or generate waste which can create health and environmental impacts if exposed to flooding. The level of exposure to chronic coastal flooding of hazardous waste generators may increase significantly in the decades to come. The increase in vulnerability would occur almost exclusively in the Hampton Roads region, where more than a third of all hazardous waste generators in coastal Virginia are located.

Operators of manufacturing facilities across coastal Virginia are concerned with increasing flood impacts and are taking action to address it. While manufacturers have long sought to manage environmental risk, the changing frequency and severity of flooding will require industries to adapt to maintain economic resilience.

In Newport News, Virginia, Huntington Ingalls Industries (HII) operates the largest shipbuilding manufacturing plant in the United States and serves as Virginia's largest industrial employer, providing jobs to more than 25,000 people.

HII has developed an enterprise risk and mitigation plan which addresses the vulnerabilities of shipyard facilities, including buildings, dry docks, piers, utility infrastructure, and more. In addition to outlining storm response approaches, the strategy includes a long-range approach to flood resilience which sets a standard for all new facilities and infrastructure to be elevated at least two feet above base flood elevation. This has included installing utilities on elevated platforms and providing elevated office space to improve the shipyard's infrastructure resiliency.

NATURAL INFRASTRUCTURE

The health of natural infrastructure underpins the overall wellbeing of coastal Virginia. Natural infrastructure provides us with resources and agricultural products, serves as tourism and recreational sites, provides wildlife habitat, protects water quality, and reduces flood risk. It is also a major contributor to Virginia's economy. Agriculture is Virginia's largest private industry. When combined with forestry, it accounts for more than $105 billion in economic impact statewide.[32]

Flooding is a natural phenomenon and is necessary for sustaining the ecosystems within coastal Virginia's floodplains. However, increasingly severe and repetitive flooding and its related impacts can overwhelm natural systems' functions. When this occurs, natural assets can be significantly degraded or lost if they are unable to adapt to changing conditions. Coastal flooding, including storm surge, can negatively impact agriculture and ecosystems that become temporarily exposed to saltwater. Permanent or daily tidal inundation impacts natural infrastructure through land conversion. For example, "ghost forests" have arisen when coastal trees cannot survive the effects of increased salinity in their environment, leaving stands of dead trees along the low-lying shores of the Chesapeake Bay.

Natural infrastructure relies on complex and dynamic ecosystems that naturally respond to changes in their surroundings, like rising seas and salinity levels. This plan does not consider several important factors that relate to ecosystems' ability to function in response to flooding, such as erosion, flood velocities, and flood durations. In recognition of these limitations, the plan focuses on impacts to natural infrastructure from exposure to tidal flooding.

Agricultural Lands

About 15% of the land in coastal Virginia is used for agriculture, which includes both cropland and pasture. Each of the eight regions has significant agricultural areas, ranging from 107,000 to 190,000 acres, but the ratio of cropland to pasture varies widely among them. The inland and upland regions contain the most pastureland, while the low-lying and tidal regions have the most cropland.

Agricultural land can be resilient to flooding while also supporting the resilience of upland and inland property by virtue of its ability to accept and absorb water. Permanent inundation and ponding of water can harm agricultural production. Generally, crops are more susceptible to flooding than grasses, and thus pastureland is more resilient to flooding. Because of the distribution of pastureland and cropland in coastal Virginia, the more susceptible agricultural lands are also the most vulnerable to flooding due to topography and tidal influences. Flood dynamics can have negative impacts on agricultural crop production; however, studies show that best management practices – such as zero tillage, crop covers, soil amendments, rehabilitation techniques, and the development of flood-tolerant crop varieties – are effective adaptation and mitigation strategies for managing these negative impacts on agricultural landscapes.[33,34]

The regions with greater frontage on tidal water bodies, whether rivers and estuaries or open water bodies, experience the most coastal flooding and will face potentially severe increases in future planning scenarios. The Eastern Shore is especially vulnerable. Today, more than 6% of its agricultural lands could be exposed to chronic flooding. In the near future scenarios, this could rise between 8% to 12%.

Beyond tidal inundation and storm event-based flooding, many other factors which are not modeled or expressed here can be expected to affect the productivity of coastal Virginia's agricultural lands, particularly in the low-lying, eastern-most portions of the state. Saltwater intrusion due to relative sea level rise may affect both crops and pastureland.

Various topographic and storm drainage factors, such as submerged culverts and storm drain network components, may introduce changing hydrologic conditions inland and can create wetland conditions by retaining flood waters well beyond normal drain times.

Agricultural Lands Exposed to Chronic (20% AEP) Coastal Flooding by Region

Agricultural Land Type, By Region	Total Area (ac)	Flood Exposure (ac)			
		Baseline	Near Future Moderate	Near Future High	% Increase over Baseline
Cropland	**705,000**	**20,400**	**27,500**	**37,600**	**35% – 84%**
Hampton Roads	170,000	3,200	5,100	8,100	59% – 153%
Middle Peninsula	117,000	4,000	5,400	7,000	35% – 75%
Eastern Shore	101,000	6,100	8,800	12,500	44% – 105%
Northern Neck	88,800	3,500	4,100	5,000	17% – 43%
Greater Richmond	79,300	1,800	2,100	2,700	17% – 50%
Crater	77,500	790	890	1,100	13% – 39%
George Washington	54,700	1,000	1,100	1,200	10% – 20%
Northern Virginia	16,800	35	40	45	14% – 29%
Pasture/Hay	**383,000**	**3,300**	**4,100**	**5,200**	**24% – 58%**
Hampton Roads	20,200	460	580	690	26% – 50%
Middle Peninsula	30,800	680	890	1,200	31% – 76%
Eastern Shore	14,900	580	860	1,300	48% – 124%
Northern Neck	28,100	760	860	970	13% – 28%
Greater Richmond	83,700	440	490	650	11% – 48%
Crater	30,200	35	35	40	0% – 14%
George Washington	52,700	300	320	340	7% – 13%
Northern Virginia	122,000	25	25	30	0% – 20%
Grand Total	**1,088,000**	**23,700**	**31,500**	**42,800**	**33% – 81%**

Conserved Lands

Conserved lands include parks and other areas managed for permanent natural resource conservation by federal, state, private, Tribal, and local entities, as well as lands under permanent conservation easements. About 9% of coastal Virginia is currently protected from human development as permanently conserved land.[35] Far-future scenarios indicate that 58,000–78,000 acres of conserved lands could become newly exposed to tidal flooding, creating conditions that could support the inland migration of wetlands.

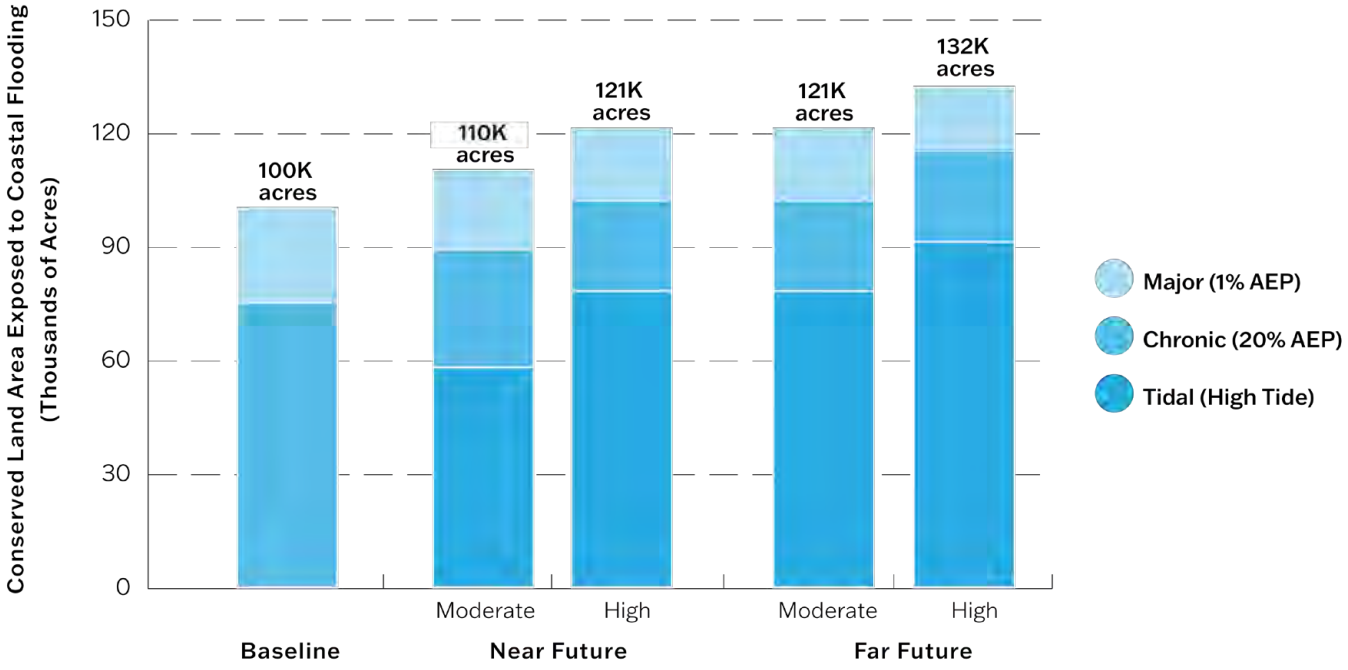
Conserved lands are more exposed to coastal flooding than other types of land evaluated in the study. This is partly because many areas along Virginia's coastal waterways are preserved for their historic, cultural and ecological significance. Changes in the extents of daily tidal inundation may result in the loss of conserved lands to permanent inundation over time.

The benefits that these conserved lands provide—such as water quality protections, preservation of diverse wildlife, and protection of important cultural and tribal landscapes—may be degraded as rising sea levels and increasing coastal flooding change the habitats and environmental conditions.

Still, land conservation is an important tool to build flood resilience to all types of flood hazards in coastal Virginia. Conserving lands that experience flooding proactively avoids flood impacts to built and human infrastructure by preventing development from occurring in harm's way.

Conserving flood-prone lands from development can also help to maintain the natural resources that underpin floodplains' natural functions. For example, tidal wetlands can lessen flood impacts to adjacent upland areas by reducing wave energy and slowing the advance of storm surge during moderate coastal flooding. Forests, vegetated buffers, and other natural upland ecosystems can reduce riverine and rainfall-driven flood impacts by slowing and absorbing rainfall before it flows downstream.

Conserved Lands Exposed to Coastal Flooding in Coastal Virginia

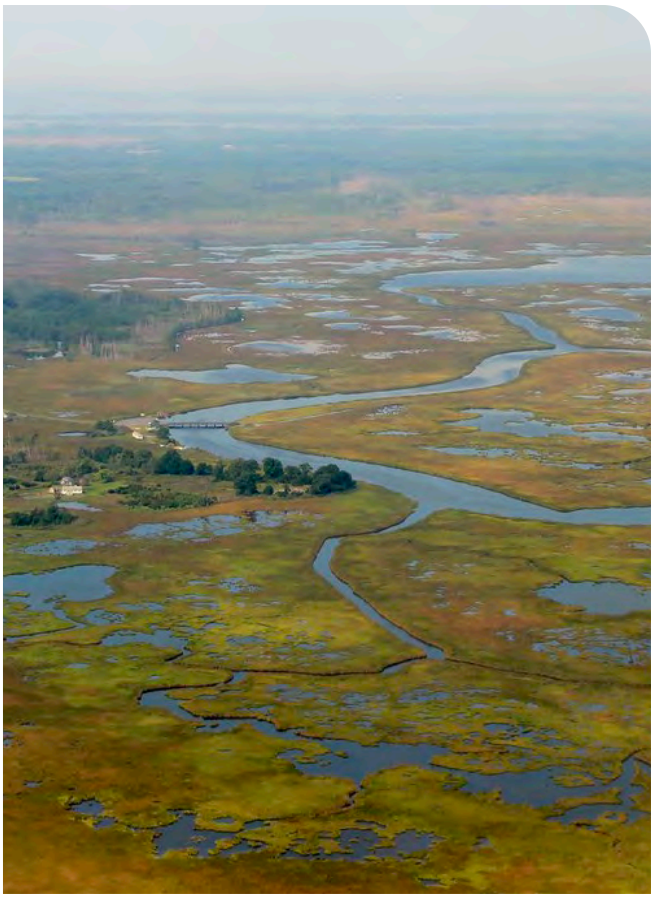


Tidal Wetlands

Tidal wetlands are critical natural infrastructure assets. They provide ecosystem services which are essential to our natural environments and offer many other benefits to human wellbeing, such as mitigating flood hazards by slowing the movement of water in rivers and creeks. Increasing relative sea level rise and tidal inundation puts pressure on tidal wetlands to migrate upland.

In the near future moderate scenario, the Middle Peninsula, Hampton Roads, and Greater Richmond regions show the greatest potential for increases in tidal marshes. This is due to the combination of rising sea levels and low land elevation. At first, a shallow layer of saltwater may inundate previously upland areas. However, as saltwater becomes increasingly deep, it transitions to open water, which can ultimately lead to a loss of tidal marsh. The potential increases in tidal marsh may also be limited by existing and future land uses.

The Eastern Shore stands out as having highest potential for acres of lost tidal wetlands by a significant margin. It is projected to lose portions of its 70 miles of barrier islands and marshes to sea level rise.



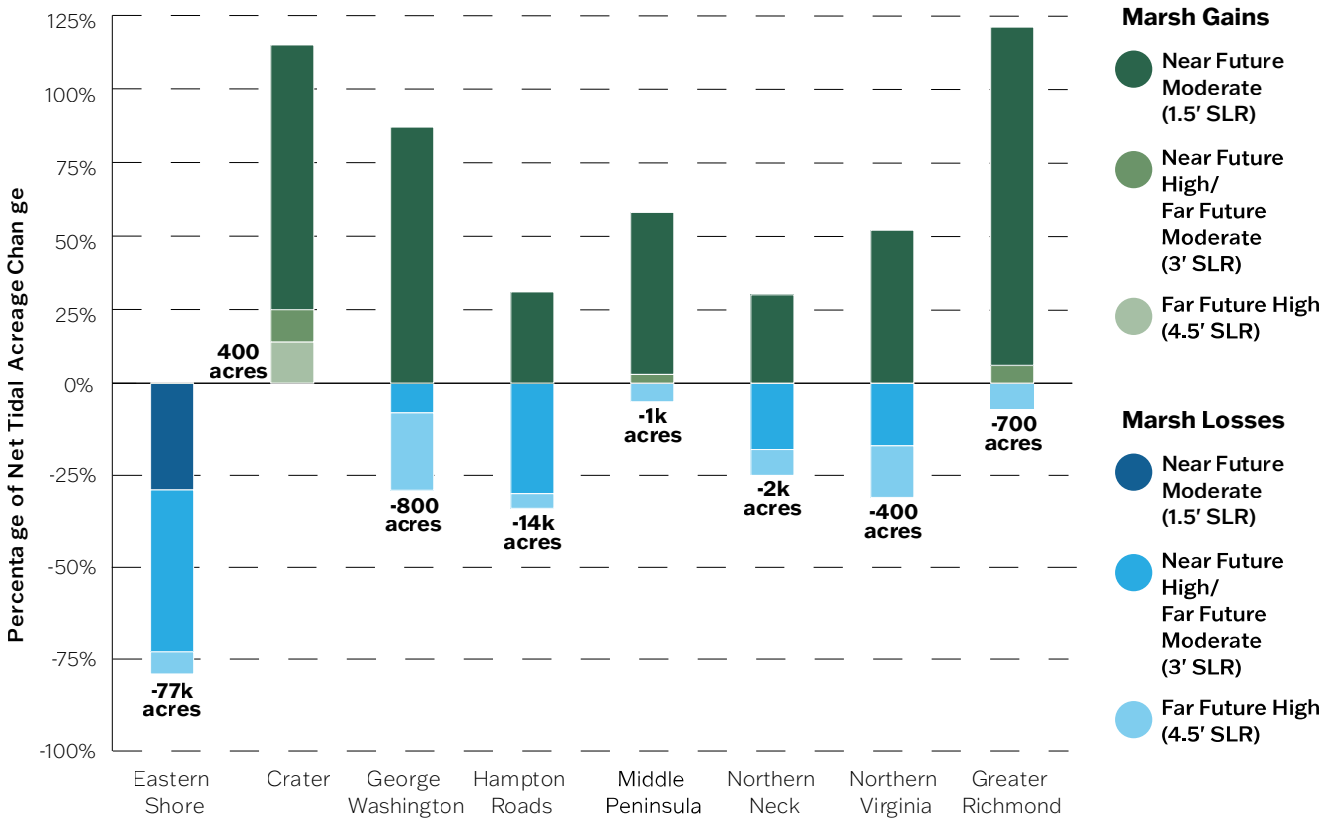
Marsh Migration Methodology

Changes in tidal wetlands were calculated using marsh migration data developed by NOAA. This data was also used in the Phase I plan and is the only readily available product which covers the entirety of coastal Virginia and aligns with the planning scenarios for sea level rise. NOAA's methodology classifies wetlands based on the Coastal Change Analysis Program, which provides inventories of coastal intertidal areas, wetlands, and adjacent uplands. The methodology assumes the wetland types that exist at a given location may migrate, based on the types of vegetation that will survive various environmental conditions, frequencies and times of inundation and levels of salinity experienced.

The marsh mapping results are available for different levels of net sea level rise in half-foot elevation increments. The planning team selected the half foot increment which was closest to the planning scenario water level ranges for use in this plan: 1.5 feet for the near future moderate, 3 feet for the near future high and far future moderate, and 4.5 feet for the far future high. The planning team then used these results to calculate tidal wetland area lost and gained by comparing the changing geographic extent of open water and different types of tidal wetlands across coastal Virginia for each planning scenario.

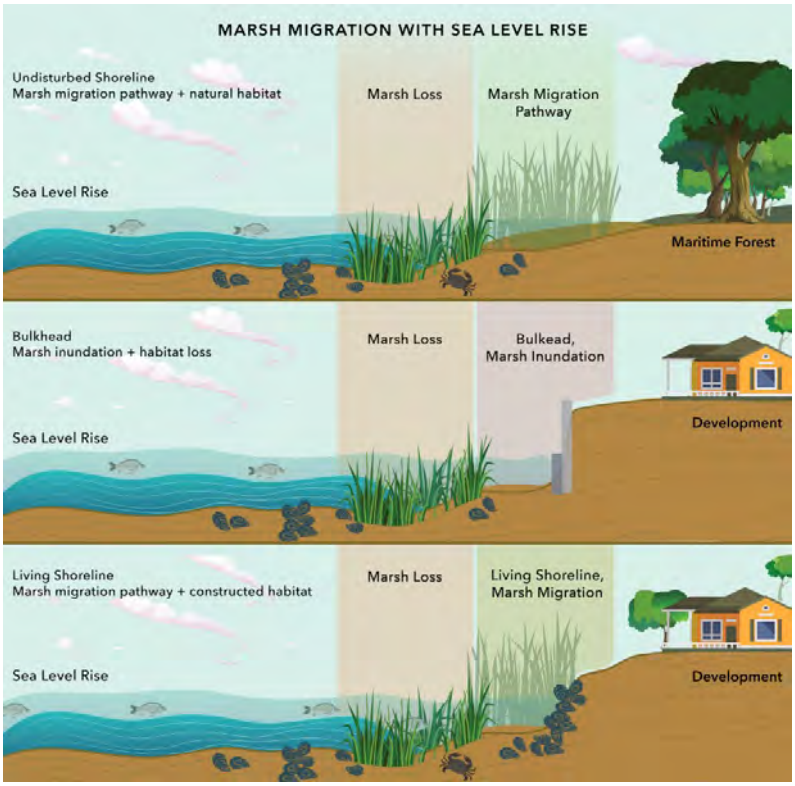
There are limitations to this methodology. It does not include marsh accretion, a process by which marshes increase in height as organic and inorganic matter builds up over time. Discussions with stakeholders indicate that NOAA's methodology may take an optimistic approach to gains in marshland migration. The methodology is primarily elevation centric and does not factor in land use in the analysis, therefore it may overestimate the marshlands.

Potential Tidal Marsh Net Gains or Losses in Coastal Virginia PDCs*



* In the figure above, the acre values for each region represent the total change in acres at the Far Future High scenario that includes 4.5′ of sea level rise.

Marsh Migration Pathways



This graphic, sourced from the Georgia Conservancy, shows the different ways that marshes may change over time under different conditions as sea levels rise. Where shorelines are undisturbed, or natural, and adjacent lands do not have hardened edges, marshes may naturally migrate inland over time.

Economic Impacts of Flooding

ECONOMIC IMPACTS ANALYSIS

Coastal Virginia comprised about 73% of Virginia's overall economy in 2023.[36] There were an estimated 2.8 million jobs generating $224.1 billion in annual wages in the region.[37] The gross domestic product (GDP) of coastal Virginia was approximately $546.1 billion in 2024 dollars, whereas Virginia's nominal GDP was approximately $748.1 billion in the first quarter of 2024. Impacts to coastal Virginia's economy affect the economy of the entire Commonwealth and beyond.

As discussed earlier in this chapter, flooding in coastal Virginia can damage and disrupt infrastructure, assets, and resources. These impacts create direct financial costs to repair flood-damaged structures and assets. Flood damages and disruptions can also create secondary effects, such as business closures, decreased worker productivity, and shifts in real estate markets and tax revenues, all of which also translate into wider economic impacts.

Understanding these economic risks is important for decision-makers as they prioritize investments in flood resilience strategies and evaluate the costs and benefits of different approaches to manage future flooding. This section provides estimates of economic risk in dollar terms for any given year over a broad period based on potential impacts from the range of modeled reference flood conditions (AEPs) in the baseline scenario. This information is designed to assist decision-makers to consider economic risk in flood resilience decisions.

Methodology

An economic impact analysis (EIA) estimates the impacts of one or more events during a specified period or scenario and geographical region on economic activity at the local, regional, or national level. For this plan, the EIA analyzed the potential impacts of coastal and rainfall-driven flooding on economic activity for each region of coastal Virginia.

The analysis estimated the potential for flooding to directly impact different industries in coastal Virginia through direct structural losses of buildings. A building inventory was developed by combining existing datasets for coastal Virginia. This inventory contained key information about individual structures, including building occupancy types. Using the building inventory and the flood hazard models, the analysis calculated the estimated potential level of damage each building might experience for each reference flood condition and assigned a monetary value for potential losses. The losses per condition were then used to calculate **average annualized losses** (AALs) for each building.

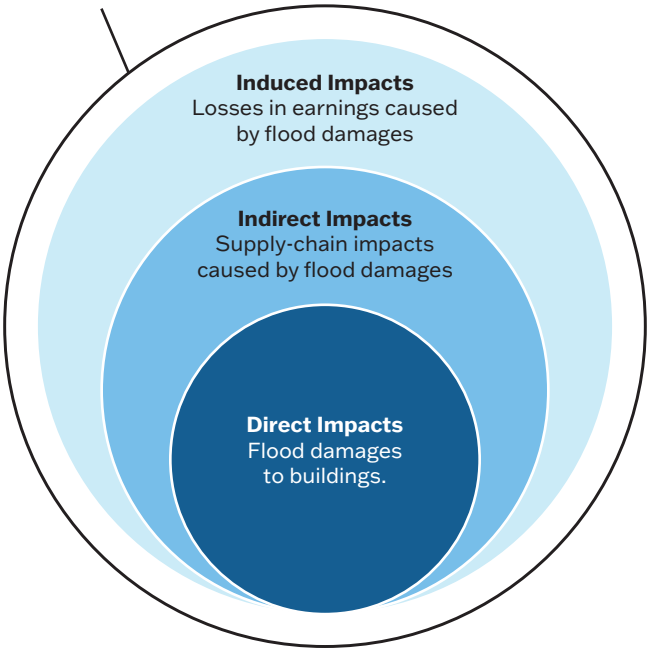
AALs are a risk metric that capture the expected flood loss for any given year over a broad period based on an individual structure's exposure to a range of flood elevations and their associated annual exceedance probabilities. The AALs quantify the average amount of costs each year resulting from the potential flood damages to buildings from each flood source independently. Within each locality, estimated AALs for both coastal and rainfall-driven flooding for each building were assigned to an industry classification by using data on the building's occupancy type.

Additional economic impacts—including indirect economic impacts to supply-chains and induced economic impacts of losses in earnings—were quantified for each industry classification within each locality by applying relevant standard economic multipliers obtained from the federal government to the calculated industry-specific and locality-specific AALs.[38] The results estimate total economic impacts in terms of annualized losses in:

- **Earnings**, which measures compensation, or the wages, salaries and benefits associated with employment by industries.
- **Value added**, which represents the level of economic activity by industries in an area, measured by the value of final goods and services produced. Value added does not include the value of intermediate goods and services used to produce final outputs. When value added is summed for all industries in a given area, the resulting value is the area's Gross Domestic Product (GDP).
- **Industry output**, which represents industry sectors' activity and measures the total value of production. It includes the final value of goods and services produced (value added), as well as the value of any intermediate inputs used in production.

Finally, the resulting estimates were combined across industries to generate estimates of the total economic impact for coastal and rainfall-driven flooding by locality. Estimates were then aggregated by PDC to generate impacts for each of the eight regions. These regional summaries were also combined to present impacts for coastal Virginia as a whole. Taken together, these impact findings provide an annualized estimate of economic risk from flooding in coastal Virginia. All findings presented are for the baseline scenario and are presented in 2024 dollars.

Total Economic Impact



Limitations

Surveys of models used to estimate the economic risks of flooding find that there is significant variation in both the approaches used and results generated.[39,40] While direct economic losses from flooding can be modeled with reasonable fidelity, indirect and induced losses are more uncertain. For example, the EIA methodology does not capture the significant variation in local and regional responses to flooding in terms of employment, expenditures, and fiscal policy. Nor does the EIA capture localized and dynamic adaptation approaches. Behavioral responses are not included in the analysis.

Additionally, all EIAs are dependent upon the underlying assumptions on which they are generated, and the limitations inherent to their inputs. For this analysis, the following limitations are notable:

- The estimates do not represent compound flooding. Instead, they provide an estimate of the aggregated annualized losses from coastal and rainfall-driven flooding occurring independently.
- The flood hazard models on which the analysis is conducted do not include stormwater infrastructure.
- Because the analysis relies on damages to structures, the estimates may not fully capture all negative externalities associated with flooding. For example, in areas where natural resources—such as agriculture and tourism—are a significant component of economic activity, the estimates provide a lower-bound on potential economic impacts from flooding.
- Estimates are based on historical data due to limitations in data availability. For example, GDP is based upon 2022 estimates for county-level economic activities inflated to 2024 dollars.
- The economic multipliers used are static and do not account for the feedback effects of changes in direct expenditures or employment. The assessment does not consider post-flood economic recovery conditions or durations.

Additional information on the methodology and limitations of the EIA can be found in Appendix B.

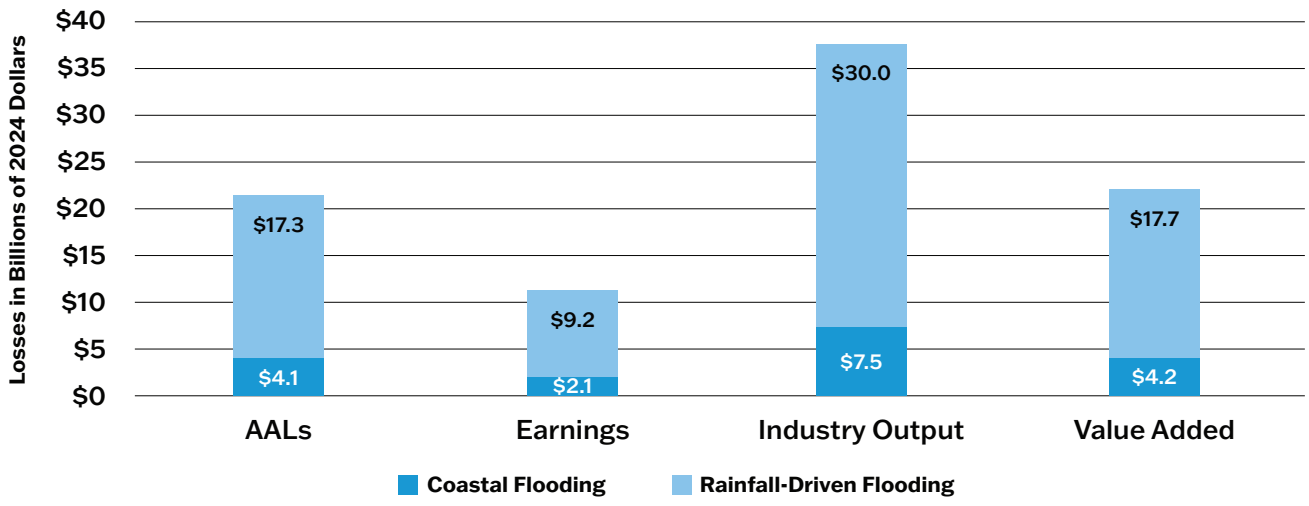
Findings

Across coastal Virginia, coastal and rainfall-driven flooding represent a meaningful source of economic risk. **Overall, the analysis found that every $1 in flood-related damage in coastal Virginia could result in reductions in industry output of about $1.80**.

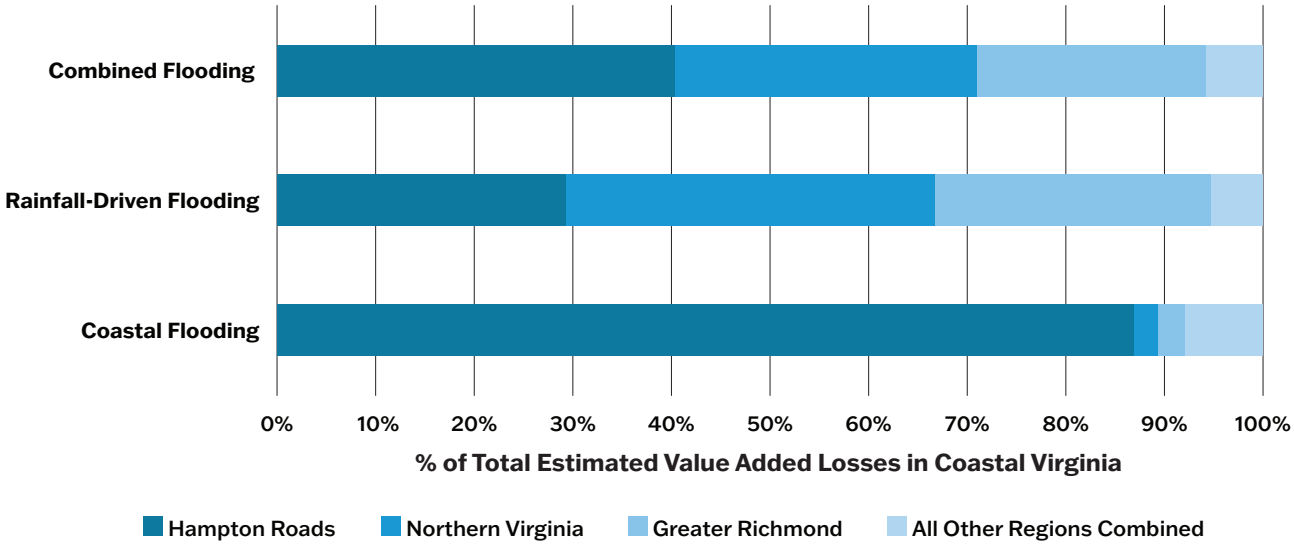
The annualized economic risk of flooding regionwide includes an estimated reduction of approximately $21.8 billion in value added. This is equivalent to nearly 4% of coastal Virginia's GDP, and nearly 3% of the entire Commonwealth's GDP.

Regionwide, the EIA estimated the economic risks from coastal flooding to be significantly lower than those from rainfall-driven flooding. AALs from coastal flooding were about $4 billion, while those from rainfall-driven flooding were more than $17.2 billion. It is important to note that the rainfall-driven flood models on which this analysis is predicated do not model stormwater infrastructure. Therefore, the results serve to underscore the

Estimated Annualized Economic Risks of Flooding in Coastal Virginia



Regional Distribution of Economic Risk from Flooding in Coastal Virginia



value and importance of investing in effective stormwater management to reduce economic impacts from rainfall-driven flooding, particularly in densely developed areas.

In general, the analysis demonstrates that taking no action to address flooding will have negative impacts on the economy. On the other hand, investing in flood mitigation tools that reduce flood impacts to structures and other infrastructure can lower the economic risks from flooding. Every dollar invested in effectively avoiding flood damages can help to avoid subsequent indirect and induced losses in earnings, industry outputs and value added.

Economic risk from flooding is concentrated in three regions of coastal Virginia: Hampton Roads, Northern Virginia, and the Greater Richmond region. This reflects the relative density of these three metro areas, which have larger building stocks than the other regions of coastal Virginia. Risks from coastal flooding are highest in Hampton Roads, which accounts for about 87% of total coastal economic impacts modeled. The economic risks of rainfall-driven flooding are more evenly distributed across the three metro regions, with Hampton Roads accounting for about 29% of the total, Northern Virginia about 38%, and Greater Richmond about 28%.

Another facet of economic risks from flooding are potential impacts on local property tax revenue. If existing developed land areas become uninhabitable or undesirable due to flooding, the resulting loss of property value may translate into a smaller tax base, should growth not occur elsewhere within the locality. This, in turn, can place pressure on local governments' budgets. Local governments seeking to build flood resilience may wish to consider these impacts as part of an overall picture of economic risk.

Economic risks from flooding are significant in coastal Virginia. As governments, private companies and individuals increasingly act to avoid these losses, strategies which effectively address flood resilience challenges provide their own economic opportunities. Industry organizations which remain at the forefront of identifying, adopting, and distributing flood resilience technology are likely to be more resilient to the changing economic conditions in the region in the decades to come.

ECOSYSTEM SERVICES IMPACTS

It is challenging to evaluate the economic value of ecosystem services, as their monetary worth is highly dependent on local factors inherent to the resources and those who rely on them. Traditionally, ecosystem services have not been factored into economic valuations, and direct and indirect impacts to natural resources have not been quantified.

Coastal flooding could have far-reaching impacts on natural resources and ecosystems. These natural resources provide critical ecosystem services which underpin our natural systems, in addition to offering protection and benefits to human wellbeing. Additionally, these natural assets provide financial benefits to the state and local communities in the form natural resources and tourism. Coastal natural infrastructure that generates ecosystem services is threatened by degradation from tidal inundation that could reduce or remove the ability to provide benefits to communities. Forests, coastal wetlands, beaches and dunes are notably vulnerable to these risks.

Recently, significant effort to quantify the benefits provided by natural resources and ecosystems has been undertaken at a variety of scales, ranging from local studies on the Middle Peninsula to nationwide calculators provided by the federal government. For this plan, FEMA's Benefit-Cost Analysis (BCA) guidance was used to estimate ecosystem service benefits and resulting losses in natural land covers and other natural resources due to sea level rise.[41]

Beaches and dunes are one of the most valuable types of natural infrastructure in coastal Virginia, providing ecosystem services that have been quantified as more than $300,000 per acre each year in aesthetic value, recreation and tourism benefits. Beaches and dunes are threatened by tidal inundation. Their loss could translate into the loss of significant benefits for the communities that rely on them. Threats to coastal wetlands and forests could also result in the widespread losses of benefits to communities across the region.

Valuing the Benefits of Living Shorelines in the Middle Peninsula

In 2023, a team at VIMS released novel study findings assigning an economic value to a known ecological benefit of living shorelines: recreational fishing. Data was collected on habitat use and preferences of about 1,500 licensed saltwater anglers located in the Middle Peninsula. The study found that anglers in this geography prefer to fish in coastal marshes and living shorelines due to low effort and high returns. Natural and nature-based features (NNBFs), like marshes and living shorelines, are expected to increase fish populations due to the creation of habitat for both juvenile and adult marine life. As such, the study found that marshes and living shorelines provide $6.42 million in annual benefits from recreational fishing. This study highlights just one of the economic benefits that could increase with the prioritization of NNBFs protection, incentivization, and creation within the Middle Peninsula. The VIMS team has created a shoreline restoration benefit tool (SHORE-BET) that calculates the economic value of the benefits Virginia coastal communities receive from existing marshes and restoring marshes with living shorelines techniques.[42]

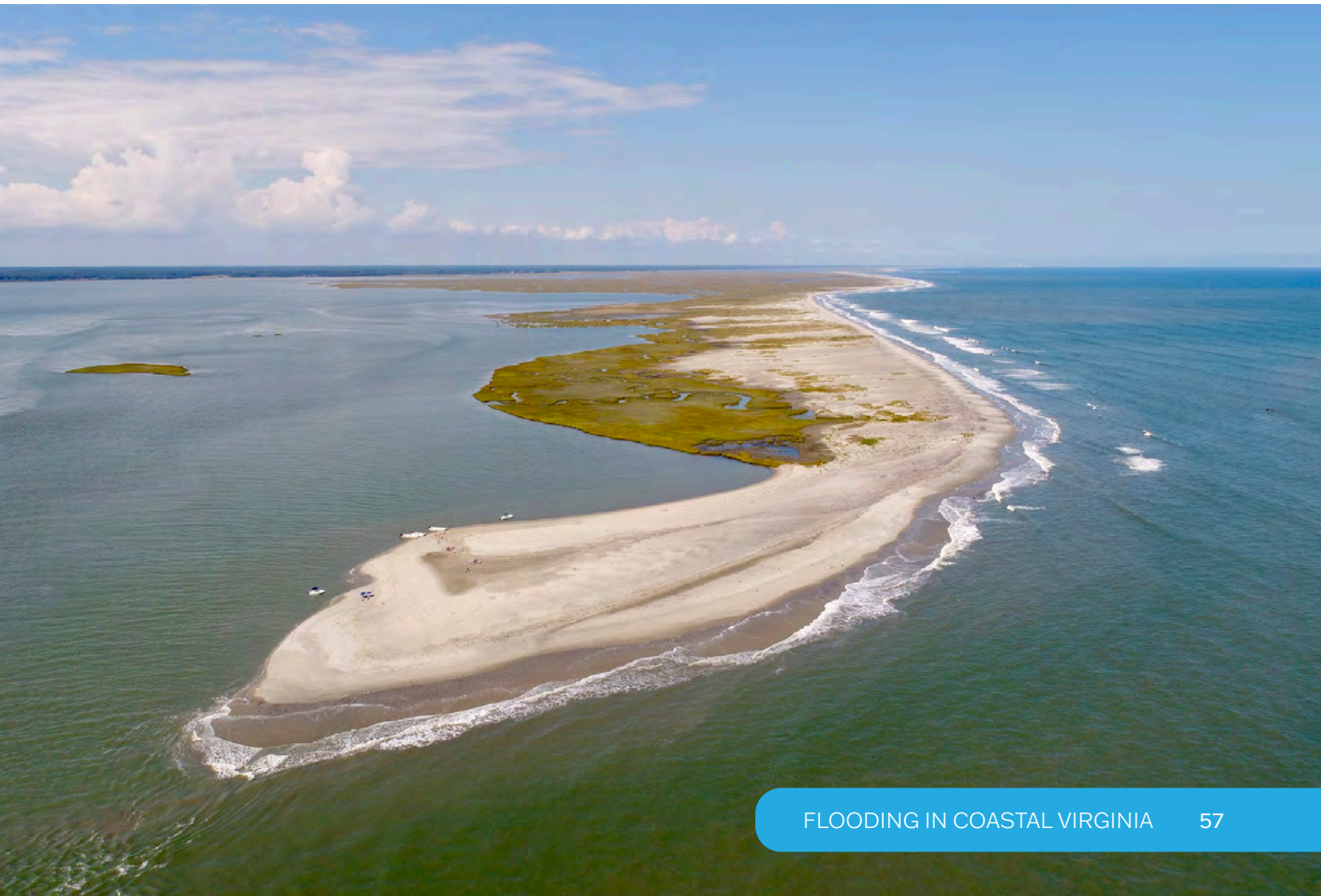
This study is an example of another approach to valuing ecosystem services which can be deployed to quantify impacts of flooding and sea level rise in coastal Virginia.

Additional Land Cover Ecosystem Services Benefits Threatened by Tidal Inundation (MHW) between the Baseline and Near Future Moderate Scenarios

Land Cover Type	Ecosystem Service Rate (2021 USD/Acre/Yr)	Acreage of Additional Tidal Inundation (MHW)	Ecosystem Service Benefit of Tidally Inundated Area
Forest	$ 12,589	23,000	$ 289,547,000
Urban Green Open Space	$ 15,541	1,500	$ 23,311,500
Rural Green Open Space	$ 10,632	4,000	$ 42,528,000
Inland Wetland	$ 8,171	4,800	$ 39,220,800
Coastal Wetland	$ 8,955	73,000	$ 653,715,000
Grand Total		**106,300**	**$ 1,048,322,300**

Additional Beaches and Dunes Ecosystem Services Benefits Threatened by Tidal Inundation (MLW) between the Baseline and Near Future Moderate Planning Scenarios

Ecosystem Service Rate (USD/Acre/Yr)	Total Acreage of Tidal Inundation (MLW)	Ecosystem Service Benefit of Tidally Inundated Area
$300,649	700	$ 210,454,300



CHAPTER 3

ADVANCING FLOOD RESILIENCE

Governments and stakeholders throughout coastal Virginia are acting to mitigate flood hazards and their impacts. However, further action is needed to ensure that communities build resilience to the growing threats of flooding through protection, adaptation, and relocation strategies. This chapter summarizes resilience actions that are underway across coastal Virginia, identifies funding needs and strategies for financing flood resilience, and highlights opportunities to advance flood resilience in the coming years. It also includes priority recommendations of the Coastal Resilience Technical Advisory Committee.

Projects and Initiatives Inventory

This section provides an overview of the flood resilience projects and initiatives that have been recorded across coastal Virginia. The projects range from historic investments to address coastal flood risk in Norfolk, to stormwater infrastructure upgrades that better manage increasing precipitation intensity in Alexandria. Initiatives such as local flood resilience plans shine a spotlight on vulnerable community assets, while updated design standards ensure that new infrastructure projects are ready to face changing flood conditions head-on.

BACKGROUND

During development of the Phase I CRMP, the planning team collaborated with local governments and PDCs to collect data on their ongoing actions to build flood resilience. This effort resulted in the creation of an inventory of flood resilience actions for coastal Virginia. The inventory was housed in the CRWE and became the only state database dedicated to compiling information on flood resilience projects and initiatives across the entirety of coastal Virginia.

In developing this plan update, the planning team refined and expanded the existing inventory through stakeholder engagement efforts. The inventory is presented in the updated CRWE and was upgraded to allow action owners to submit new projects and initiatives—or update existing ones—at any time. The inventory is now dynamic, evolving as projects and initiatives advance.

This Phase II plan includes more than 520 new or updated projects and initiatives identified since the release of Phase I, reflecting both broader participation in the inventory's development and an increase in flood resilience actions in coastal Virginia. Most new entries were collected between April and July 2024. Throughout the plan, information about projects and initiatives is presented using data available via the inventory as of July 2024. Effective planning for flood resilience projects and initiatives benefits from a more comprehensive understanding of estimated costs and the alignment of funding to advance efforts. Where available, cost data is presented to highlight current investments and identify where additional funding could potentially help reduce flood risk.

Important Limitations

The inventory presented in this plan is neither comprehensive, nor should it be considered as a "needs assessment." The data on flood resilience actions presented in this plan is sourced from the CRWE projects and initiatives inventory. The inventory was developed via the voluntary submission of projects and initiatives data by stakeholders across coastal Virginia. Entries were typically submitted by the project or initiative owner. DCR reviewed submissions received for completeness, but not for accuracy or efficacy. Additionally, DCR did not prioritize the projects and initiatives received. Inclusion of a project or initiative in the inventory is not an endorsement of the action by DCR or the Commonwealth.

In response to DCR's call for projects and initiatives, some stakeholders provided only partial data. Importantly, approximately 10% of reported projects and 30% of reported initiatives do not include cost data. Therefore, the inventory likely underestimates the cost of implementing reported actions. Other stakeholders elected not to submit any actions due to limited staff capacity and resources. As a result, this list does not capture all flood resilience projects and initiatives in coastal Virginia.

Finally, the scope and scale of actions submitted vary significantly across coastal Virginia. For example, in some cases, a single project encompasses similar interventions on many distinct sites, while in others, a project consists of a discrete infrastructure enhancement.

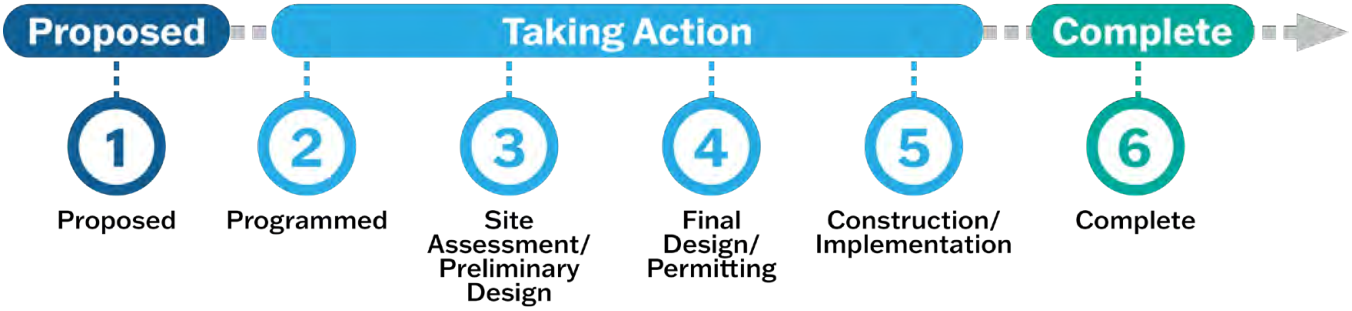
Even with these limitations, the inventory and the trends it reveals allow DCR and other stakeholders to better identify data and information gaps, direct capacity building support to areas in need, support resiliency coordination and knowledge sharing, and aid in project identification and resource allocation.

The inventory contains projects and initiatives in various phases of development and implementation. For projects, the inventory contains owner-submitted information about the phase, ranging from proposed to complete. Project phases are presented using three categories: proposed, taking action, and complete. Initiative entries do not have a phase and therefore include efforts ranging from those which are planned to those which have concluded. Many projects in the proposed phase of development do not yet have identified funding sources. Where necessary to reflect the status of efforts underway more accurately, the projects data analysis presented in this plan focuses on projects in the taking action and complete phases. However, all projects submitted can be viewed in the Coastal Resilience Web Explorer.

Proposed projects have been identified through a formal planning process for future progression by the project owner. Funding for project completion is typically not guaranteed. However, all projects submitted can be viewed in the Coastal Resilience Web Explorer.

Taking action includes projects that are programmed in a budget, undergoing site assessment and preliminary design, construction and implementation, or final design and permitting. These projects are assumed to be funded in part or in full.

Project Phases



Projects are flood resilience activities that will lead to a place-based reduction of flood risk to people, property, or the environment through physical protection, adaptation, or avoidance measures. Project phases can include site assessments, conceptual or preliminary designs, permitting, final design and construction. Where possible, project should incorporate natural and nature-based approaches.

Initiatives give regions and localities the tools they need to efficiently and effectively understand their risks and take concrete actions to protect their residents and assets from the threats posed by coastal hazards. Initiatives include studies, data tools, programs, plans, policies, and technical assistance.

COASTAL VIRGINIA STAKEHOLDERS ARE TAKING ACTION

Flood resilience stakeholders—and particularly local governments—are developing and implementing actions to address the challenge of flooding. There are nearly 950 projects and initiatives in the inventory, over 80% of which are owned by local governments.

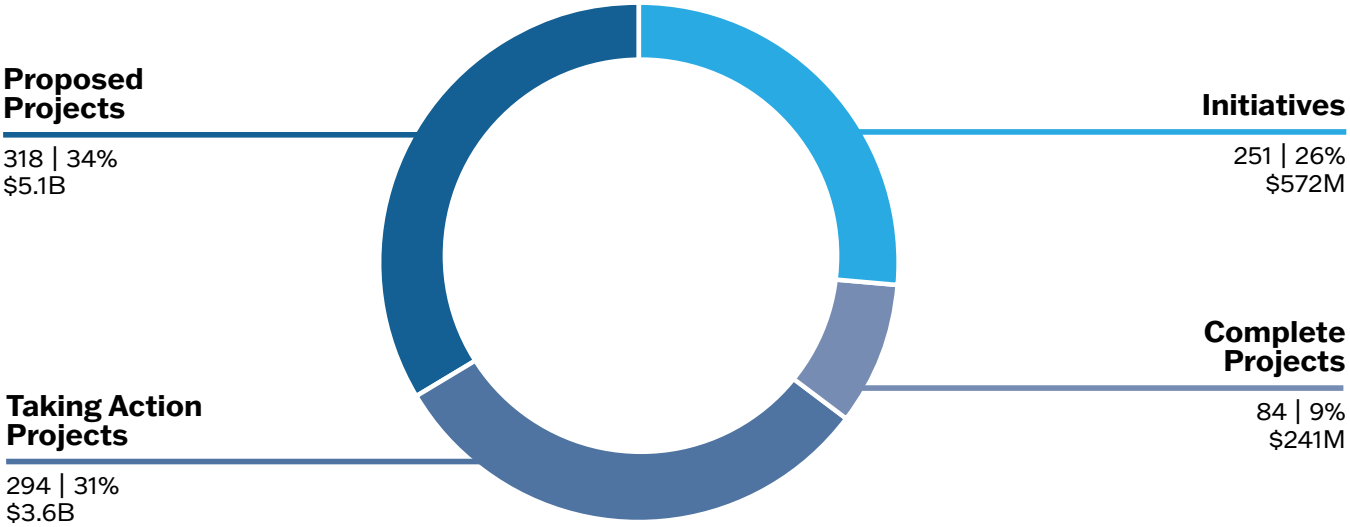
On average, projects are about 17 times more costly than initiatives. This result is not surprising due to the nature of these different actions. Initiatives are often policies or studies and costs are primarily driven by labor. Capital projects involve physical construction and material costs in addition to labor.

The number and cost of actions vary by region. In general, areas of high investment correlate with more resourced local and regional governments. This likely reflects both lower capacity to develop and implement actions, as well as lower capacity to respond to DCR's data call to develop the inventory in lower resourced areas.

The Hampton Roads region accounts for more than 55% of the total inventory by number and 75% by cost. Submissions from Hampton, Virginia Beach, and Norfolk—which have relatively high levels of resources and capacity—comprise the majority of Hampton Roads' effort. The level of investment occurring in Hampton Roads correlates with levels of flood risk. In the baseline scenario, the Hampton Roads region has the second highest exposure to major coastal flooding, the highest exposure to major rainfall-driven flooding, and the second highest exposure to major riverine flooding. Meanwhile, the Northern Neck, Crater, and George Washington regions have relatively few actions and collectively less than 1% of all inventoried costs.

In addition to projects and initiatives located within a single region, there are 19 initiatives and three projects that span multiple regions in coastal Virginia. These regionwide actions are led primarily by state agencies, including the Virginia Department of Transportation, Virginia DEQ's Coastal Zone Management Program, and the Virginia Marine Resources Commission. Other actions are led by non-profit organizations. Some of these initiatives increase collaboration within major watersheds, creating important forums for coordination across PDC and locality boundaries. Expanding inter-regional collaboration across coastal Virginia is an opportunity to harness co-benefits across jurisdictional boundaries. Additionally, the engagement of state agencies and regionwide actors in submitting actions was low compared to local governments and PDCs. Future efforts should focus on understanding existing regional collaboration and exploring new opportunities for working together.

Breakdown of Projects and Initiatives



Total and Average Implementation Cost of Projects and Initiatives

Implementation Cost	Project	Initiative
Total	$3,871,532,802	$571,987,352
Average	$3,723,808	$324,343
Maximum	$510,439,000	$200,000,000
Minimum	$558	$5,000

Table includes only projects in the taking action or completed phases. Calculation of averages excludes the top and bottom 10% of costs to avoid skewing values due to abnormally high and low project costs. 5% of all projects are missing cost data are excluded from calculations. Projects and Initiatives without a cost were excluded from the minimum.

Initiatives

The inventory catalogs more than 250 initiatives across coastal Virginia. These initiatives include plans, studies, policies, programs, data collection, education, financial assistance, and resource assistance.

Since 2022, studies have been the most frequently documented type of initiative, suggesting that many localities are working to understand their vulnerabilities. Resilience planning and education is the second most documented initiative type. Across the region, 26 cities and counties and seven PDCs submitted initiatives related to developing flood resilience plans.

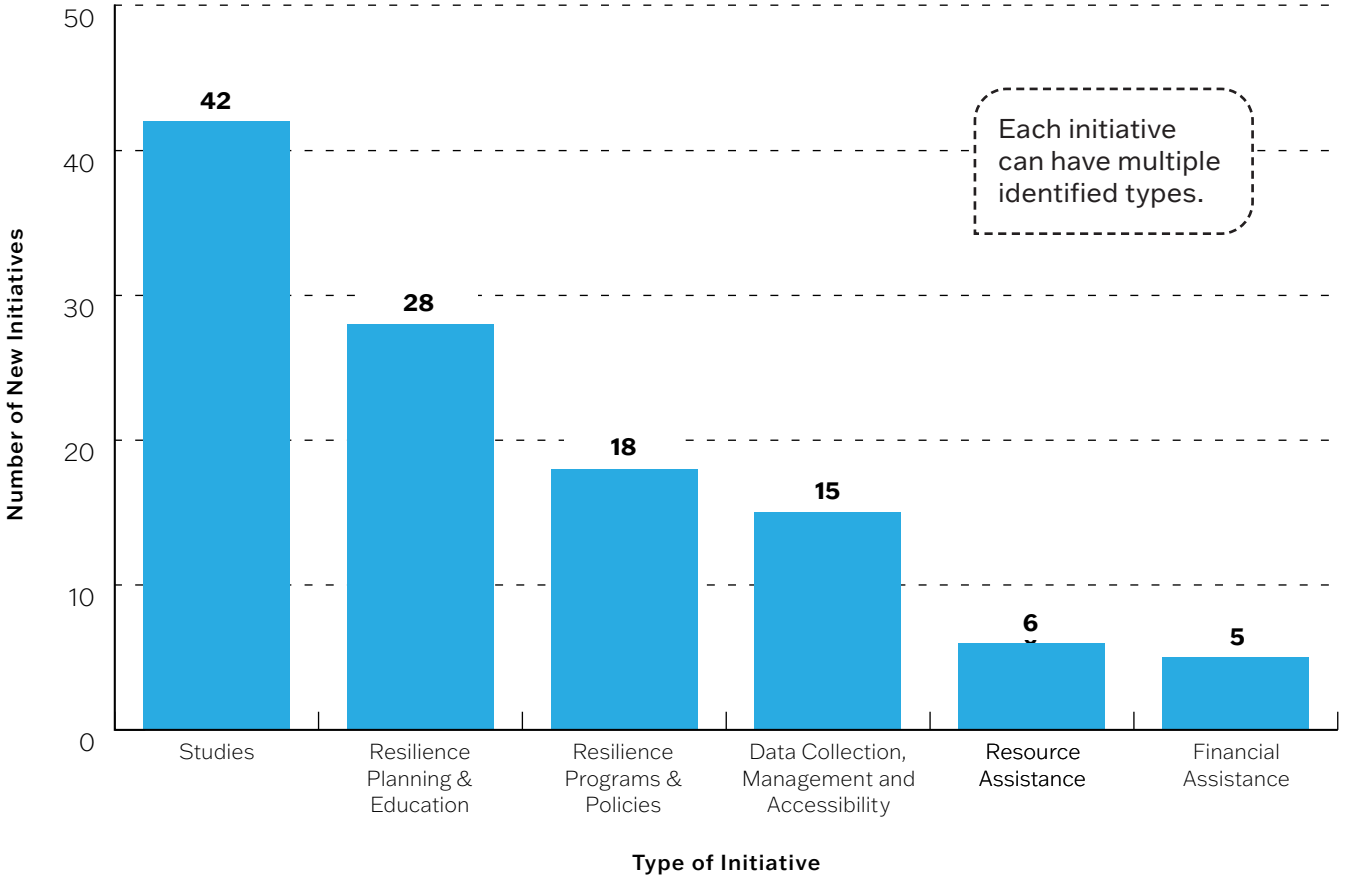
The initiatives inventoried serve various purposes, ranging from building organizational funding capacity to supporting ecosystem resilience. More than half of all initiatives address actions related to community resilience, planning capacity, and/or adaptation options.

- **Community resilience initiatives** increase a community's capability to prepare for, respond to, and recover from a hazardous event. For example, the George Washington Regional Commission is engaging and educating developers and realtors on sustainable and resilient development.
- **Planning capacity initiatives** improve a community's capacity to engage in coastal adaptation and resilience planning efforts. For example, the Nansemond Indian Nation is expanding internal capacity for climate data gathering and analysis.
- **Adaptation options initiatives** establish a community's options to increase resilience and adapt to future coastal hazards. For example, the City of Richmond is developing resilience design guidelines to incorporate climate change impacts and convey the benefits of adaptive and resilient buildings.

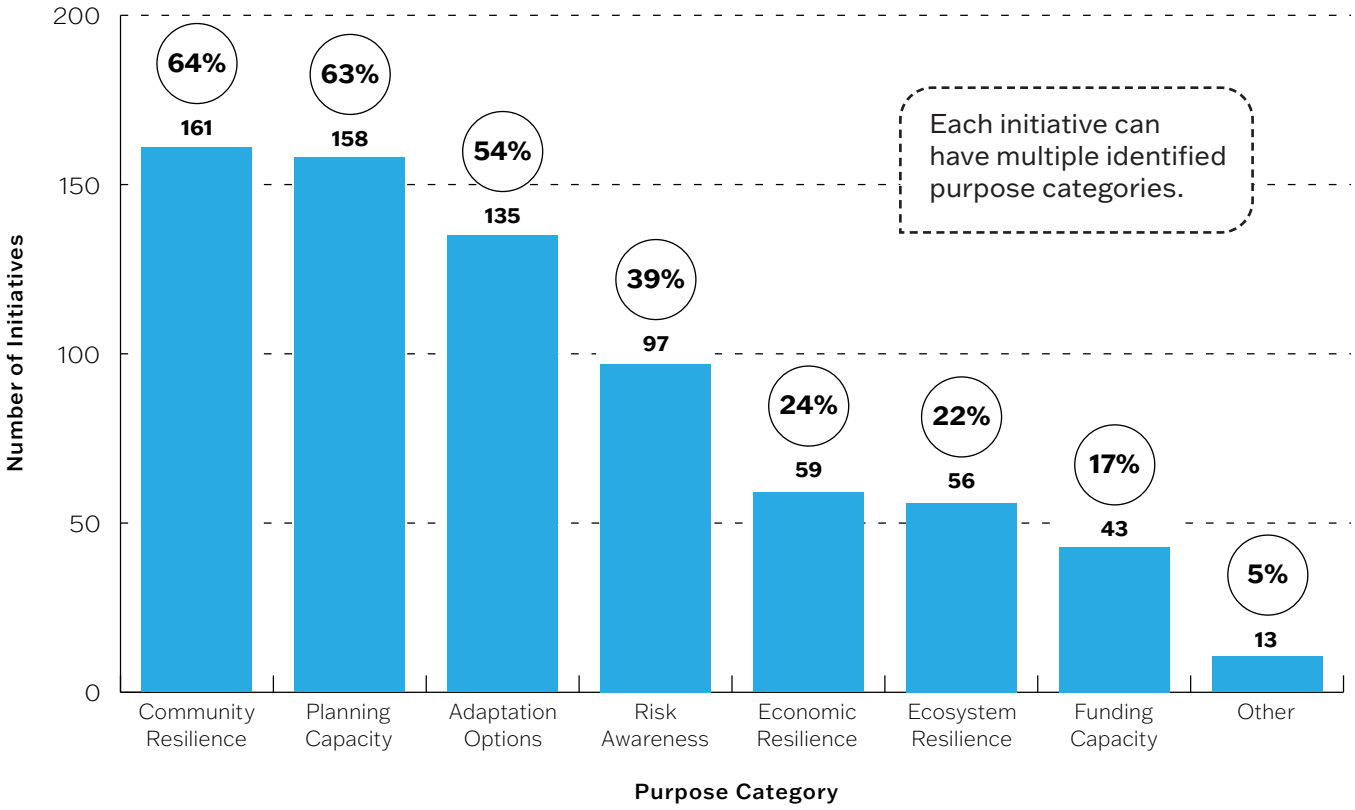
Relatively few initiatives in the inventory are intended to develop an organization's capacity to acquire funding for flood resilience efforts. During stakeholder engagement, local governments stated that funding—and the capacity to acquire funding—is one of the most prevalent challenges to advancing flood resilience efforts. Although many organizations have experience securing state and federal grant funding for flood resilience activities, insufficient staff capacity and technical expertise as well as local match requirements are cited as barriers to accessing grant funding. This is particularly true for smaller or less resourced local governments.

Additionally, very few local governments report experience with, or intentions to, secure non-grant funding for flood resilience efforts. Although historic levels of grant funding were made available from both federal and state sources in recent years, additional funding would be required to complete all inventoried projects and initiatives. Alternative financing mechanisms will be needed to support flood resilience action in the long-term. Initiatives that build local governments' capacity to secure funding and financing are currently an important unmet need.

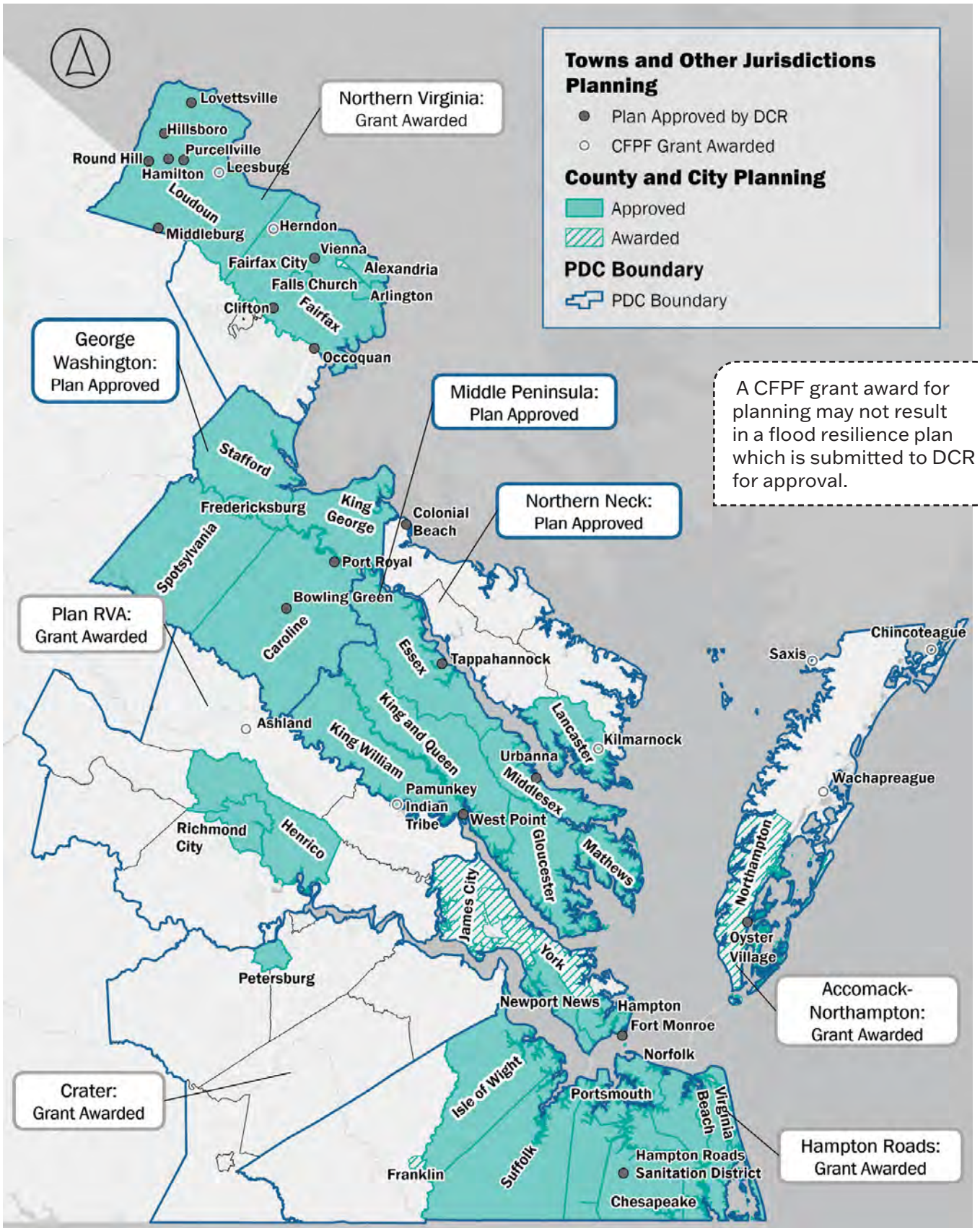
Initiative Classifications since 2022



Initiatives by Purpose



DCR-Approved Flood Resilience Plans and CFPF Awards for Planning to Areas without a DCR-Approved Plan through Round 6 (2025)



Status of Flood Resilience Planning in Coastal Virginia

DCR incentivizes local governments to conduct flood resilience planning through its Community Flood Preparedness Fund (CFPF) program. Only local governments with a flood resilience plan approved by DCR are eligible to receive project funding through the CFPF. Across coastal Virginia, there are nearly 40 DCR-approved flood resilience plans. In addition, CFPF funding has been awarded for 18 more flood resilience planning efforts for towns, cities, counties, and tribal communities in coastal Virginia.

RAFT Program Engagement

The Resilience Adaptation Feasibility Tool (RAFT) is an 18-month facilitated process that assists localities and sovereign Tribal nations to engage in resilience planning and action, while supporting their local economies and community social structures. The RAFT process consists of three parts: an assessment of the community's existing level of resilience through a quantitative scorecard and qualitative interviews and focus groups, development of a community-defined resilience action checklist, and technical assistance to implement the identified checklist items over the course of a year. The scorecard assessment incorporates factors such as policy, risk assessment, infrastructure resilience, planning and community engagement, health and well-being.

The RAFT is led by a team of experts from the University of Virginia's Institute for Engagement & Negotiation, Old Dominion University's Institute for Coastal Adaptation and Resilience, Virginia Tech's Coastal Collaborator, and is supported by a variety of partners across the Commonwealth. To date, it has brought capacity building support to more than 29 localities across coastal Virginia, spanning the Eastern Shore, Middle Peninsula, Northern Neck, Crater, and Hampton Roads regions as well as Southwest Virginia. The program has also partnered with the Upper Mattaponi Indian Tribe and the Mattaponi Indian Tribe and Reservation. It is currently working with the Rappahannock Indian Tribe and Nansemond Indian Nation.

Through the years, The RAFT process helped participating communities translate resilience planning into action. For each participating community, The RAFT created a detailed, customized "opportunity list" for improving resilience to climate change, and supported the implementation of resilience priorities for each locality. In total, the program has supported nearly 150 resilience-building opportunities. Those localities that remain actively engaged during and after the process benefit the most. Participating communities have increased their resilience in numerous ways, including through a Small Business Preparedness Planning tool, draft ordinances, customized risk maps, green infrastructure plans, nature-based plans, and educational and training workshops. In addition, many participants indicated that increased resilience literacy and communication with community service organizations is an important benefit of the program.

Projects

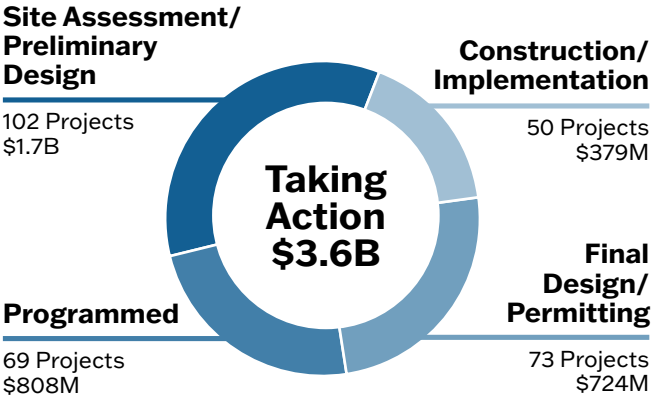
There are nearly 700 projects inventoried across coastal Virginia. Twelve percent of all projects in the inventory—84 projects—have been completed at a total cost of more than $240 million. More than 294 of the projects in the inventory (42%) are in taking action phases.

Projects are located in each region of coastal Virginia. However, most are in the Hampton Roads, Greater Richmond, and Northern Virginia regions. Overall, the Hampton Roads region has the most identified projects, accounting for more than 75% of the total documented costs. In Hampton Roads, project owners have already invested $222 million in complete projects, while projects in the taking action phase are estimated to cost about $2.9 billion. Most of the region's projects are owned by Virginia Beach, Hampton, and Norfolk.

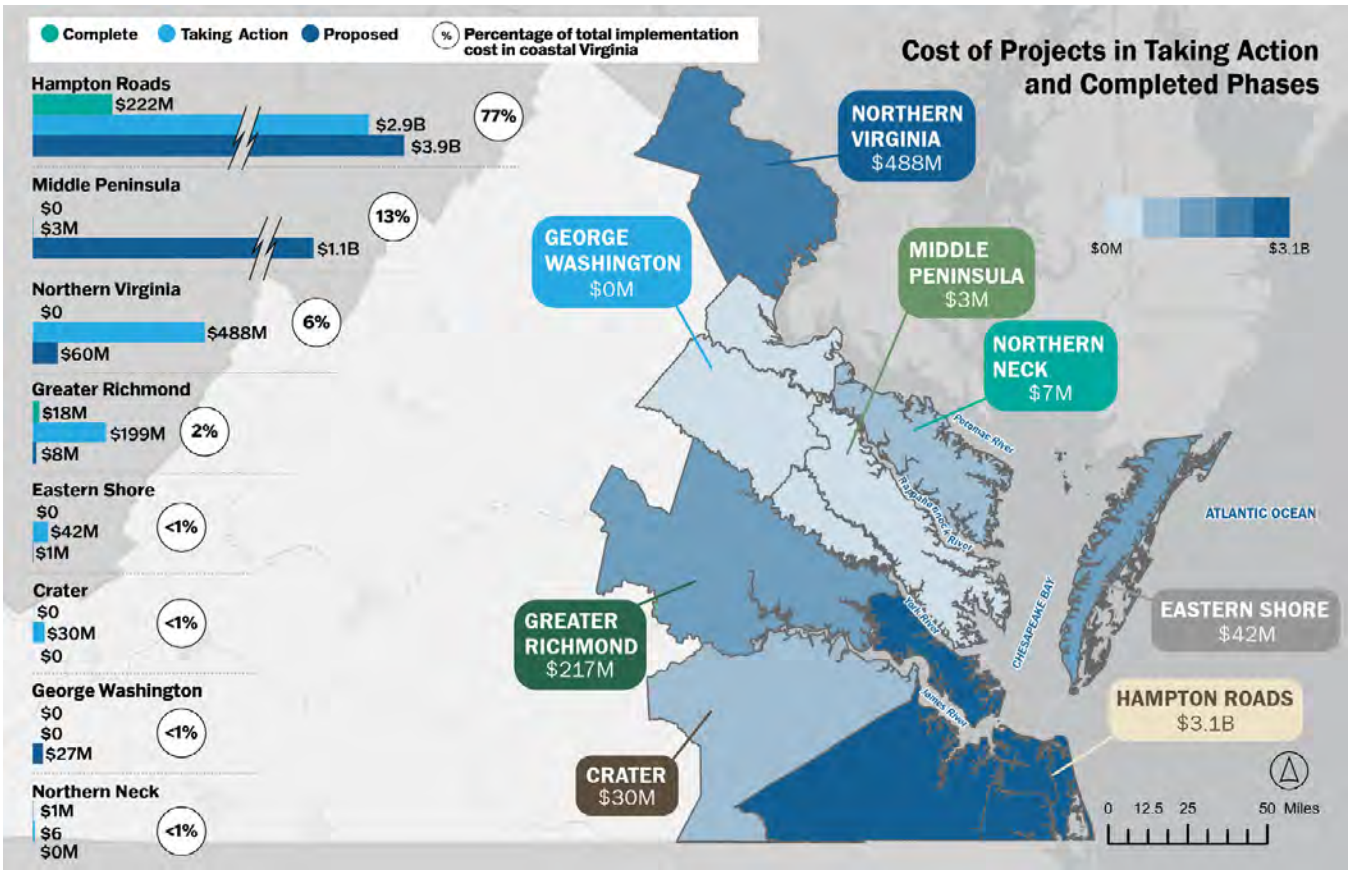
The George Washington, Crater, Northern Neck, and Eastern Shore regions have the fewest identified projects, collectively representing less than 1% of the total. These regions all have exposure to flooding as discussed in Chapter 2. The regions with the fewest identified projects and lowest costs correlate with the localities and PDCs with reported capacity constraints. This presents an opportunity to further engage with these communities to understand their priorities and opportunities.

Implementation Costs of Projects

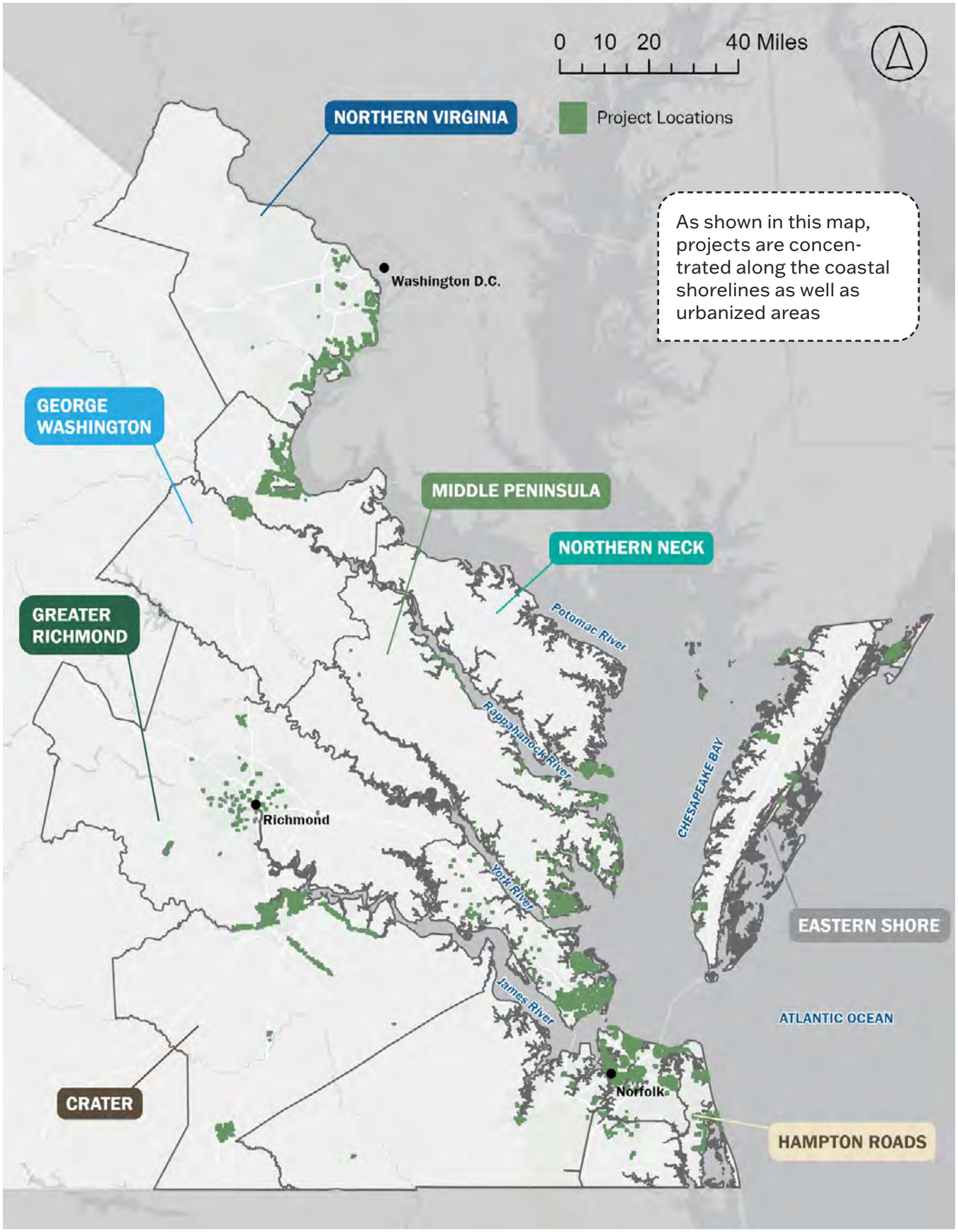
Proposed $5.1 B | **Complete $241 M**



Inventoried Project Costs by Region



Inventoried Project Locations



USACE Coastal Storm Risk Management

The USACE CSRM program was created to manage the risk of flood and storm damage to coastal communities. The program focuses on increasing resilience and managing storm damage risks through providing support and technical expertise from planning to implementation for activities including building and maintaining structural projects, implementing nature-based approaches, and providing technical assistance. This program can provide important resources and support to communities to address the growing challenges of coastal flooding.

CSRM activities can be conducted through different USACE programs, depending on the scale of the problem. Studies addressing smaller, more discrete challenges can generally be conducted through the Continuing Authorities Program (CAP) without additional congressional authority. Larger feasibility studies require specific congressional authority and require authorization through the Water Resources Development Act (WRDA) and funding by congressional appropriation bills.

All feasibility studies and projects require a local request and a non-federal sponsor that can participate in cost-sharing agreements with USACE, for example, a city government. The complete process for project development spans three phases: feasibility study, pre-construction engineering and design, and construction. The first step in the process is for a non-federal sponsor to submit a request for support.

In coastal Virginia, four CSRM efforts are underway.

Norfolk Feasibility Study and Project: USACE Norfolk completed the feasibility study in 2019 for the City of Norfolk. The study identified structural measures and nature-based features along with property-specific nonstructural measures that will manage the risk of coastal flooding and damages from storm events. The project is estimated to cost more than $6 billion to complete. Norfolk received $399 million from the Bipartisan Infrastructure Law of 2021 to design and construct features identified in the study, such as storm surge barriers, levees, and stormwater pump stations. The project will also replace Norfolk's downtown floodwall and support privately owned property mitigation efforts.

Metropolitan Washington, D.C. Study: Led by USACE Baltimore, the feasibility study was completed in June 2024. The study resulted in an authorization request for risk reduction features for critical infrastructure, including the Arlington County Water Pollution Control Plant.

Virginia Beach Study: Led by USACE Norfolk, this effort was initiated in July 2022 and is currently in the feasibility study phase.

Peninsula Regional Study: Led by USACE Norfolk, this effort was initiated in July 2024 and is currently in the feasibility study phase.

TYPES OF PROJECTS IMPLEMENTED

Flood resilience projects are classified into three categories in the inventory:

- **Structural projects** encompass engineered flood risk reduction measures such as floodwalls, pump stations, and drainage improvements.
- **Natural or nature-based projects** use environmental processes and natural systems (or simulated natural systems) such as barrier islands and living shorelines to reduce the impacts of flood and storm events.
- **Hybrid projects** incorporate project features of both structural projects and natural or nature-based projects.

When a project does not fit into any of these three classes, it is classified as "**other**."

For projects in the taking action and complete phases, structural improvements to public facilities and infrastructure are by far the most common type across the region by count. Specifically, this includes drainage improvements, road elevations, bridge elevations, and utility retrofits and upgrades. Compared to other classes, structural projects are generally reported to be less costly. In contrast, hybrid projects make up the largest percentage of total cost while comprising a comparatively small number of projects. Hybrid projects are typically multi-faceted in nature which likely contributes to higher costs.

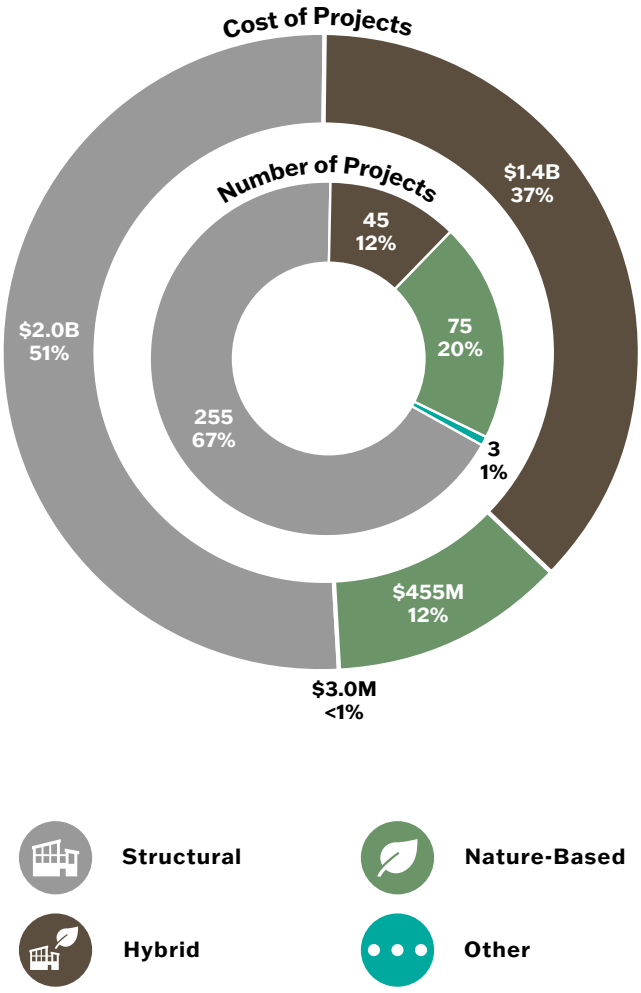
Approaches to Addressing Flood Hazards

Flood resilience projects are designed to address multiple types of flooding and related hazards, including stormwater flooding, coastal flooding (tidal flooding and/or storm surge flooding), riverine flooding, shoreline erosion, and groundwater impacts. "Other" projects include projects like mitigating flood risk from dam failure and minimizing the effects of power outages.

Stormwater flooding is the hazard most addressed by projects in the inventory. More than two-thirds of all projects identified stormwater flooding as one of the hazards addressed by the project. This reflects this plan's finding explored in Chapter 2, Flooding in Coastal Virginia, that rainfall-driven flooding is the most common flood challenge in coastal Virginia. Of these projects, roughly three-quarters are structural improvements to drainage infrastructure, such as upsizing pipes, culverts, and manholes. This is consistent with existing design and regulatory guidance that influences stormwater management practices.

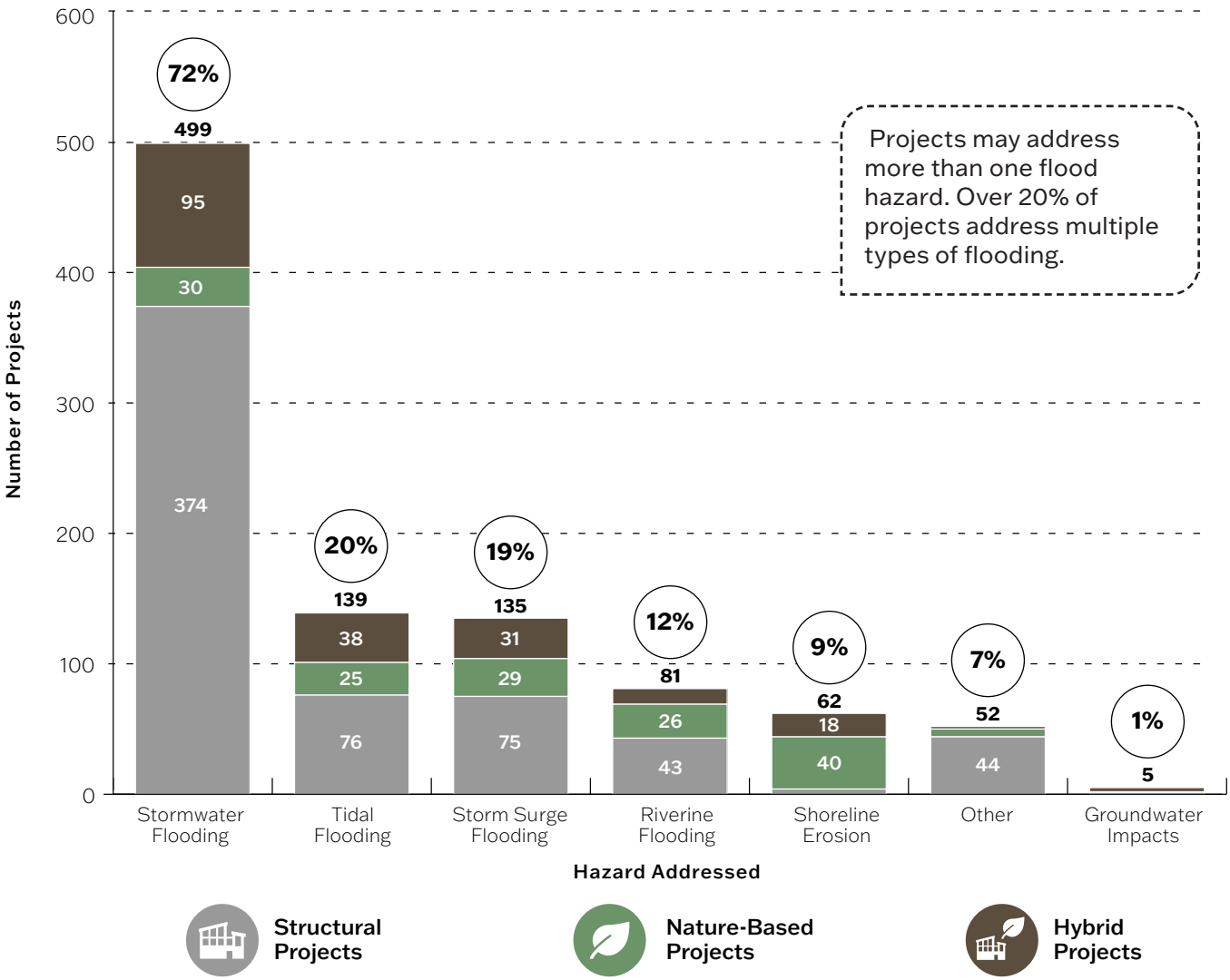
The second most common flood hazard addressed is coastal flooding, representing about 40% of the projects. Most of these projects are designed to address both tidal flooding and storm surge. Structural projects such as elevating coastal structures, installing tide check valves, and constructing sluice gates are common.

Project Class and Share of Cost



This graph includes only projects in the taking action or completed phases.

Flood Resilience Projects by Hazard Addressed



Hybrid Projects to Address Stormwater Flooding

Some actors in coastal Virginia are using hybrid infrastructure to address storm-water flooding challenges. For example, the City of Hampton's proposed Downtown Waterfront Management District project would identify hybrid stormwater storage solutions for the urban area utilizing streets, parking lots, rights-of-way, and city-owned parcels. Identified strategies include blue/green streets, sub-surface storage, pervious pavement, and silva cells.

The inventory reveals that there is likely opportunity for continued investment in nature-based and hybrid solutions to address shoreline erosion across the region. Currently, less than 10% of all projects in the inventory address shoreline erosion. Of these projects, most use nature-based or hybrid solutions. This reflects the increasing emphasis on living shorelines, a nature-based solution to address shoreline erosion, which is encouraged by state policy. Since living shorelines became the preferred alternative for stabilizing tidal shorelines in the Commonwealth in 2021, the number of living shorelines in the project inventory has increased from 15 to 25. Living shorelines help protect tidal marshes and prevent loss of ecosystem service value while stabilizing shorelines, creating habitats, improving water quality, storing carbon, and creating recreational value. Additionally, living shorelines have the potential to naturally migrate with sea level rise.

For all hazard types other than shoreline erosion, structural solutions are used more than nature-based or hybrid solutions. In some cases, structural approaches are the most appropriate flood resilience solution. In other cases, several factors might contribute to this finding. For example, stormwater engineering staff, who are often responsible for traditional drainage infrastructure, may have been more likely than other local government staff to respond to the project and initiative data request. Another factor may be that structural projects generally serve smaller geographic areas than natural or hybrid projects. Additional investigation is needed to understand these factors.

Nevertheless, the inventory indicates that traditional approaches to flood resilience using hardened infrastructure are favored regionwide. Although natural and nature-based projects cannot replace the need for structural projects in all cases, incorporating their approaches where possible can offer benefits beyond flood risk reduction. These benefits can include improved water and air quality, restored or enhanced natural habitats, added recreational spaces, and increased property values.

Incorporating Climate Scenarios into Project Design

Although about a third of projects inventoried use flood scenarios consistent with the Phase I CRMP for project design, more than 45% do not use any climate scenarios to forecast future flood impacts. The Eastern Shore is the region most frequently incorporating climate scenarios into their projects. There, all 24 projects use forward-looking flood hazard data. In some cases, efforts to address current flood risks may not sufficiently address how those risks will change in future decades. Over 60% of projects addressing riverine flooding, over 50% of projects addressing shoreline erosion, and over 40% of projects addressing stormwater flooding do not use any climate scenarios. Moving forward, project owners should consider using forward-looking data in their designs to successfully mitigate the impacts of low-probability, high-risk events, and to enhance long-term sustainability and safety.

Addressing Water Quality and Quantity

Additional analysis of descriptions in the inventory reveals that improving water quality is important to project implementers. This suggests that local governments and other stakeholders seek to attain water quality co-benefits from projects, in addition to addressing flooding. Most of coastal Virginia is in the Chesapeake Bay watershed, and the region is subject to the Watershed Implementation Plan goals for water quality improvement contributions to reach the EPA's "pollution diet." Some flood resilience projects—particularly those addressing stormwater flooding—can help meet these goals by reducing and cleaning stormwater runoff before it reaches waterbodies.

Opportunities to Advance Projects and Initiatives

Findings from the submissions to the inventory, in addition to results from stakeholder engagement conducted for this plan, illustrate numerous opportunities to enhance flood resilience. By addressing key gaps and leveraging these opportunities, the Commonwealth can develop a more strategic approach to flood resilience implementation and funding.

INCREASE REGIONWIDE COORDINATION FOR FLOOD RESILIENCE

Flooding stretches across jurisdictional boundaries and infrastructure systems. As a result, regional coordination is important to enhance flood resilience. The state government can play an important role in supporting this coordination. DCR is the Commonwealth's lead coordinating agency for flood resilience, while the Chief

Resilience Officer (CRO) is responsible for coordinating all-hazards resilience. As the CRO position and structure is further established in the coming years, DCR and the CRO can work together to advance the following coordination opportunities.

Continue to build and maintain the projects and initiatives inventory

DCR and CRO will encourage and support additional actors to provide inputs to the inventory. This includes conducting outreach, engagement and technical assistance to localities who were unable to participate in prior data calls. It also includes promoting the CRWE with state agencies and other stakeholders addressing flood resilience at regional scales. Additionally, DCR will conduct periodic data calls to all project and initiative owners to ensure that the inventory remains up to date.

Use the inventory to identify partnership opportunities

DCR and CRO will identify existing projects and initiatives related to newly identified needs and consider opportunities to coordinate between implementers. Opportunities might exist for geographically adjacent projects, or initiatives with similar goals and scales. Increasing collaboration can reduce project costs, lower demands on staff resources, reduce potential conflict or redundancy, and provide access to advanced technical assistance and expertise. This includes identifying partnerships for interjurisdictional planning. Coordinating plans across jurisdictions with shared flood risks can further help minimize impacts by identifying vulnerable areas across political boundaries, unifying zoning and land use policies across shared watersheds, preserving shared natural infrastructure, and coordinating emergency response and recovery. By coordinating efforts, planning teams can develop plans they otherwise would not have capacity to create, making them eligible for additional funding streams.

Share experience and technical expertise across coastal Virginia

While many PDCs coordinate regularly within their regions, there are fewer interregional forums for developing collective solutions and sharing knowledge for flood resilience. The DEQ Coastal Policy Team is one such forum that has focused on resilience topics in recent years. Continuing to invest in this and other forums may prove fruitful.

Many technical experts—such as universities, state agencies, federal government actors, and non-profit organizations—are already working together with local governments and tribal governments to address flood challenges. Additional partnerships that address gaps identified in this plan could help to further build staff capacity.

Flood Resilience Design Guidelines and Policy Toolkits

Numerous government entities in coastal Virginia, including the Hampton Roads PDC, the City of Newport News, VDOT, the City of Richmond, Arlington County, the City of Virginia Beach, and the Northern Virginia Regional Commission have adopted or are developing flood resilience design guidelines or updating existing standards to incorporate climate change projections into infrastructure design. These organizations may benefit from coordination and knowledge sharing to learn from the overall successes and challenges in adopting and implementing similar design guidelines. As these guidelines continue to evolve, regionwide application and coordination should be considered to leverage completed work, establish a more predictable environment for developers and contractors, create a more cohesive infrastructure system, and minimize costs.

York River State Park Living Shoreline

With this project, the Virginia Department of Transportation (VDOT) and the Department of Conservation and Recreation (DCR) collaborated to address shoreline erosion and improve water quality in the Chesapeake Bay Watershed. VDOT identified living shorelines as a cost-effective solution to meet water quality requirements for it's Municipal Separate Storm Sewer System (MS4) permit but lacked suitable properties, while various DCR State Parks were experiencing eroding shorelines and insufficient funding to address the issues. The two agencies partnered to review state park shorelines and selected York River State Park for a phased living shoreline project.

This project included breakwaters, beach nourishment, marsh restoration, and bank stabilization, resulting in habitat restoration and significant anticipated sediment reductions that can be credited towards VDOT's MS4 permit requirements. The collaboration between two agencies effectively combined VDOT's funding with DCR's shoreline needs to address the challenge of erosion and achieve water quality improvement goals.

BUILD LOCAL FUNDING AND FINANCING CAPACITY

The Commonwealth and other flood resilience stakeholders can help to advance projects and initiatives by assisting local governments and other local actors to build capacity to fund and finance flood resilience. When surveyed to ask what the Commonwealth could do to help address funding barriers, the plan's primary end-users suggested the following approaches would be most effective:

- Offer training to enhance staff capacity
- Share best practices and case studies
- Provide direct technical assistance
- Support resource sharing

Some tools already exist to build this capacity. For example, DCR updated the inventory of funding opportunities in the CRWE for this plan. These existing tools and resources could be more widely promoted to support their use.

INCORPORATE MORE NATURE-BASED PROJECT APPROACHES WHERE APPROPRIATE

Flood resilience actors working across coastal Virginia can help build the region's resilience by further investigating why local governments and other project owners implement relatively few hybrid and nature-based projects when compared to structural projects. This may reveal more specific opportunities to encourage uptake, such as revising policies, providing technical support and guidance, developing design standards, and establishing contract specifications for construction.

Barriers might include:

- Low acceptance of innovative nature-based solutions by permitting agencies
- Higher upfront investments of time and resources in practices that are relatively unfamiliar to project implementers
- In general, existing standards, policies, and project prioritization structures favor traditional structural projects
- Nature-based approaches generally provide limited protection against the largest storm surge events.

Water quality improvements are one important co-benefit offered by many nature-based flood resilience projects. Given that enhancing the water quality of the Chesapeake Bay is a priority across much of the region, decision makers should consider opportunities to align flood mitigation and water quality objectives to further encourage and support uptake of nature-based approaches.

CONSIDER FUTURE CONDITIONS WHEN DESIGNING PROJECTS

Within the inventory, more than 45% of all projects do not consider future climate scenarios in their design, including over 40% of stormwater projects. This illustrates a significant gap in the ability to ensure flood resilience solutions will be operational throughout their lifespan. Project owners can use the data available through this plan as a starting point for project design. Forward-looking data for both rainfall-driven and coastal flood hazards is available via DCR's Open Data Portal.

With the release of the rainfall-driven flood data models developed for this Phase II plan, future-looking flood hazard data is now available to support stormwater projects as well as those addressing coastal flood hazards. While the off-the-shelf rainfall-driven flood models are not appropriate for direct use in project design, they can be adapted by engineering professionals to support local project needs. DCR's Pluvial Model Use Case Guide, available via the Open Data

During the planning process, local governments were engaged through meetings and an end-user survey. This engagement consistently revealed that staff capacity is a limiting factor for implementation. Local governments expressed a need for:

- Enhanced coordination and collaboration across departments and agencies to produce and share data and information
- Better training opportunities for government entities
- Citizen education on flood risk
- Leadership buy-in for resilience projects

Portal, contains additional information about the models available and how they can be used.

In areas where additional modeling is required, the state can help project owners by providing additional outreach and technical assistance. These activities should be developed to help communities understand the benefits of proactive, climate-aware infrastructure to mitigate future risks and to provide tools and guidance for how to leverage and cater available resources.

In general, a balanced approach is essential to integrate short-term actions with long-term strategies. In addition to support with understanding specific forward-looking flood hazard datasets, localities may need more general technical assistance, guidance, and resources to support incorporating climate-informed long-range planning into capital improvement planning and infrastructure decisions.

EXPLORE NEW PROJECT DEVELOPMENT

DCR and other actors, together with local and regional governments, can continue to investigate areas likely to be impacted by flooding that are without inventoried projects to explore whether new flood resilience actions are needed. To support this work, this section presents potential geographic opportunity areas for new projects. Specifically, it identifies areas of high combined flood exposure and high social vulnerability under the baseline planning scenario that are outside the footprint of an inventoried project.

It is important to note that, because the project inventory is incomplete, existing work may already be addressing flood risk in these areas. Where projects do exist, they may be insufficient to address all flood risks. Further, projects may not be cost-effective or feasible in every area. Before advancing efforts in any of the identified locations, actors should conduct additional investigation into local conditions.

In confirmed areas without projects where new actions would be beneficial, local governments can incorporate information about flood impacts into planning activities and begin identifying appropriate solutions. For example, PDCs may benefit from including the results of this analysis in existing or new regional flood resilience plans. One existing tool to support project identification is DCR's Project Suitability Matrix. The matrix explains project types by defining their characteristics, including flood hazards addressed, assets benefitted, level of adaptive capacity, project lifespan and typical costs. The matrix is an existing resource available on page 41 in Appendix G of the CRMP, Phase I.

The Hampton Roads region—particularly Hampton, Norfolk, Virginia Beach, and Chesapeake—continues to be at the forefront of developing and implementing flood resilience projects and initiatives. Most of these localities began tackling the challenge of sea level rise a decade ago in response to their significant level of risk, as illustrated by this plan's impact assessment. Since then, they have continued to build programmatic responses to growing flood challenges. The Hampton Roads region has relatively few locations of high flood exposure and social vulnerability without identified projects.

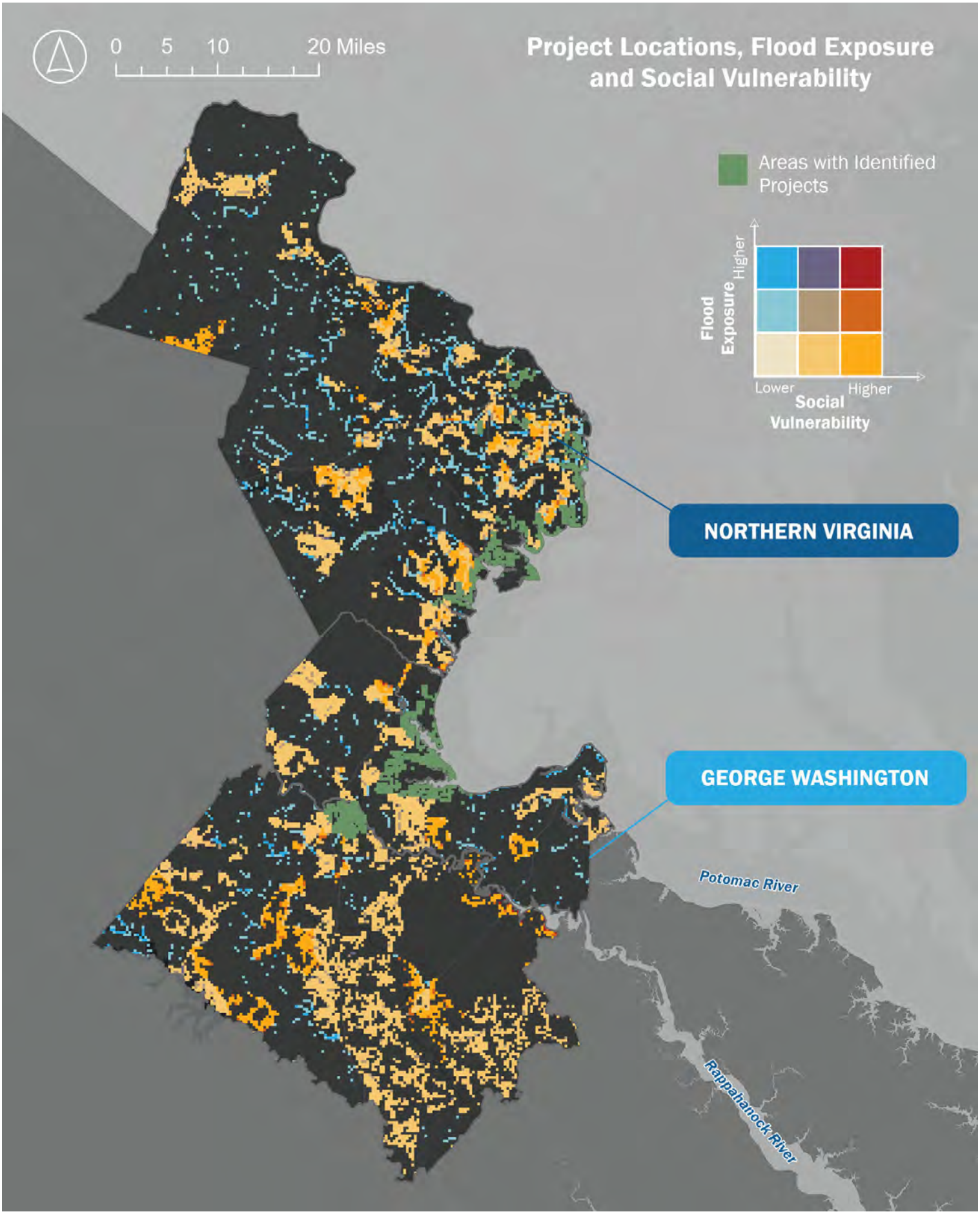
Meanwhile, the regions with the greatest number of potential opportunities for new projects are: George Washington, Eastern Shore, Northern Neck, and Greater Richmond. Most of the opportunities identified are in rural areas and along shorelines.

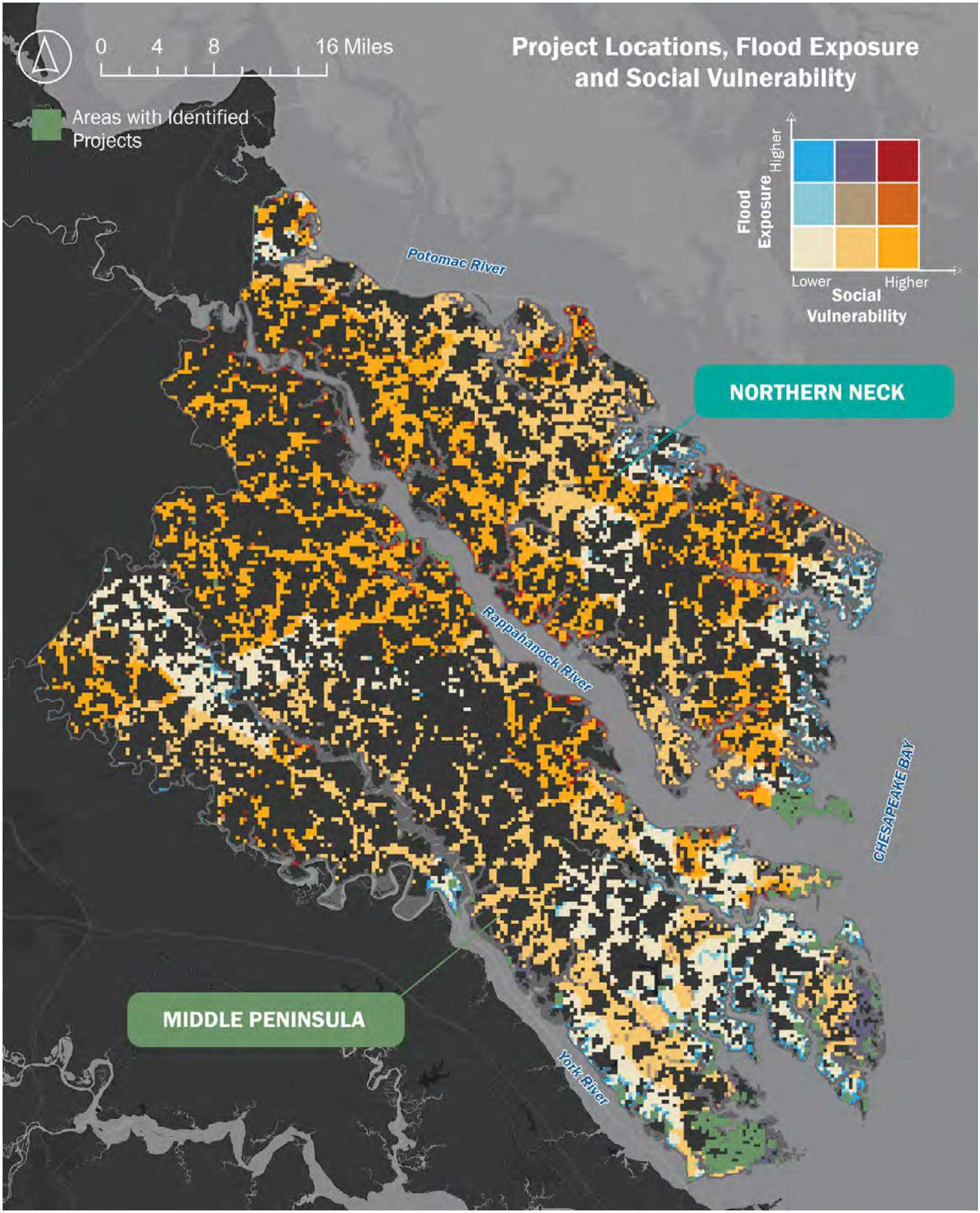
The George Washington Regional Commission, Accomack-Northampton PDC, and Northern Neck PDC all have DCR-approved flood resilience plans. These PDCs can review their plans to ensure that the identified areas are sufficiently addressed by projects. In Greater Richmond, many of the areas with relatively high flood exposure and social vulnerability are more rural, and outside of DCR-approved and funded flood resilience plans. In the future, if a regional flood resilience plan is identified, it could investigate these and address project identification where appropriate.

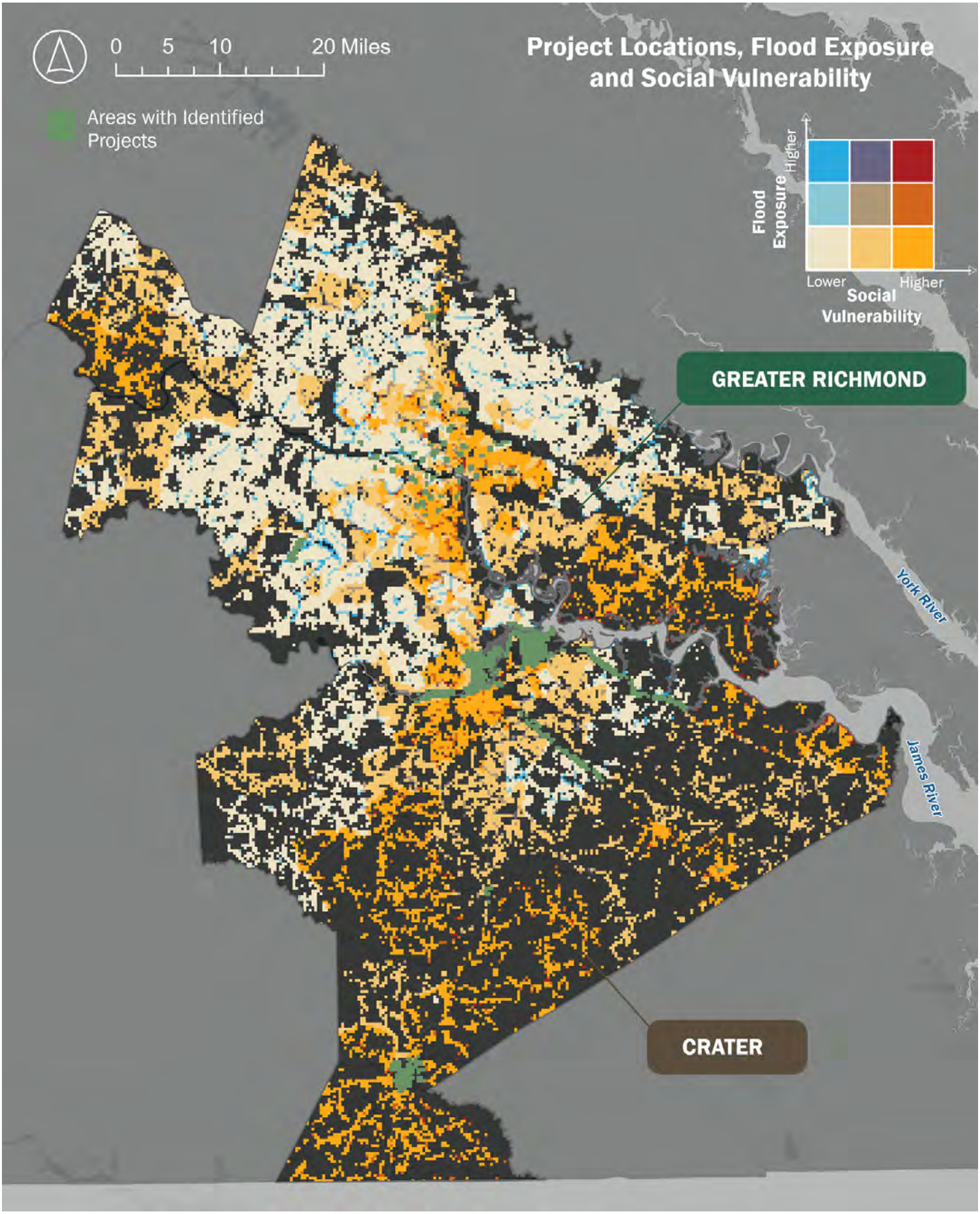
The following maps show areas of high combined flood exposure and high social vulnerability under the baseline planning scenario that are outside the footprint of an inventoried project.

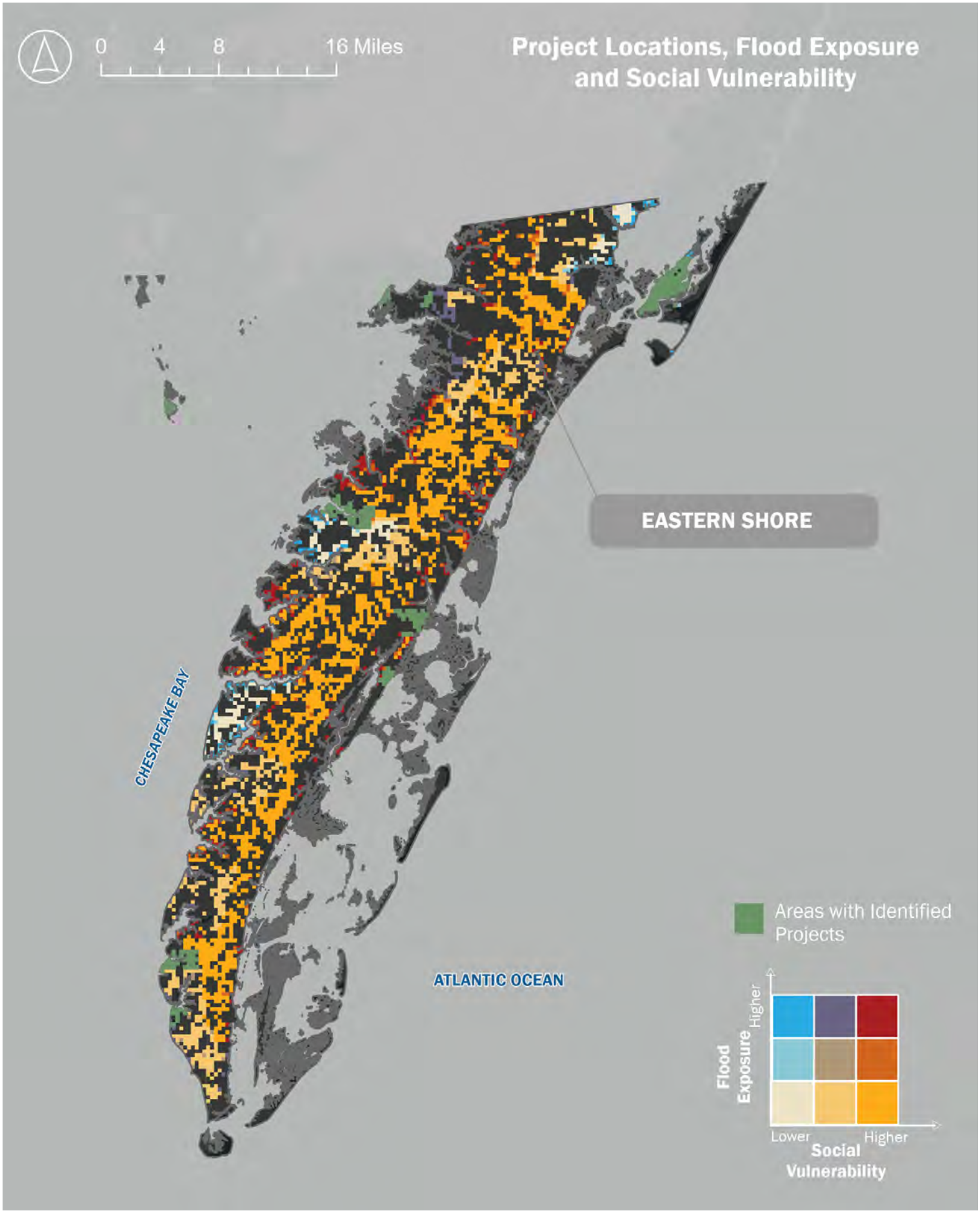
Explore the Project Suitability Matrix by visiting Appendix G of the CRMP, Phase I:

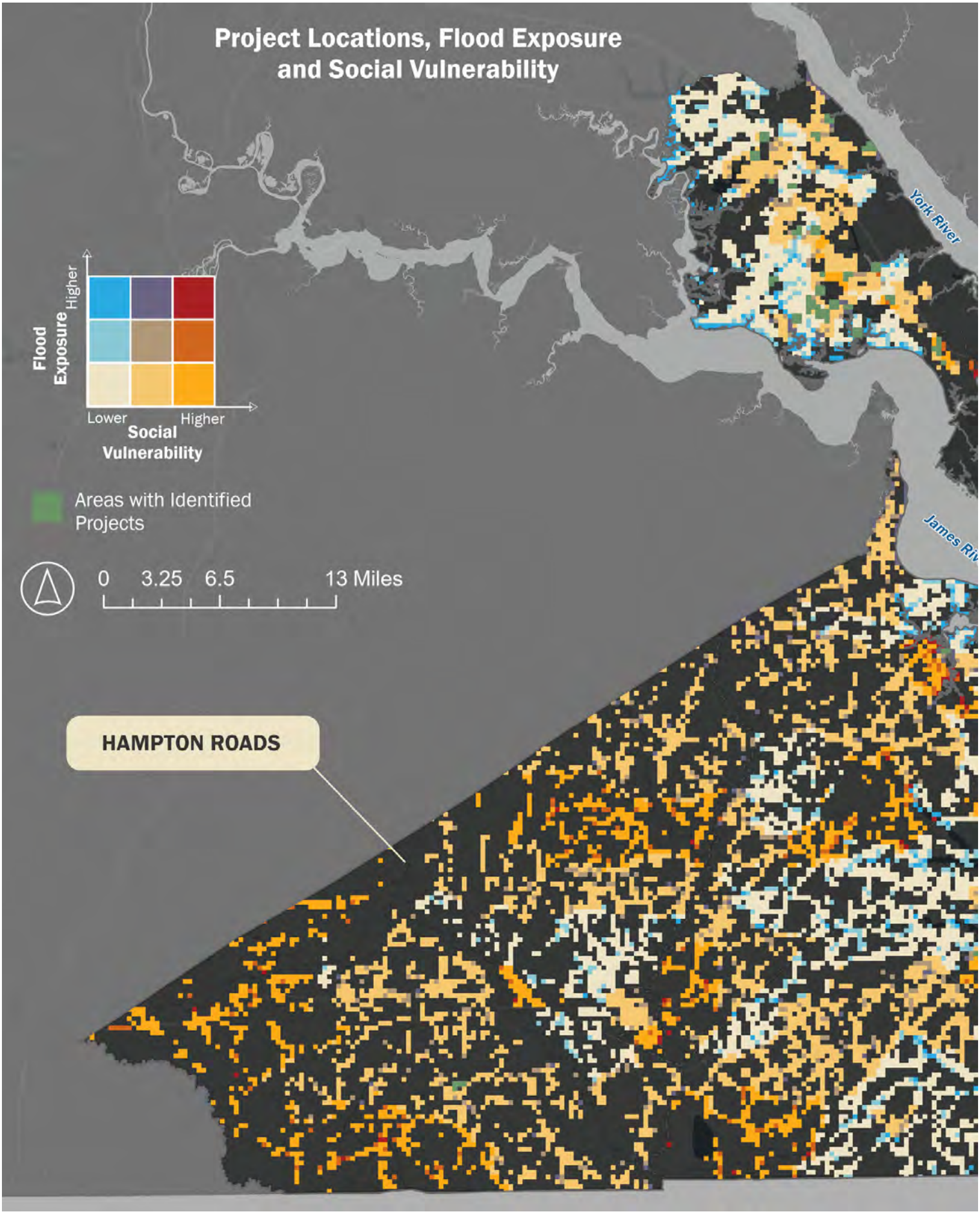
https://www.dcr.virginia.gov/crmp/document/Appendix-G-Project-and-Capacity-Building-and-Planning-Needs-Schema-Suitability-Matrix.pdf

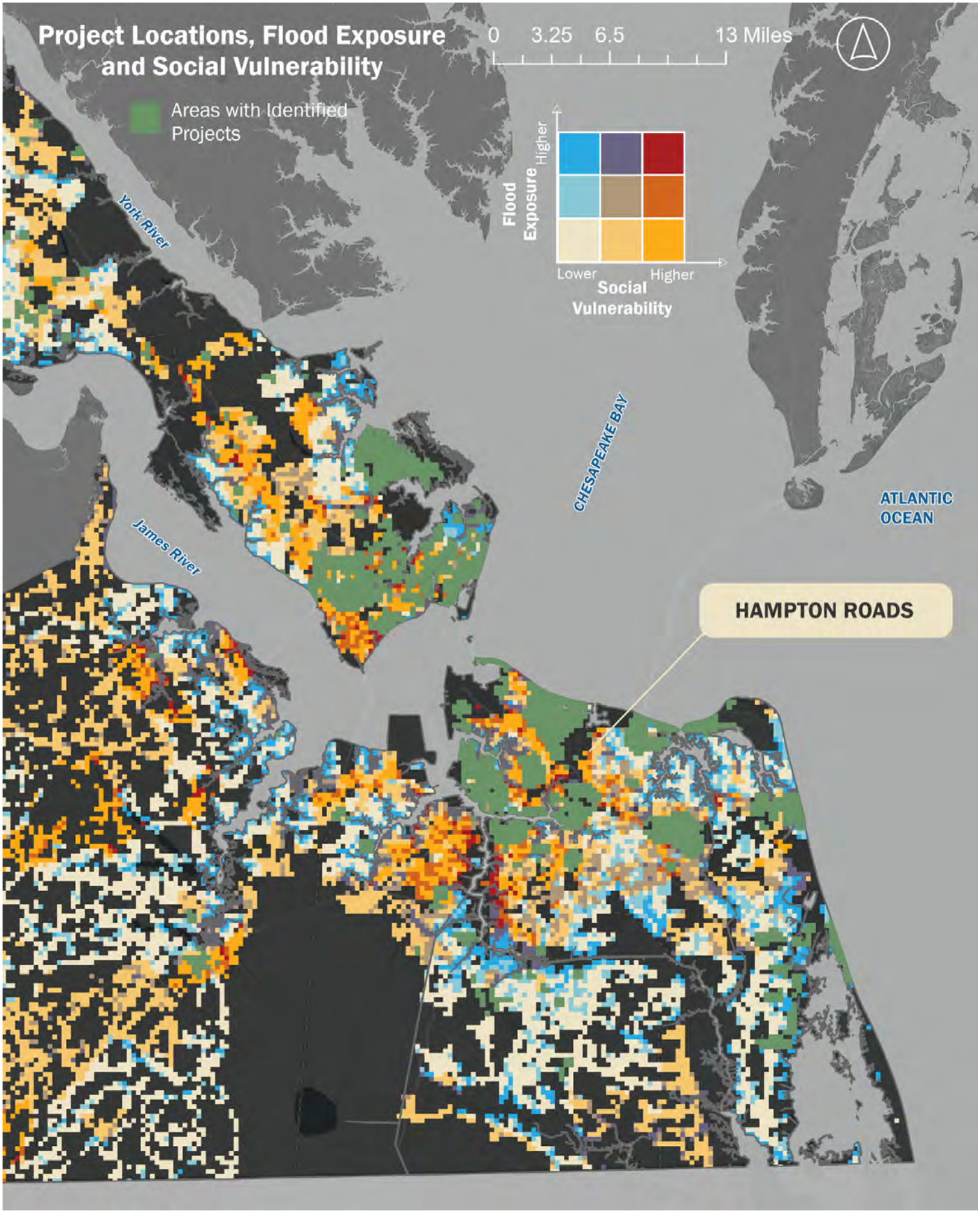












Financing Flood Resilience

Achieving a resilient coastal Virginia requires significant financial resources. However, the cost of doing nothing or delaying action can also be significant. While action is delayed, infrastructure continues to age, implementation and recovery costs increase due to inflation, and any disasters that occur can cause costly damage. FEMA reports that investing in mitigation ahead of a disaster saves on average $6 for every $1 spent.[1]

To maximize finite resources, it is important to understand what funding and financing opportunities exist for flood resilience actions. This section outlines some of those existing resources.

GRANT FUNDING

There are many state and federal agencies that provide grants to fund flood resilience actions. Two of the most leveraged grant sources to address flood challenges are the Virginia CFPF and a variety of the Federal Emergency Management Agency (FEMA) flood-related assistance programs.

FEMA provides funding to support disaster mitigation and flood resilience, including the Flood Mitigation Assistance (FMA) program and the Hazard Mitigation Grant Program (HMGP). In Virginia, FEMA grant programs are managed and administered by the Virginia Department of Emergency Management (VDEM). The funds have assisted more than 40 localities throughout Virginia since 2020, including 15 projects in coastal Virginia. Within coastal Virginia, the most common types of projects funded by FEMA are acquisition/demolition.[2]

The CFPF was established by the General Assembly in 2020 and is administered by DCR to provide funding to reduce the impacts of flooding. Awarded funds can be used by communities to develop resilience plans and to implement projects that mitigate future flood damage.

CFPF grants have significantly changed the flood resilience funding landscape in Virginia. Through grant rounds one through six, more than $300 million in funding has been distributed to more than 90 recipients. Coastal Virginia received about 75% of those awarded funds.

In the coming years, the CFPF will continue to provide an important resource to lower-resourced localities seeking to increase their capacity, as well as to localities farther along in their flood resilience journey that are expanding their investments.

Between 2020 and 2025, across both FEMA and CFPF grant sources, more than 60% of awarded funds in coastal Virginia were distributed to the Hampton Roads region. Chapter 2 illustrates that the Hampton Roads region faces some of the highest flood exposure and risk within coastal Virginia. The Northern Virginia and Greater Richmond regions received 17% and 8% of the funds, respectively. The Northern Neck PDC region and George Washington region both received the lowest amount of overall grant funding.

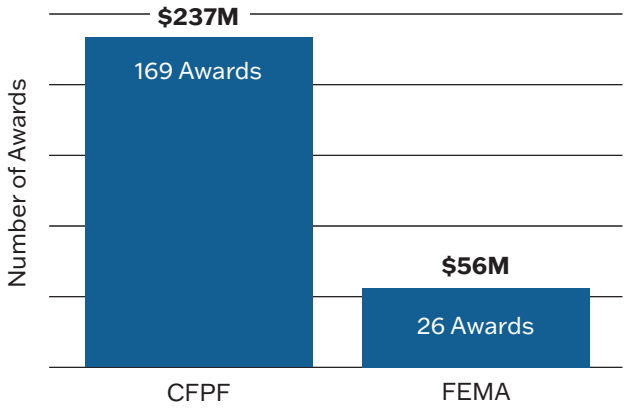
Funding Resources in the Coastal Resilience Web Explorer

The CRWE is a powerful tool to help identify funding opportunities. DCR has compiled an inventory of more than 140 resources to assist communities in implementing flood resilience actions. Users can view all resources, or filter and search them using a variety of categories in the tool.

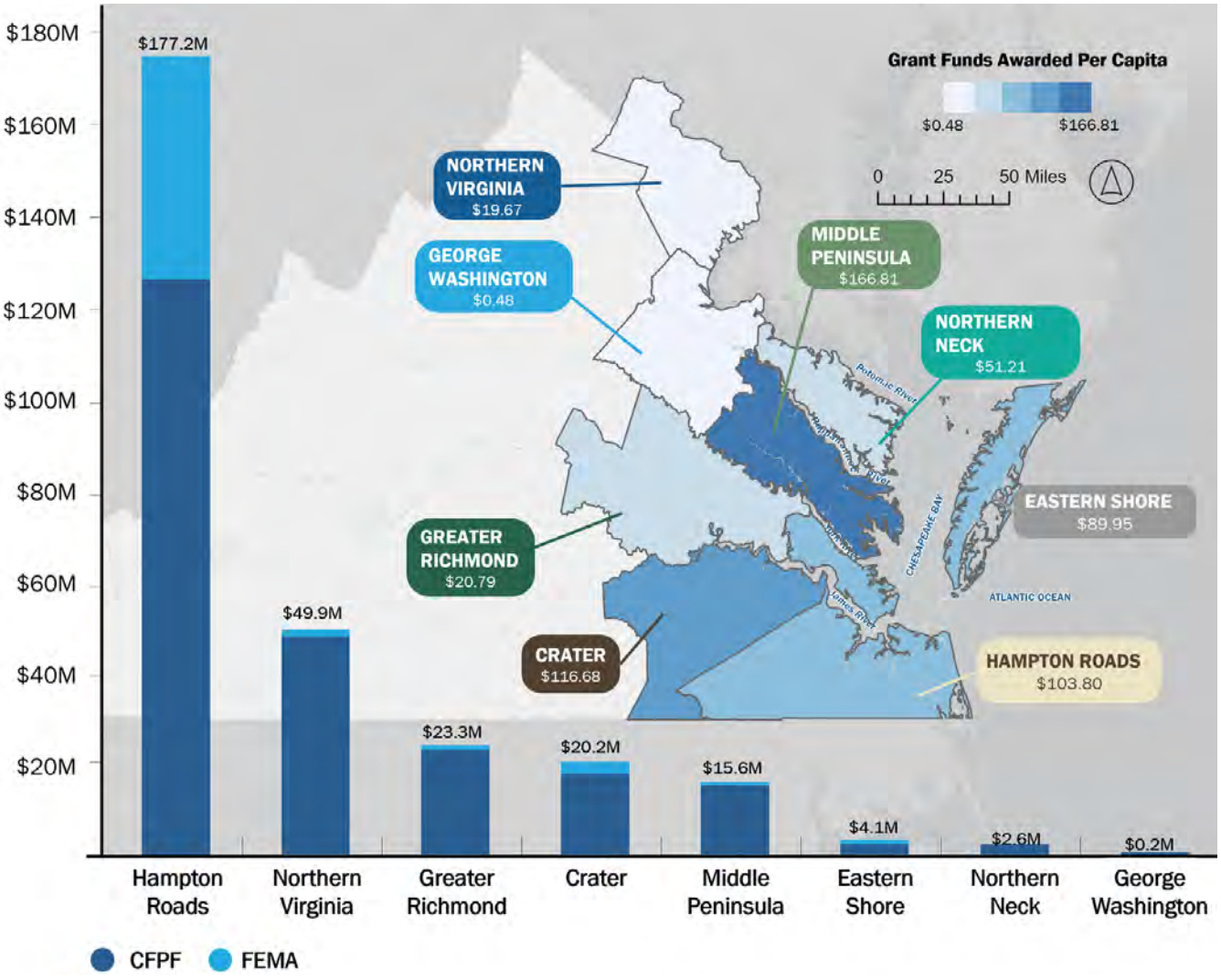
Additionally, within the Projects and Initiatives page, the CWRE has an alignment process to match actions with funding. Projects and initiatives in the inventory are automatically matched with relevant funding opportunities. These matches offer a starting point for project owners to quickly narrow down the vast field of potential funding sources for further investigation.

Visit the the CRWE to explore funding opportunities, projects and initiatives: dcr.virginia.gov/crmp/ResilienceExplorer

Awards made from CFPF and by FEMA to Address Flood Risk in Coastal Virginia (2020–2025)



Funding Received Per Capita and by Program (2020-2025)



FEMA Flood Mitigation Assistance Grant Funding

FEMA's Flood Mitigation Assistance (FMA) Grant Program provides funding to states, local governments, and federally recognized Tribal governments for projects aimed at reducing flood losses to structures insured by the National Flood Insurance Program (NFIP). Between 1978 and 2021, Virginians filed more than 5,500 NFIP claims statewide, resulting in net claim payments of more than $66 million.

The FMA grant program focuses on mitigating long-term flood risks through the elevation, relocation, or acquisition of insured structures in floodplains that face repetitive or severe losses.

By leveraging FMA Grant funding, localities can enhance flood resilience and potentially improve their Community Rating System (CRS) score, which FEMA uses to determine flood insurance premiums. Improved CRS scores benefit the entire community through NFIP policy discounts and reduced flood losses.

NFIP participation is heavily concentrated in coastal Virginia, where over 58,000 policies—more than 90% of the statewide total—are held. Flood-risk mitigation efforts are further supported by 25 CRS-participating coastal communities, which collectively provide 5% to 25% premium discounts to over 90% of the region's NFIP policyholders.

Through VDEM, localities can apply for FMA grant funding for projects and programs including:

- Mitigation plans
- Localized flood risk reduction projects
- Individual flood mitigation projects
- Management costs
- Project scoping
- Capability and capacity building activities, such as enhancing local floodplain management and developing a severe repetitive loss strategy

Localities in coastal Virginia have leveraged FMA funds totaling to nearly $4 Million in 2023. Examples of localities that utilized FMA grants include:

- The City of Norfolk received $2.01 million to raise seven residential properties at least three feet above the base flood elevation. These efforts will help lower flood insurance rates and enhance the entire City's resilience.
- The Northern Neck PDC received $1.61 million to elevate and build engineered foundations for six homes.
- Gloucester County received $176,000 to elevate a 1947 home with over $30,000 in flood losses. The project includes erosion control and nature-based solutions to prevent future flooding.
- In 2020, the City of Chesapeake received $1.07 million for the acquisition of five properties that have experienced repetitive losses and for the conversion of the property in the floodplain to open space for the community.

GRANT FUNDING AND VIRGINIA CZM

The Virginia Coastal Zone Management (CZM) Program, administered by DEQ, is 100% funded under the Coastal Zone Management Act (CZMA) of 1972. The Virginia CZM Program provides grants to state agencies, PDCs, local governments, public academic institutions, and non-governmental organizations engaged in the protection of coastal resources including the people and industries reliant on the coastal ecosystems.

The DEQ submits an annual grant application to NOAA providing information on the projects identified for funding with the annual allocation. Grant applications submitted to DEQ by localities are evaluated for inclusion in the annual state grant application that is submitted to NOAA. CZM funding may be used for planning and implementation of environmental programs including climate resilience.

Since the beginning of the program in 1986, Virginia has received over $92 million in federal CZMA funds.

OTHER FINANCING MECHANISMS

Many localities treat grants as the primary or exclusive method for funding flood resilience actions. However, additional mechanisms are available and being utilized for flood resilience action. Additional sources include bonds, which local governments can issue to raise funds for large-scale infrastructure projects; taxes, such as special assessments or dedicated taxes that generate revenue specifically for resilience initiatives; and loans, including low-interest or revolving loans from state and federal programs designed to finance flood mitigation and resilience efforts.

Locally-driven sources can generate dedicated revenues for flood resilience to fill budget gaps or secure matching dollars to compete for federal or state funding. Non-grant financial mechanisms provide flexible and sustainable funding options to help local governments implement necessary resilience actions against flooding and other climate-related impacts.

Notably, the first round of the Resilient Virginia Revolving Loan Fund has been underutilized by communities to date, presenting an opportunity for communities to leverage future rounds. Established in 2022, the fund is a self-sustaining program to aid communities and property owners impacted by flooding. The first round of the program offered up to $12.5 million in loans for localities. Funds are available to advance projects that will improve flood resilience in two distinct categories: local match for non-federal programs and hazard mitigation of buildings. These funds can also be utilized as match for the FEMA Storm Revolving Loan Fund.

Even with these local, state, and federal programs, some funding gaps will remain. Philanthropic support from national, regional, and community foundations can offer more flexible funding and often have less demanding application requirements. Philanthropic support can also provide funds or technical assistance for communities to build staff capacity and technical expertise to implement on-the-ground resilience projects in the future. Other organizations may support pilot or demonstration programs for innovative resilience projects that may be ineligible under existing public sources.

Several private foundations already provide funding for coastal resilience initiatives. For example, the National Fish and Wildlife Foundation (NFWF) is a private grant-making institution that is chartered by Congress and distributes funds from both federal and non-federal sources. Non-federal sources include funds from regulatory actions or legal settlements. The institution also provides funding through the Chesapeake Bay Stewardship Fund, Five Star and Urban Waters Restoration Program, and its Emergency Coastal Resilience Fund. NFWF's National Coastal Resilience Fund was established in 2018 and supports the implementation of nature-based solutions to enhance the resilience of coastal communities and ecosystems to natural hazards. Several localities and tribes in coastal Virginia have been awarded grants through the program. In 2023, the City of Norfolk was awarded $10 million to construct a stormwater wetland to improve flood management and water quality.

Examples of Non-Grant Financing Mechanisms

Type	Description	Example
Catastrophe, Environmental Impact, and Resilience Bonds	Debt instrument through which governments and investors establish pre-determined outcomes and benchmarks tied to resilience that dictate when and how much of a return on investment an investor will receive.	Hampton's Environmental Impact Bond
Commercial Property Assessed Clean Energy (C-PACE)	Loan program enabled through local ordinances that finance resiliency and energy efficiency improvements at fixed rates for up to 30 years.	Fairfax County C-PACE and Resiliency Financing Program
Direct Federal Funding	A range of federal entities can offer direct funding for flood resilience and hazard mitigation efforts.	Community Project Funding, U.S. House of Representatives Appropriations Committee
Green Banks	Financial institutions that attract private investment into environmental infrastructure, like clean energy or climate resilience, and leverage limited cash into bigger investments, much like a traditional bank.	Montgomery County (MD) Green Bank
Revolving Loan Funds	Self-sustaining financial instruments that use collected interest and principal payments from former loans to issue new ones and can be a flexible source of gap financing.	Middle Peninsula PDC Revolving Loan Program
Special Service Districts	Special-purpose governmental units established by localities to provide additional, more complete, or more timely government services to a designated area or an entire locality, and the services of which are funded by fees, which can be used to adapt facilities to rising sea levels.	Norfolk Special Service District Policy for Flood Protection Virginia Beach's Sandbridge Special Service Tax District and Neighborhood Channel Dredging Fee
Tax Increment Financing	Land use mechanism capturing the anticipated property tax increases generated by a project to pay for its capital costs and can be used to finance resilience projects in coastal or flood risk-prone areas with high development interest.	Virginia Beach's Sandbridge Beach Restoration Program
Taxes and Fees	Revenue collected by local or county governments for general funds or specific services.	Norfolk's Resilience Penny Alexandria's stormwater utility fees
Technical Assistance	Targeted support to provide agencies additional capacity or subject matter experts to support projects and initiatives. Activities can include grant writing, training, management assistance, and direct technical work such as study development.	USACE Coastal Storm Risk Management (CSRM) Feasibility Studies and Projects

Recommendations of the Coastal Resilience TAC

During the development of this plan, the four subcommittees of the Coastal Resilience Technical Advisory Committee (TAC) convened quarterly and developed recommendations to improve flood resilience outcomes in coastal Virginia. The resulting 20 recommendations help to lay the foundation for the Commonwealth's future efforts. They also may serve as a guidepost for other stakeholders seeking to address changing flooding challenges in the region.

These recommendations include actions to be implemented before the next master planning phase as well as suggestions for improving the planning process. They were approved by the TAC in November 2024. The list of more than 100 initial recommendation concepts is provided in Appendix D.

KEY THEMES

Recommendations are organized within the four subcommittees in which they were developed: (1) Research, Data and Innovation, (2) Project Prioritization, (3) Funding, and (4) Outreach and Coordination. Several key themes emerged during the development of the recommendations which revealed areas of alignment across all four subcommittees. These themes underscore the need for a coordinated and unified strategy involving all relevant parties—from government organizations to local communities—to effectively manage flood risk and enhance resilience throughout the Commonwealth.

Collaboration and Capacity Building

The recommendations encourage collaborating, coordinating actions and sharing resources—particularly across state agencies and levels of government—to reduce duplication of efforts, streamline processes, and enhance overall capacity of flood resilience actors.

Research and Data-Driven Decision Making

Maintaining high-quality, forward-looking, scientifically sound data to guide decision-making is essential to effectively identify risks, evaluate the success of resilience projects, and support adaptive management. The recommendations encourage strategic research and a data-driven approach to ensure that strategies can be effectively refined and adapted in response to changing conditions.

Engagement with Local Stakeholders

Proactive outreach and meaningful engagement at local levels will support the development of flood resilience efforts informed by on-the-ground realities. The recommendations emphasize that resilience strategies should be informed by and implemented in collaboration with local practitioners and communities.

Economic Drivers for Resilience

The recommendations encourage clear communication of the long-term economic benefits of resilience investments for both public and private stakeholders to motivate flood resilience action and garner broad support.

Strategic Implementation and Plan Uptake

The recommendations recognize that in order to ensure effective use and uptake of the plan, actionable goals, strategies, and measures of success must be developed, along with sustainable funding. Further engagement and support to intended plan end users is needed to spur action.

Although the Coastal Resilience TAC sunset in February 2025, statewide coordination for flood resilience will continue through the Flood Resilience Advisory Committee. The new Flood Committee will advise DCR on the VFPMP, as well as the Department's other efforts to implement the Commonwealth's flood resilience, preparedness, prevention, and protection programs. As outlined in the Code, the Director may establish subcommittees or other bodies of the Flood Committee to advise on the development and implementation of the CRMP and other regional flood resilience plans. In addition, the Code states that DCR shall engage with a range of other stakeholders outside of the Flood Committee in developing the VFPMP.

Research, Data, and Innovation

	SUBCOMMITTEE RECOMMENDATION	PURPOSE
R.a	The CRO should coordinate with the Commonwealth's research universities and the Interagency Resilience Management Team to regularly inventory existing data and to collect and share quantitative and qualitative flood resilience data, data production efforts, and assessments of data usage in decision-making applications across the Commonwealth.	Minimize duplication of efforts and effectively mobilize our collective capacity to support evidence-based flood resilience decision making with best available data.
R.b	The DCR Office of Resilience Planning and other state agencies, in collaboration with research universities and local governments, should identify priority data needs to support ongoing planning and decision making and recommend implementation strategies for fulfilling those needs.	Maintain the best available data to inform decisions in a changing environment.
R.c	The Flood Resilience Advisory Committee should actively support DCR in establishing clear and measurable resilience goals aimed at enhancing the Commonwealth's capacity to withstand and recover from flood events. DCR should solicit the involvement of the Commonwealth's research universities and other key stakeholders to contribute their expertise in developing relevant indicators and metrics to monitor progress toward these resilience goals.	Define, measure, and monitor the efficacy of resilience projects to support adaptive management. This should be based on Virginia-centric data and address ecological, infrastructure, social, economic, cultural, environmental justice, and other emerging dimensions of resilience performance.
R.d	DCR's Office of Resilience Planning should engage with key stakeholders to understand local obstacles and gaps in state-level programs and develop a statewide strategy that leverages co-production of innovative state-level solutions to meet local needs.	Identify appropriate state-scale collective actions to support local resilience challenges through community engagement and innovation.
R.e	The Commonwealth's research universities should evaluate the performance and co-benefits of existing and emerging nature-based and hybrid solutions for water quantity and water quality protections through collaborations with public and private stakeholders. These efforts should track progress, adapt approaches, and identify funding sources for continued collaborative efforts.	Understand the flood risk reduction and other benefits of existing and emerging nature-based and hybrid solutions through collaborative research efforts.

SUBCOMMITTEE OBJECTIVES

- Inform development of the flood hazard exposure model.
- Inform input to flood hazard risk assessment.

Project Prioritization

	SUBCOMMITTEE RECOMMENDATION	PURPOSE
P.a	The DCR Office of Resilience Planning should incorporate best available science into future iterations of the Coastal Resilience Master Plan for all components of flood risk to support appropriate project prioritization.	Enhance informed decision-making for flood resilience.
P.b	The Commonwealth should establish sufficient funding to implement the Coastal Resilience Master Plan and a dedicated, sustainable source for this funding.	Improve buy-in for the Coastal Resilience Master Plan.
P.c	The CRO should coordinate state agencies to develop, maintain, and enhance appropriate datasets needed to assess flood impacts. The CRO should invite broad participation from key stakeholders in coordination efforts.	Minimize duplication of efforts, streamline communications, and effectively mobilize our collective capacity.
P.d	State agencies should establish programs to engage with and support local governments and PDCs, with an emphasis on communities with high flood risk and without flood resilience projects or initiatives. Involved agencies may include DCR, VDEM, and DHCD and, where appropriate, state agencies should involve regional institutions of higher education in engagement efforts.	Understand and address the factors preventing flood resilience action by local governments.
P.e	The DCR Office of Resilience Planning should work with the Flood Resilience Advisory Committee to establish a coordinated framework to operationalize the Coastal Resilience Master Plan at local, regional, and state scales. The framework should integrate data and needs assessments with Coastal Resilience Master Plan principles to develop success metrics and set clear short-, mid-, and long-term goals, to be measured on regular, near-term timespans.	Establish a structure to connect the state's coastal flood resilience findings to informed and coordinated action that minimizes adverse impacts and maximizes long-term benefits.

SUBCOMMITTEE OBJECTIVES

- Inform and support the flood hazard risk assessment.
- Inform and support the identification of planned resilience actions.

Funding

	SUBCOMMITTEE RECOMMENDATION	PURPOSE
F.a	The CRO should request that the Interagency Resilience Management Team provide timely financial tools and reports to local governments, state legislators, and other official entities. These tools and reports should clearly demonstrate the immediate and mid-term costs of inactions to address flood resilience and inform appropriations.	Explain the flood consequences of doing nothing at the local, regional, and state levels.
F.b	The Commonwealth's economic development enterprise, public and private, should ensure that businesses, government officials, citizens, and other stakeholders are aware of the economic benefits of developing and implementing Virginia-based flood resilience products and services and exporting them to an emerging global market.	Ensure stakeholders understand the positive financial potential of investing in resilience solutions.
F.c	The CRO should request that the Interagency Resilience Management Team provide information to local governments, state legislators, and other official entities about existing, available, and emerging sources of funding and financial strategies that can support local, regional, and state-wide flood resilience initiatives.	Establish an understanding of the financial resources to develop a financial strategy for implementation.
F.d	The CRO should request that the Interagency Resilience Management Team identify the challenges in the flood-related grant and loan processes specific to private projects and public projects, then recommend opportunities to improve implementation.	Understand the financial needs, limitations, and challenges to implementing resilience on public and private property. Example challenges may include administrative, legal, cash flow, reimbursement, proof of expenditure, and others.
F.e	The CRO should request that the Interagency Resilience Management Team report on the effectiveness of state funding and financing programs to address short-term and long-term flood-related challenges for local governments, PDCs, and the Commonwealth and consider additional financial mechanisms as appropriate.	Utilize adaptive management for state-directed funding programs to address the immediate and long-term challenges of flooding.

SUBCOMMITTEE OBJECTIVES

- Inform quantification of financial needs for flood resilience.
- Identify and examine financial tools and processes that are suited and/or needed to implement flood resilience.
- Identify challenges and opportunities to implement financial tools.

Outreach and Coordination

	SUBCOMMITTEE RECOMMENDATION	PURPOSE
O.a	The DCR Office of Resilience Planning should develop and maintain a comprehensive list of available funding resources which can be leveraged to sustainably support uptake and implementation of the Coastal Resilience Master Plan.	Assist in addressing budgetary constraints which limit plan uptake.
O.b	The CRO should coordinate with DCR to provide resources and supporting information on the necessity of increased flood resilience funding utilizing project prioritization and evidence of project readiness.	Provide support through information sharing to minimize budgetary constraints which limit plan uptake.
O.c	The DCR Office of Resilience Planning should collaborate with potential end-users of the Coastal Resilience Master Plan, such as local governments and PDCs, by improving usability. This may include providing accessible and straightforward available virtual tools and customized technical support to develop locally specific project prioritization using the plan.	Increase flood resilience action and encourage informed decision-making through use of existing plan data and resources.
O.d	The DCR Office of Resilience Planning should develop a strategy to increase use of the Coastal Resilience Master Plan by plan end-users, including local governments and PDCs. The strategy should seek to identify and bridge capacity constraints within DCR and for end-users that prevent plan uptake. The strategy should also clearly define roles for state agencies to support end-users.	Establish a coordinated, actionable strategy to ensure the Coastal Resilience Master Plan is used.
O.e	The DCR Office of Resilience Planning should collaborate with key stakeholders, including local governments and PDCs, to identify the populations and communities at greatest flood risk and offer clear, consistent messaging that can be tailored to a community.	Improve outreach to populations at greatest flood risk.

SUBCOMMITTEE OBJECTIVES

- Inform and support outreach and engagement for Phase II of the Coastal Resilience Master Plan.
- Strengthen relationships with key stakeholders identified as critical to engaging in Phase II of the Coastal Resilience Master Plan.

CHAPTER 4

LOOKING AHEAD

The completion of Phase II of the Coastal Resilience Master Plan marks a significant milestone in the Commonwealth's ongoing efforts to build flood resilience. Resilience is a long-term, evolving process driven by continuous learning, collaboration, and adaptation. Building on the foundation laid in Phase I, this second phase broadens our understanding of the changing picture of flooding in coastal Virginia through the end of the century. This document stands apart as a unified summary of the challenges, opportunities, and needs for long-term flood resilience in coastal Virginia.

The Importance of Regional Collaboration

Regional collaboration is a critical component in the development of a coordinated response to flood hazards that impact coastal Virginia. Although changing flood risks will impact each region, locality, neighborhood, and individual in different ways, many challenges and opportunities are shared across coastal Virginia. Working together to address common challenges and advance coordinated resilience strategies allows the Commonwealth's governments to maximize the benefits gained from limited resources. Collaboration facilitates knowledge sharing, allowing local governments, PDCs, state governments, and others to learn from each other and identify opportunities to improve collective outcomes.

This plan facilitates opportunities for increased partnerships across coastal Virginia, providing a comprehensive and unified analysis of flooding to compare impacts, as well as a regionwide summary of existing actions led by a variety of government actors and partners to address flood risk. However, continued coordination to act upon the findings presented is needed to advance a collaborative response to flooding. Stakeholders can leverage this plan as a launching point for continued connections, sharing data, coordinating strategies, and communicating lessons learned along the way.

Flood resilience actors are encouraged to continue submitting and sharing project, initiative and funding information through the CRWE user portal to ensure this remains a "living" database of information which adapts and evolves as efforts continue in the years to come.

The Commonwealth's Role in Flood Resilience

The Commonwealth has a critical role to play in the continued advancement of flood resilience efforts in coastal Virginia. The state government is uniquely positioned to provide coordination across and between the whole community of decision makers responsible for addressing flood resilience challenges ahead, including federal partners and agencies, state agencies, regions, localities, communities, and other stakeholders.

The Commonwealth's role, first, is to **lead by example**, embracing the guiding principles of flood resilience across its own decision-making. This leadership includes embracing flood resilience adaptation, protection, and relocation of state-owned facilities and assets in coastal Virginia and beyond. For example, DCR issued the Virginia Floodplain Management Standards to formalize requirements for state-owned development in flood risk areas, as established in the Code of Virginia.[1] The Commonwealth must also incorporate the increasing threat of flood risk into its own relevant programs and policies. This includes coordinating amongst state agencies to ensure that the Commonwealth's flood resilience efforts are aligned with one another, maximizing benefits of flood resilience efforts and avoiding conflicting approaches.

The state also plays an important role in providing guidance and support to other decision makers, particularly political subdivisions of the state, as they make their own decisions that impact coastal Virginia's flood resilience. This includes **providing high-quality, accessible data and information** needed to facilitate informed decision making at multiple levels of government. Because data and information come from many different sources, the state can provide a critical service by coordinating data for these agencies and other users.

Some stakeholders require additional capacity to leverage information effectively. Certain groups, such as less-resourced local governments, welcome assistance to obtain data and develop flood resilience strategies. In these cases, the state can play a crucial role by **offering capacity-building support**, such as providing technical assistance, resources, and funding opportunities. The Commonwealth can also support stakeholders to **fill gaps in flood resilience action**. In areas where significant flood risks remain unaddressed, the state can explore why the gap exists and, in collaboration with local stakeholders and partners, help develop strategies to build flood resilience.

This plan illustrates that the Commonwealth is actively embracing several of these supporting and coordinating roles. The plan itself is the product of significant coordination between flood resilience stakeholders in coastal Virginia. Many stakeholders came together to guide DCR to develop this foundational set of flood resilience data. The data in turn positions the Commonwealth to better lead by example and provide information

to local governments, PDCs, and other flood resilience decision makers. Through the plan's complementary tools—the CRWE and the Flood Resilience Open Data Portal—the DCR Office of Resilience Planning has resources to leverage in conducting capacity building and supporting efforts to address gaps in action in collaboration with others in the coming years.

EXPANDING THE STATE'S RESILIENCE EFFORTS

In 2023, DCR convened the Resilience Coordination Working Group to improve intergovernmental and interagency coordination and maximize the procurement of federal and private funding opportunities for planning and implementing flood resilience throughout the Commonwealth. The Working Group developed 23 recommendations for legislative action, administrative action, and future consideration. The Working Group made recommendations on the Commonwealth's resilience coordinating structures, resilience funding, locality readiness, flood resilience planning, and resilience data and resources.

Many of the Working Group's recommendations for legislative action have already been codified by the General Assembly in the 2024 session. Legislation included in HB 1458 amended provisions related to the Chief Resilience Officer (CRO), Virginia Community Flood Preparedness Fund, and Resilient Virginia Revolving Fund.

The CRO and All-Hazards Resilience Efforts

A major update to the state's resilience duties is the addition of a CRO and dedicated staff. The CRO is responsible for coordinating all-hazards resilience efforts, developing resilience and adaptation strategies, and maximizing funding to address related challenges. The CRO convenes an Interagency Resilience Management Team consisting of resilience coordinators from state agencies to support the coordination of planning and implementation of resilience efforts.

DCR and Flood Resilience Efforts

DCR is the lead agency responsible for flood resilience, charged with creating and overseeing the CRMP, the Virginia Flood Protection Master Plan (VFPMP), and related outreach and engagement efforts. DCR convenes the Flood Resilience Advisory Committee, which advises the agency on:

- Assessing the impacts of flooding on people, the economy, and the environment;
- Establishing and measuring flood resilience goals and metrics for the Commonwealth;
- Prioritizing state policies, programs, funding, and other strategies to mitigate the impacts of severe and repetitive flooding;
- Enhancing intergovernmental and interagency coordination for flood resilience planning and strategy implementation;
- Conducting stakeholder outreach and engagement in support of flood resilience planning and implementation;
- Assisting local governments to minimize loss of life, property damage, and negative impacts on the environment resulting from flooding; and
- Addressing issues relating to the VFPMP.

How to Use this Plan and Its Products

The CRMP, Phase II and its complementary products assist coastal actors and decision makers by providing data and information to effectively identify flood risks and enhance resilience in their communities. The interactive databases that complement this plan—the CRWE and Open Data Portal—allow stakeholders to better understand the challenges of increased flooding, as well as opportunities to advance flood resilience. With this information, coastal actors can develop effective plans, seek funding and policy-maker support, incorporate flood resilience information into their operations, and educate public audiences about flood risks and resilience.

UNDERSTANDING THE CHALLENGES OF INCREASED FLOODING

The CRMP can be leveraged to understand potential future flood risks and their impacts on infrastructure, assets, populations, and ecosystems. While there are many sources of predictive flood data, this plan's data is specifically tailored to meet the needs and reflect the conditions of coastal Virginia, featuring unique analyses of tidal, rainfall-driven, riverine, and combined flooding. Detailed documentation on the methodologies used in the data analyses is available in the Appendices.

The plan's hazards and impacts data can be visualized through the CRWE and is also available for download through the Open Data Portal, enabling deeper investigation, analysis, and manipulation. DCR will make new data products available via this portal as they are developed.

For those interested in exploring localized rainfall-driven flood hazard models with enhanced land cover or stormwater infrastructure data, the models which underpin the plan are also accessible for download. These models can be adjusted to meet specific applications, serving to accelerate action by minimizing upfront effort. More information about the flood hazard models and examples of use cases for them are available via the Pluvial Model Use Case Guide, which is accessible via DCR's website and Open Data Portal.

DEVELOPING LOCALLY SPECIFIC OR SECTOR-SPECIFIC PLANS

After using the CRMP data to understand flooding's impacts now, and into the future, local, regional, and state government entities can begin to develop their own plans for physical development or programmatic advancement. Examples of planning efforts that may benefit from the inclusion of this data include local comprehensive plans, regional hazard mitigation plans, and state agency infrastructure plans. The data is particularly relevant for plans which focus on long-term timespans to anticipate changes and outline a path to success. Although additional data that is more spatially explicit or relevant to a particular set of assets may ultimately be needed for these other planning efforts, leveraging the CRMP data can provide a valuable starting point upon which these additional datasets can be integrated. This can reduce time, effort and funds spent on flood impact data generation.

Gaining Eligibility for the Community Flood Preparedness Fund Projects Grants

To be eligible for project grants from the Community Flood Preparedness Fund (CFPF), applicants must develop and adopt a flood resilience plan that meets requirements laid out in the CFPF Grant Manual. The data and information contained in the CRMP can be directly leveraged to fulfill this requirement. The CRMP contains model predictions, regionally specific data, and needs assessments, and may serve as a useful resource for CFPF applicants developing or updating their own flood resilience plans.

Explore the Coastal Resilience Web Explorer: dcr.virginia.gov/crmp/ResilienceExplorer

Find data and other resources, including the Pluvial Use Case Guide, via the Flood Resilience Open Data Portal: https://floodplan-vdcr.hub.arcgis.com/

IDENTIFYING OPPORTUNITIES TO COORDINATE WITH OTHERS

The CRMP can be a valuable resource for understanding existing flood resilience work across coastal Virginia. Plan end users can explore the updated inventory of projects and initiatives, filtering data by project location and type. Users can learn about the hazards each project addresses, implementation costs, funding sources, and more. Actors and decision makers can use this information to identify potential partnerships with others advancing similar efforts and gain inspiration from others' efforts.

FILLING FLOOD RESILIENCE GAPS

Chapter 3 of this plan highlights numerous ways in which various flood resilience actors—ranging from local governments, to PDCs, to state agencies—can fill existing gaps. The opportunities identified range from locations where flood resilience projects may be insufficient to address flood risk, to subjects requiring enhanced coordination between different types of actors. Some actors, such as local governments and state agencies, are positioned to directly address identified gaps because of their responsibilities and authorities. Others, such as community-based organizations and neighborhood groups, may be well-positioned to use the opportunities to champion need, build momentum, and encourage action by their local governments or other actors to advance flood resilience solutions in their communities.

USING DATA AND INFORMATION IN OPERATIONAL DECISIONS

The plan's data provided via the Open Data Portal can be leveraged as a tool to inform operational decision-making. For example, local governments could leverage spatial data showing intersections of social vulnerability and flood risk as a tool to support Capital Improvement Plan project prioritization. Local housing authorities could leverage information about flood risk to support evaluation decisions for whether to invest in supporting property acquisition and redevelopment in flood prone areas. In general, the tools can provide an additional lens through which decisions can be evaluated, particularly in areas where flood risks are high or increasing. Data users should refer to the limitations explored on pages 23 and 60 of this document.

SEEKING FUNDING AND POLICYMAKER SUPPORT

The plan's updated list of funding opportunities helps flood resilience stakeholders connect with potential resources to accomplish resilience efforts. Users that submit projects to the CRWE will have access to automated matching tools which align projects, based on a variety of user-provided data, with appropriate funding mechanisms. The result is a set of recommended funding opportunities that would be applicable to fund each submitted project.

In addition, data and information in the plan can be used to justify and secure funding, such as in grant applications. Spatial and tabular data can be downloaded via the Open Data Portal. Results from the plan's impact assessment – such as projected average annualized losses for all structures in a locality over the planning scenarios – can be particularly useful as summary statistics to incorporate into funding requests.

EDUCATING PUBLIC AUDIENCES

The CRWE and Open Data Portal are intended to be useful tools for educating the public about the changing picture of flood risk and resilience. Flood resilience stakeholders can leverage the maps and charts in their own communications and messaging to show impacts to specific areas of interest on different planning horizons and for various flood conditions. This can help spread public understanding and awareness of the challenges and build public support for action.

The Virginia Coastal Zone Management Program and Continued Coordination

Virginia Coastal Zone Management (CZM) is a program led by the Department of Environmental Quality (DEQ) in partnership with the National Oceanic and Atmospheric Administration (NOAA). It is a networked program, meaning that it involves 12 state agencies, including DCR, which are responsible for administering the policies that protect Virginia's coastal resources. The Program has ten goals which fall into three broad themes: coastal resource protection, coastal resource sustainable use, and coastal management coordination. The program is fully federally funded, and currently receives about $3 million annually from NOAA to advance its strategic priorities in alignment with federal goals. Portions of this funding are leveraged directly by CZM program staff, while other funding is distributed via competitive and non-competitive grants to other actors. Over the last 20 years, the Virginia CZM program has provided roughly $5 million of federal funds for coastal projects.

Given the networked approach and the importance of cross-cutting coordination, the program established a Coastal Policy Team to facilitate interagency and intergovernmental cooperation. The Coastal Policy Team includes the 12 key state agency partners and the eight coastal PDCs, which convene and communicate on a regular basis to learn about and collaborate on coastal issues, funding sources, and projects.

Every five years, the CZM Program staff, with support from the Coastal Policy Team, develop a strategy to develop enforceable policies to better manage high priority issues for coastal resource management. This strategy in turn guides allocation of awarded funding. Addressing coastal hazards and building coastal resilience have, in recent years, been identified as among the program's top priorities, highlighting the importance of flood risk reduction and coastal resilience to state agencies and PDCs. Additionally, coastal resilience is currently the program's three-year focal area in support of the goals and needs described in the CRMP, Phase I.

In the past five years, the CZM Program has worked alongside the CRMP as the plan has evolved to support, inform, and advance the process in integral ways. For example, the staff from the Virginia CZM Program supported the Coastal Resilience TAC during development of the Phase I plan and attended and participated in most Phase II TAC meetings. Additionally, CZM grant funding distributed to PDCs was leveraged to build the projects and initiatives inventory contained in this Phase II plan.

The continued collaboration between Virginia CZM and the Office of Resilience Planning can help to advance and operationalize the recommendations of the Coastal Resilience TAC and other opportunities contained in this plan. For example, the Virginia CZM program is working on revising and updating its strategies through a collaborative planning process to develop a Coastal Needs Assessment and identify priority strategies for FY2026-2030. Where the needs assessment addresses topics of flood hazards and resilience, it can potentially build upon the findings and opportunities identified in this Phase II plan. Likewise, the DCR Office of Resilience Planning, in developing its Adaptive Management Plan, can explore opportunities for alignment with the CZM Coastal Needs Assessment and priority strategies, in coordination with the Coastal Policy Team. The Coastal Policy Team could continue to serve as an important forum for coordination on topics of flood resilience – in addition to other coastal policy goals.

Next Steps for the Office of Resilience Planning

The CRMP will be updated every five years. Between now and then, the Office of Resilience Planning will coordinate with other key flood resilience stakeholders in coastal Virginia to advance the use of this plan and the opportunities it identifies. In addition, the Office will continue efforts to develop the Commonwealth's VFPMP, and advance opportunities for alignment between planning efforts as flood resilience efforts expand statewide.

SHARING REGIONAL FINDINGS

DCR will coordinate with external stakeholders to develop and present data and information tailored to each of the eight regions described in the plan. Each presentation will provide further regionally relevant information on impacts, challenges and opportunities. Presentations will be designed to assist PDCs, local governments, and other actors working at local scales to leverage the plan's findings to build flood resilience.

ENCOURAGING AND SUPPORTING THE USE OF FLOOD RESILIENCE DATA

The Office of Resilience Planning will actively promote the CRMP, the CRWE, and the Open Data Portal as critical resources to end users. The Office will continue to provide technical assistance to those seeking to use the data to facilitate access and aid them to leverage specific data findings that support flood resilience planning decisions.

ADAPTIVE MANAGEMENT PLAN TO ADVANCE OPPORTUNITIES

From opportunities to advance projects and initiatives to priority recommendations of the TAC, this plan outlines numerous paths by which the Commonwealth can advance flood resilience in coastal Virginia. To translate these ideas into realities, the DCR Office of Resilience Planning will develop an Adaptive Management Plan for the CRMP, Phase II. This Adaptive Management Plan will build upon the identified challenges and opportunities in the CRMP to define specific goals, objectives, actions, and measures of success which can be accomplished by the DCR Office of Resilience Planning prior to the next five-year update. The Adaptive Management Plan will also establish a framework by which DCR will evaluate the measures of success and subsequently adapt its approach in response to findings.

The responsibility for advancing flood resilience in coastal Virginia is shared by many government agencies and non-government partners. It will take the whole community to accomplish a resilient coastal Virginia. In developing and carrying out this Adaptive Management Plan, DCR will look for opportunities to work together with others, leveraging existing efforts where possible.

COLLECTING AND MONITORING FEEDBACK ON THE PLAN

DCR will seek comments on this plan upon its release and gather valuable insights and feedback to inform its use and future updates. Beyond this initial public comment period, the Office will conduct periodic efforts to collect feedback from intended plan users through interviews and surveys. This feedback will ensure that opportunities for improvement are captured for future planning efforts.

Virginia Flood Protection Master Plan

The Virginia Flood Protection Master Plan (VFPMP) is under development. When released, it will provide an actionable framework for state government to use in crafting policies and programs to mitigate the impacts of flooding on people, the economy, and the environment. Unlike the CRMP, the VFPMP will address flood challenges across the entire Commonwealth.

The VFPMP will draw from key findings from this Phase II plan relevant to state policy, identifying opportunities which can be scaled beyond the coastal Virginia to address challenges in other parts of the state.

Acknowledgements

Phase II of the CRMP is the result of the collaborative efforts of practitioners and stakeholders throughout coastal Virginia. The Department of Conservation and Recreation extends a special thanks to the Coastal Resilience Technical Advisory Committee (TAC) members and alternates for their invaluable expertise, experience, and guidance in developing this plan. Special appreciation goes to the subcommittee chairs for their leadership in planning and coordinating our quarterly meetings. We are also grateful to TAC members for their dedication in crafting recommendations for the Office of Resilience Planning and other flood resilience stakeholders to implement over the next five years.

We would also like acknowledge the Office of Resilience Planning staff for their commitment to the successful development and release of this plan.

We are appreciative of the professional support, technical studies, and Coastal Resilience Web Explorer development provided by the Dewberry team. In addition, we thank the Stantec/Launch! team for supporting and developing report content and facilitation of outreach and engagement events. We also extend our thanks to the AECOM team for their support of outreach and engagement efforts thought this process.

Virginia Sea Grant provides access to high quality, compelling photos of coastal Virginia at no cost to users. Most of photography that appears in this plan was sourced from their extensive online photography database. DCR expresses its gratitude to the Virginia Sea Grant team for providing this public service to the Commonwealth.

Finally, we express our gratitude to the many regional, state, and local organizations, non-profits, and communities that have been working toward a more flood-resilient coastal Virginia. We value their leadership and support in crafting a better plan; many organizations provided critical inputs to help ensure this plan is a stronger document. Many partnerships were formed and strengthened during stakeholder engagement efforts, and we look forward to continuing our shared mission of addressing flooding and advancing flood resilience strategies through collaborative and coordinated efforts.

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Endnotes

EXECUTIVE SUMMARY

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