2737 - Henrico County Stream Gauge Network

Application Details

Funding Opportunity:	2337-Virginia Community Flood Preparedness Fund - Study Grants - CY24 Round 5
Funding Opportunity Due Date:	Jan 24, 2025 11:59 PM
Program Area:	Virginia Community Flood Preparedness Fund
Status:	Under Review
Stage:	Final Application
Initial Submit Date:	Jan 24, 2025 7:00 PM
Initially Submitted By:	Kristin Owen
Last Submit Date:	
Last Submitted By:	

Contact Information

Primary Contact Information

Active User*:	Yes
Type:	External User
Name*:	Ms. (Salutation) Kristin (First Name) Middle Name Owen (Last Name)
Title:	Floodplain and Dam Safety Manager
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Address*:	Henrico County PO Box 90775 Henrico (City) Virginia (State/Province) 23273 (Postal Code/Zip)
Phone*:	(804) 396-1156 Ext. Phone ###-###-####
Fax:	###-###-####
Comments:	

Organization Information

Status*:	Approved
Name*:	Henrico County
Organization Type*:	Local Government
Tax ID*:	54-6001344
Unique Entity Identifier (UEI)*:	H1QHB3BCK665
Organization Website:	https://henrico.gov/

Address*: Henrico County

PO Box 90775

Henrico (City) Virginia (State/Province) 23273- (Postal Code/Zip)

Phone*: (804) 396-1156 Ext.
###-###-####

Fax: ###-###-####

Benefactor:

Vendor ID:

Comments:

VCFPF Applicant Information

Project Description

Name of Local Government*: Henrico County

Your locality's CID number can be found at the following link: Community Status Book Report

NFIP/DCR Community Identification Number (CID)*: 510077

If a state or federally recognized Indian tribe,

Name of Tribe:

Authorized Individual*: Kristin (First Name) Owen (Last Name)

Mailing Address*: PO Box 90775
Address Line 1

Address Line 2

Henrico (City) Virginia (State) 23273-0775 (Zip Code)

Telephone Number*: 804-396-1156

Cell Phone Number*: 804-396-1156

Email*: owe042@henrico.gov

Is the contact person different than the authorized individual?

Contact Person*: No

Enter a description of the project for which you are applying to this funding opportunity

Project Description*:

Henrico County is applying for funding to install, monitor, and maintain a stream gauge network, in partnership with the US Geological Survey (USGS).

Low-income geographic area means any locality, or community within a locality, that has a median household income that is not greater than 80 percent of the local median household income, or any area in the Commonwealth designated as a qualified opportunity zone by the U.S. Secretary of the Treasury via his delegation of authority to the Internal Revenue Service. A project of any size within a low-income geographic area will be considered.

Is the proposal in this application intended to benefit a low-income geographic area as defined above?

Benefit a low-income geographic area*: No

Information regarding your census block(s) can be found at census.gov

Census Block(s) Where Project will Occur*: Countywide - see attachment for complete list

Is Project Located in an NFIP Participating Community?*: Yes

Is Project Located in a Special Flood Hazard Area?*: Yes

Flood Zone(s) (if applicable): Multiple - see attachment for complete list

Flood Insurance Rate Map Number(s) (if applicable): Multiple - see attachment for complete list

Eligibility - Round 4

Eligibility

Is the applicant a local government (including counties, cities, towns, municipal corporations, authorities, districts, commissions, or political subdivisions created by the General Assembly or pursuant to the Constitution or laws of the Commonwealth, or any combination of these)?

Local Government*: Yes

Yes - Eligible for consideration
No - Not eligible for consideration

If the applicant is not a town, city, or county, are letters of support from all affected local governments included in this application?

Letters of Support*: N/A

Yes - Eligible for consideration
No - Not eligible for consideration

Has this or any portion of this project been included in any application or program previously funded by the Department?

Previously Funded*: No

Yes - Not eligible for consideration
No - Eligible for consideration

Has the applicant provided evidence of an ability to provide the required matching funds?

Evidence of Match Funds*: Yes

Yes - Eligible for consideration
No - Not eligible for consideration
N/A - Match not required

Scope of Work - Studies - Round 4

Scope of Work

Upload your Scope of Work

Please refer to Part IV, Section B. of the grant manual for guidance on how to create your scope of work

Scope of Work*: 510077_HenricoCo_SOWNarrative.pdf

Comments:

Includes scope of work narrative (supporting documentation included on the application attachments page), budget narrative (includes Board authorization, County budget information, and USGS Agreement; detailed budget breakdown in excel provided below

Budget Narrative

Budget Narrative Attachment*: 510077_HenricoCo_BudgetNarrative.pdf

Comments:

This file is the detailed budget breakdown in excel. Narrative explanation is included in the scope of work attachment above.

Scoring Criteria for Studies - Round 4

Scoring

Revising floodplain ordinances to maintain compliance with the NFIP or to incorporate higher standards that may reduce the risk of flood damage. This must include establishing processes for implementing the ordinance, including but not limited to, permitting, record retention, violations, and variances. This may include revising a floodplain ordinance when the community is getting new Flood Insurance Rate Maps (FIRMs), updating a floodplain ordinance to include floodplain setbacks or freeboard, or correcting issues identified in a Corrective Action Plan.

Revising Floodplain Ordinances*: No

Select

Creating tools or applications to identify, aggregate, or display information on flood risk or creating a crowd-sourced mapping platform that gathers data points about real-time flooding. This could include a locally or regionally based web-based mapping product that allows local residents to better understand their flood risk.

Mapping Platform*: No
Select

Conducting hydrologic and hydraulic studies of floodplains. Applicants who create new maps must apply for a Letter of Map Revision or a Physical Map Revision through the Federal Emergency Management Agency (FEMA).

Hydrologic and Hydraulic Studies*: No
Select

Studies and Data Collection of Statewide and Regional Significance. Funding of studies of statewide and regional significance and proposals will be considered for the following types of studies:
Updating precipitation data and IDF information (rain intensity, duration, frequency estimates) including such data at a sub-state or regional scale on a periodic basis.

Updating Precipitation Data and IDF Information*: No
Select

Regional relative sea level rise projections for use in determining future impacts.

Projections*: No
Select

Vulnerability analysis either statewide or regionally to state transportation, water supply, water treatment, impounding structures, or other significant and vital infrastructure from flooding.

Vulnerability Analysis*: No
Select

Flash flood studies and modeling in riverine regions of the state.

Flash Flood Studies*: No
Select

Statewide or regional stream gauge monitoring to include expansion of existing gauge networks.

Stream Gauge Monitoring*: Yes
Select

New or updated delineations of areas of recurrent flooding, stormwater flooding, and storm surge vulnerability in coastal areas that include projections for future conditions based on sea level rise, more intense rainfall events, or other relevant flood risk factors.

Delineations of Areas of Recurrent Flooding*: No
Select

Regional flood studies in riverine communities that may include watershed-scale evaluation, updated estimates of rainfall intensity, or other information.

Regional Flood Studies*: No
Select

Regional Hydrologic and Hydraulic Studies of Floodplains

Regional Hydrologic and Hydraulic Studies of Floodplains*: No
Select

Studies of potential land use strategies that could be implemented by a local government to reduce or mitigate damage from coastal or riverine flooding.

Potential Land Use Strategies*: No
Select

Pluvial Studies

Pluvial Studies*: No
Select

Other proposals that will significantly improve protection from flooding on a statewide or regional basis.

Other Proposals*: No
Select

Is the project area socially vulnerable? (based on ADAPT Virginia?s Social Vulnerability Index Score)
Social Vulnerability Scoring:
Very High Social Vulnerability (More than 1.5)
High Social Vulnerability (1.0 to 1.5)
Moderate Social Vulnerability (0.0 to 1.0)
Low Social Vulnerability (-1.0 to 0.0)
Very Low Social Vulnerability (Less than -1.0)

Socially Vulnerable*: Moderate Social Vulnerability (0.0 to 1.0)

Is the proposed project part of an effort to join or remedy the community?s probation or suspension from the NFIP?

NFIP*: No

Is the proposed project in a low-income geographic area as defined below?

"Low-income geographic area" means any locality, or community within a locality, that has a median household income that is not greater than 80 percent of the local median household income, or any area in the Commonwealth designated as a qualified opportunity zone by the U.S. Secretary of the Treasury via his delegation of authority to the Internal Revenue Service. A project of any size within a low-income geographic area will be considered.

Low-Income Geographic Area*: No

Projects eligible for funding may also reduce nutrient and sediment pollution to local waters and the Chesapeake Bay and assist the Commonwealth in achieving local and/or Chesapeake Bay TMDLs.

Does the proposed project include implementation of one or more best management practices with a nitrogen, phosphorus, or sediment reduction efficiency established by the Virginia Department of Environmental Quality or the Chesapeake Bay Program Partnership in support of the Chesapeake Bay TMDL Phase III Watershed Implementation Plan?

Reduction of Nutrient and Sediment Pollution*: No

Comments:

Scope of Work Supporting Information - Studies

Scope of Work Supporting Information

Is the proposed study a new study or updates on a prior study?

New or Updated Study*: New Study

Describe the relationship of the study to the local government's needs for flood prevention and protection, equity, community improvement, identification of nature-based solutions or other priorities contained in this manual

Relationship of Study to Priorities Contained in this Manual*:

Henrico County is seeking funding to create a comprehensive, county-wide, hydrologic monitoring network to inform floodplain management, flood-risk reduction, and emergency management, and to inform potential future analysis of how changing climate and land-use patterns affect hydrology county-wide.

Describe the qualifications of the individuals or organizations charged with conducting the study or the elements of any request for proposal that define those qualifications

Qualifications of Individuals Conducting Study*:

USGS operates and maintains the largest stream gauge network in the world, with over 7,600 actives gauges in 2010. USGS will be responsible for the implementation, operation, and maintenance of the proposed monitoring network.

Describe the expected use of the study results in the context of the local resilience plan or, in the case of regional plans, how the study improves any regional approach

Expected use of Study Results*:

The monitoring network will be used to inform the County's Resilience Plan, as well as the regional Hazard Mitigation Plan. There is a significant gap in monitoring gauges within Central Virginia, and the installation of 21 gauges monitoring precipitation, flow, and water level will provide critical data to inform both local and regional planning efforts.

If applicable, describe how the study may improve Virginia's flood protection and prevention abilities in a statewide context (type N/A if not applicable)

Statewide Improvements*:

Precipitation data collected through this network will be used to develop more accurate precipitation graphs, providing critical context in changing climate trends within the Commonwealth.

Provide a list of repetitive and/or severe repetitive loss properties. Do not provide the addresses for the properties, but include an exact number of repetitive and/or severe repetitive loss structures within the project area

Repetitive Loss and/or Severe Repetitive Loss Properties*: 510077_HenricoCo_RepetitiveLoss.pdf

Describe the residential and commercial structures impacted by this project, including how they contribute to the community such as historic, economic, or social value. Provide an exact number of these structures in the project area

Residential and/or Commercial Structures*:

The Richmond Crater Hazard Mitigation Plan provides a Hazus 100-year Flood Damage Vulnerability assessment. Within Henrico County, results for a 100-year flood include 197 residential buildings within the FEMA SFHA receiving moderate damage (41-50% of value), as well as 383 residential buildings receiving substantial damage (over 50% of value). The combined building and content losses from this damage is estimated at over $300 million. Commercial damages are estimated at over $200 million.

If there are critical facilities/infrastructure within the project area, describe each facility

Critical Facilities/Infrastructure*:

There are 40 critical facilities within both the FEMA 100-year floodplain and the County floodplain. As this project impacts the entire County, they will all benefit from a hydrologic monitoring network.

Budget

Budget Summary

Grant Matching Requirement*: Flood Prevention and Protection Studies - Fund 50%/Match 50%

Is a match waiver being requested?

Match Waiver Request No

Note: Only low-income communities are eligible for a match waiver

*:

Total Project Amount (Request + Match)*: $1,124,170.00

**This amount should equal the sum of your request and match figures

REQUIRED Match Percentage Amount: $562,085.00

BUDGET TOTALS

Before submitting your application be sure that you meet the match requirements for your project type.

Match Percentage: 50.00%

Verify that your match percentage matches your required match percentage amount above.

Total Requested Fund Amount: $562,085.00

Total Match Amount: $562,085.00

TOTAL: $955,544.00

Personnel

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Fringe Benefits

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Travel

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Equipment

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Supplies

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Construction

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Contracts

Description	Requested Fund Amount	Match Amount	Match Source
USGS Joint Funding Agreement	$477,772.00	$477,772.00	Local Funding
	$477,772.00	**$477,772.00**	

Pre-Award and Startup Costs

Description	Requested Fund Amount	Match Amount	Match Source
Gauge Network Installation	$84,313.00	$84,313.00	Local Funding
	$84,313.00	**$84,313.00**	

Other Direct Costs

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Supporting Documentation

Supporting Documentation

Named Attachment	Required	Description	File Name
Detailed map of the project area(s) (Projects/Studies)		Overview Map of Hydrologic Monitoring & Maintenance Network	510077_HenricoCo_Ga
FIRMette of the project area(s) (Projects/Studies)		Overview Map including FEMA SFHA and Community SFHA	510077_HenricoCo_Ga
Historic flood damage data and/or images (Projects/Studies)		Excerpt from the regional Hazard Mitigation Plan detailing historic flooding events	510077_HenricoCo_Flo
A link to or a copy of the current floodplain ordinance		Copy of Chapter 10, Article I of the Henrico County Code (Floodplain Ordinance)	510077_HenricoCo_Flo
Maintenance and management plan for project			
A link to or a copy of the current hazard mitigation plan		Plan and appendices are available online here: https://planrva.org/emergency-management-home/the-alliance/hazard-mitigation/#:~:text=The%202022%20Richmond%2DCrater%20Multi,available%20to%20reduce%20those%20risks.	510077_HenricoCo_20

A link to or a copy of the current comprehensive plan	The current adopted County comprehensive plan, Henrico County Vision 2026, is available online here: https://henrico.us/planning/2026-comprehensive-plan/ The County is currently undergoing a 2045 comprehensive plan update. More information is available here: https://www.henriconext.us/about	510077_HenricoCo_20
Social vulnerability index score(s) for the project area	Social Vulnerability Index class by census block	510077_HenricoCo_Ce
Authorization to request funding from the Fund from governing body or chief executive of the local government	Approved Board Paper for authorization to request funding	510077_HenricoCo_Ap
Signed pledge agreement from each contributing organization	Joint funding agreement between USGS and Henrico County	510077_HenricoCo_US
Maintenance Plan	Overview of USGS maintenance standards	USGS Maintenance Fac

Benefit-cost analysis must be submitted with project applications over $2,000,000. in lieu of using the FEMA benefit-cost analysis tool, applicants may submit a narrative t narrative must explicitly indicate the risk reduction benefits of a flood mitigation project and compares those benefits to its cost-effectiveness.

Benefit Cost Analysis	
Other Relevant Attachments	

Letters of Support

Description	File Name	Type	Size	Upload Date
Letter of Support from the VA Department of Emergency Management	510077_HenricoCo_LetterOfSupport_VDEM.pdf	pdf	310 KB	01/24/2025 01:33 PM

Application to Develop a Stream Guage Network

Community Flood Preparedness Fund
2024 Funding, Round 5 | Study

Henrico County, Virginia
CID: 510077
January 24, 2025

Application to Develop a Stream Guage Network

SCOPE OF WORK NARRATIVE

Community Flood Preparedness Fund
2024 Funding, Round 5 | Study

Henrico County, Virginia
CID: 510077
January 24, 2025

TABLE OF CONTENTS

SCOPE OF WORK NARRATIVE 1

Introduction 1

Review of Needs & Problems 1

Goals & Objectives: 6

Work Plan: 6

Task 1: Site Selection and Preparation 6

Task 2: Installation of Monitoring Equipment 8

Task 3: Development of Web Application 8

Task 4: Data Collection and Analysis 9

Task 5: Ongoing Maintenance and Support 9

Maintenance Plan 9

Evaluation 10

Supporting Documentation 11

Scope of Work Narrative

Introduction

Henrico County is susceptible to riverine, pluvial, coastal, and dam flooding which impacts its residents, homes and businesses, landmarks, and the economic vitality of the county. Henrico County is seeking funding to create a comprehensive, county-wide, hydrologic monitoring network to inform floodplain management, flood-risk reduction, and emergency management, and to inform potential future analysis of how changing climate and land-use patterns affect hydrology county-wide.

Review of Needs & Problems

Henrico County has a history of flooding as evidenced by previous storm events, its 24,000 acres of floodplain, and the presence of 24 repetitive and severe repetitive loss properties in the county. Creating a comprehensive county-wide hydrologic monitoring network is a critical tool to advance a range of Henrico's resiliency and emergency management initiatives. The following narrative provides responses to the prompts in the 2024 Funding Manual for the Virginia Community Flood Preparedness Fund Round 5 ("2024 CFPF Manual").

a. Specific problem being solved (not just that flooding exists or may occur in the future).

This project addresses the critical issue of flood risk in Henrico County, which is exacerbated by its proximity to major rivers and low-lying areas. Flooding poses significant threats to public safety, property, and infrastructure. There is a significant gap in hydrologic monitoring within Central Virginia, and this lack of real-time data and accurate flood forecasting hampers effective flood management and emergency response, both within the County and the larger region.

b. Factors which contribute to the identified problem.

Henrico County is subject to flood threats from riverine, heavy rain, coastal, pluvial/stormwater, and dam sources. The County is bounded by two major rivers, the James River to the south, and the Chickahominy River to the north. Hydric soils within the County also result in slower drainage and naturally swampy areas. The County is also located in the Chesapeake Bay watershed, and the eastern portion of the County is tidally influenced, making it susceptible to future sea level rise impacts.

The County has a long-standing history of flooding impacts, dating back to 1771 when the James River reached a flood stage of 45 feet above normal conditions and killed about 150 people. Tropical weather events, including Hurricane Camille (August 1969), Hurricane Agnes (June 1972), Hurricane Juan (November 1985), and Hurricane Gaston (August 2004), have resulted in fatalities and hundreds of millions of dollars of damage. Additional information associated with these events is available on the County's Flood Resiliency Story Map here:
https://storymaps.arcgis.com/stories/f0b76754b9dd475ab3153c635c0bf241

Along the James River, the construction of the Richmond Flood Wall resulted in major flooding being reduced in parts of the City of Richmond, but areas upstream and downstream of the Richmond

Flood Wall within Henrico County are still susceptible to flooding. Additionally, downstream impacts from rain events happening in the western part of the state can result in high water levels on sunny days due to the time it takes for that water to make it through the watershed. Heavy rainfall events can also overwhelm the stormwater system in more urbanized areas of the County and lead to flash flooding. Heavy rainfall events in the spring and summer of 2018 caused widespread flooding throughout the County, resulting in water rescues and transportation system impacts, including multiple washouts of roadways and a brief closure of the Richmond International Airport.

Additionally, there are 35 dams in the County. Five of these dams are owned by the County and regulated by the state: Canterbury (Pump Rd.) Dam, Echo Lake Dam, Cox Rd. Dam, Wyndham Dam, and Wellesley Dam. During one of the heavy rainfall events in the spring and summer of 2018 mentioned above, the Canterbury Dam overtopped, resulting in significant flooding of downstream properties and several road closures.

The County has mapped areas of repetitive and recurrent flooding, as shown in Figure 1 below. In addition, there are more than 2,000 properties with known flood risk (further defined in the response to prompt g) which is likely to increase over time due to changing climate patterns and land use. In addition to properties, infrastructure and environmental resources are at risk of flooding.

According to the National Oceanic and Atmospheric Administration (NOAA) Mid Atlantic Regional Integrated Sciences and Assessments (MARISA) team, heavy rainfall is increasing in frequency and intensity within the County. Annual rainfall in Henrico County will likely increase by an average of 2 inches (2050-2079 average compared to the 1990-2019 average).[1] The County will also be subject to rising sea level conditions. Based on NOAA 2022 projections for the Richmond scenario marker, the area will experience increases to the Mean High High Water levels between 1.21 feet and 1.67 feet by 2050, for the intermediate low and high scenarios, respectively. By 2100, these levels rise to 2.43 feet and 6.69 feet, emphasizing the need to plan for changing future conditions.

[1] Penn State University. Marisa. https://www.marisa.psu.edu/misc/outlooks/2022-01-11/VA/Henrico_County_VA.pdf

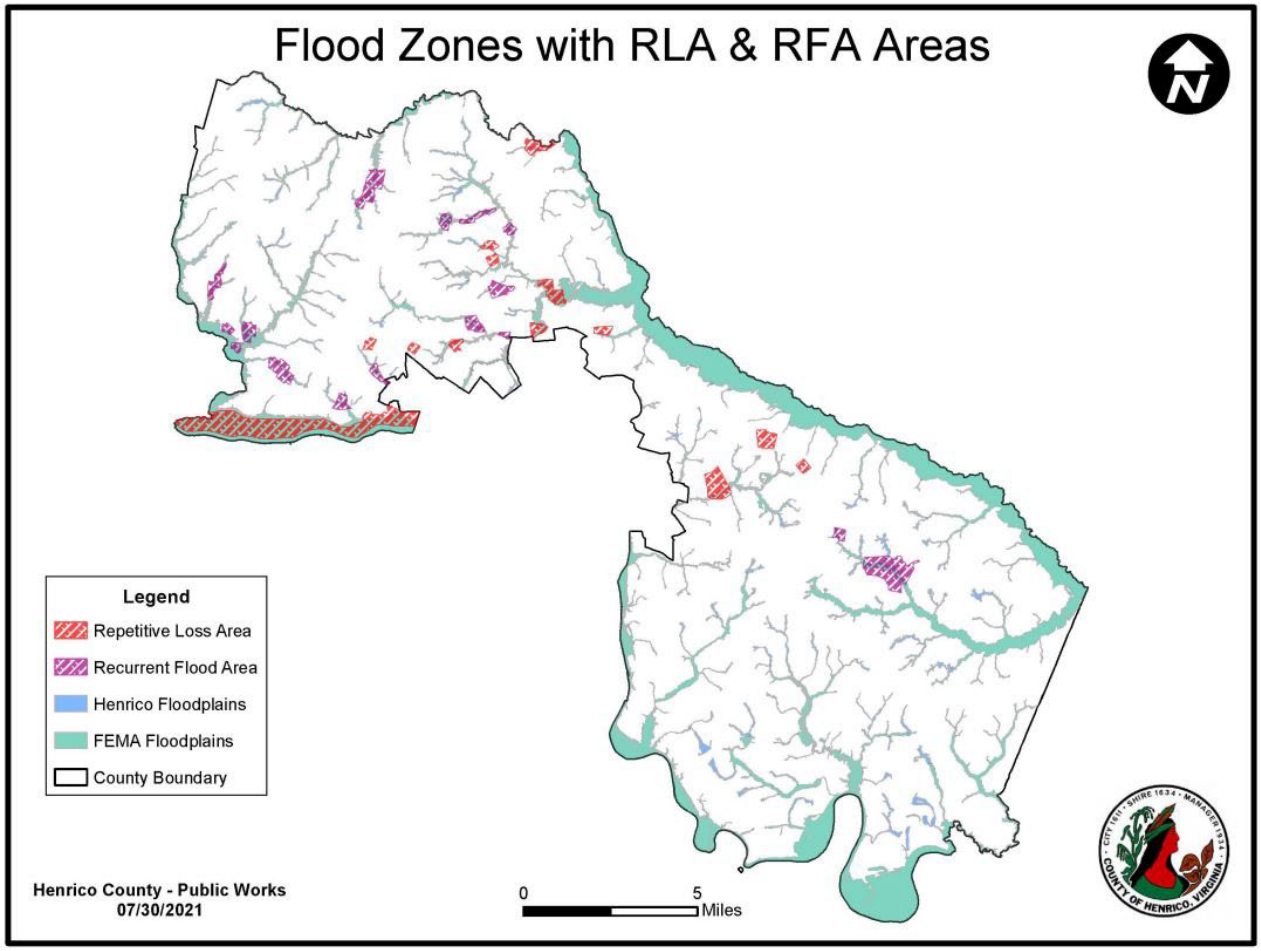


Figure 1: Henrico County Repetitive Loss and Recurrent Flood Areas

c. Why the project is needed either locally or regionally.

This project is crucial for Henrico County and the surrounding region due to its significant role in managing flood risks, adapting to climate change, and ensuring community safety. Locally, the hydrologic monitoring network will provide real-time data to predict and manage flooding, protect homes and infrastructure, and enhance emergency preparedness. Regionally, this project will address a key gap within the state's monitoring network, providing data that can inform precipitation modeling and regional planning efforts.

d. How the project decreases the risk to public safety through flood risk reduction.

By continuously monitoring water levels and weather conditions, the hydrologic network will provide up-to-date information, allowing for timely warnings and alerts. Accurate data helps predict when and where floods are likely to occur, enabling better planning and preventive measures. The data will guide decisions on where to build, ensuring new development is not placed in high-risk flood zones, thus reducing future flood damage. This data will also provide information on flooded roads, so the County can adequately prepare in advance of storms, provide warning notifications to residents and commuters, and influence mitigation projects to reduce flooding and road closures.

e. How the project protects or conserves natural resources.

High quality hydrologic data will guide conservation planning and implementation measures, ensuring the preservation of the County's floodplains and wetlands. Data provided by this stream gauge network will be used in planning efforts to address watershed management, flood risk, development of County Capital Improvement Projects, and more. Overall, this will help the County promote sustainable water management practices that benefit both the environment and the community.

f. Who or what is protected.

This project will benefit all residents, workers, and visitors within Henrico County by providing real time updates for inundated transportation corridors and guiding sustainable land use practices.

g. The safety threats, or environmental concerns related to flood risk.

Historic flooding events within Henrico County have threatened resident safety and in extreme circumstances, resulted in fatalities. During severe storm events, flooding can impact roadway conditions at certain stream crossings in the County. Within Henrico's currently mapped floodplains, there are approximately 1,500 residential and commercial structures. The County also has approximately 7,000 residential properties with known drainage issues. The County Department of Public Works continues to gather data on reported flooding and drainage concerns.

Flood risk in the County will also be impacted by sea level rise and changing rainfall patterns. Sea level rise can impact sensitive tidal wetland habitats. Land area loss can also result from permanent inundation. This hydrologic monitoring effort will help to prioritize preservation of ecological sensitive areas.

h. Groups who might directly benefit from this flood risk reduction effort.

The hydrologic monitoring network will provide benefits to the entire county, as it will inform planning at both local and regional levels. The development of the web application to host hydrological data is especially valuable for residents, as it provides another tool to describe flood risk within the County. It is vital to provide near real-time updates on flooding, especially for the approximately 1500 residential and commercial structures within the combined SFHA. Overall, the project will help protect lives, property, and natural resources across Henrico County. Additionally, residents and commuters within the entire region will benefit from this effort.

i. What would happen (or not happen) if the applicant does not receive funding.

If Henrico County does not receive funding for the hydrologic monitoring network, it will face increased flood risks, reduced emergency preparedness, and environmental degradation. Additionally, the region and state will be impacted by continuing to have a lack of hydrologic data within this region. Currently, there are two stream gauges on the James River in this area, and there are none on the Chickahominy River or smaller streams and creeks throughout the County. There are currently no known plans for other entities to increase the number of gauges in the region. The

need for a comprehensive hydrologic monitoring network has been well established within the County and the region, but a lack of funding could greatly delay the implementation of this work.

j. Alternatives analysis of the viability of the project, how selected project reduces risk to populations at risk of flooding. Provide examples of current or previous related projects, data, outcomes etc. that justify the approach chosen. Include how long and how much protection to be achieved.

The hydrologic monitoring network project in Henrico County is a viable and essential initiative for reducing flood risks and protecting vulnerable populations. Supported by a joint-funding agreement between the U.S. Geological Survey (USGS) and Henrico County, the project will implement a comprehensive network of precipitation and stream gauges to collect real-time hydrologic data. This data will enhance long-term flood prediction and management, enabling timely warnings and better emergency response. Similar projects by the USGS, such as the Great Lakes Water Availability Pilot Project, have demonstrated the effectiveness of real-time data collection in managing water resources and reducing flood risks.

k. Relationship to Other Projects

Henrico County is proactive in addressing resiliency issues, and as such there are a number of initiatives that will benefit from this monitoring network. The data collected will inform both the County's local Resilience Plan, as well as the regional Hazard Mitigation Plan. Additional priorities including the development of precipitation graphs, inundation mapping, forecasting, and potential flood warning systems are reliant on this data for future implementation. Additionally, the data provided by this stream gauge network will be instrumental in updating and maintaining flood risk modeling throughout the county, for both riverine and pluvial flooding.

l. Residential/Commercial Structures

Henrico County has approximately 1500 residential and commercial structures in the FEMA and Community SFHA. However, the data provided by this stream gauge network will be used to improve flood risk reduction, emergency preparedness, and other initiatives countywide, so all residential and commercial structures could benefit from this initiative.

m. Critical Facilities/Infrastructure

Henrico County has 32 critical facilities in the FEMA SFHA, and an additional 8 facilities in within the Community SFHA. However, the data provided by this stream gauge network will be used to improve flood risk reduction, emergency preparedness, and other initiatives countywide, so all critical facilities and infrastructure could benefit from this initiative.

n. No Adverse Impact

As a monitoring effort, this project has no potential to adversely impact the floodplain or Henrico residents. It will, however, allow the County to measure hydrologic conditions, helping to ensure future development does not adversely impact the property and rights of others.

o. Local Floodplain Management

Any stream gauges installed within the SFHA will be done in accordance with the local floodplain ordinance requirements. Additionally, this project will support the local floodplain management program by providing data that will be used to update local flood hazard maps. Link to Floodplain Ordinance: Chapter 10 - ENVIRONMENT
https://henrico.gov/pdfs/countyattorney/Chpt010Environment.pdf

Goals & Objectives:
Henrico County has established the following Goals and Objectives for the planning process.

Table 1: Goals and Objectives

Goal 1: Ensure comprehensive and accurate monitoring of precipitation and streamflow across Henrico County to support effective flood risk management and water resource planning.	Objective 1.1: Install and operate a network of precipitation and stream gauges
Goal 2: Create an intuitive and user-friendly platform that allows Henrico County staff and residents to easily access and interpret real-time hydrologic data, enhancing community awareness and engagement.	Objective 2.1: Develop a web application for data access
Goal 3: Deliver timely and reliable hydrologic data to inform floodplain management decisions and improve emergency response efforts, ultimately reducing flood risks and protecting public safety.	Objective 3.1: Provide real-time data to support floodplain management and emergency response

Work Plan:
TASK 1: SITE SELECTION AND PREPARATION

- **Activities**: Conduct site reconnaissance; finalize monitoring locations.
- **Responsible**: USGS Field Team
- **Timeframe**: January 2025 - June 2025
- **Partners**: Henrico County, USGS
- **Deliverables**: Final list of gauge locations

Table 2: Proposed Gauge Locations

Gage Number	Location Description	Gage Function	Flood Hazard Area ID	Study Type	Flood Zone Designation	Floodway Designation
PR-01	River Rd	Gauge - Water Level and Flow Rates	51087C_1093	SFHA with BFE & floodway	AE	FLOODWAY
PR-03	U of R Drive	Gauge - Precipitation, Water Level and Flow Rates	51087C_670	SFHA with unpublished BFE	A	-
PR-05	Old Washington Hwy (North Run)	Gauge - Water Level and Flow Rate	-	Community SFHA	-	-
PR-06	Mountain Road (North Run)	Gauge - Water Level and Flow Rates	51087C_1253	SFHA with BFE & floodway	AE	FLOODWAY
PR-08	Westwood Trail near CSX Railroad	Gauge - Precipitation, Water Level and Flow Rates	-	Community SFHA	-	-
PR-09	Spring Park (Upham Brook)	Gauge - Precipitation, Water Level and Flow Rates	51087C_1040	SFHA with BFE & floodway	AE	FLOODWAY
PR-10	Hillard Road (North Run)	Gauge - Water Level and Flow Rates	51087C_1040	SFHA with BFE & floodway	AE	FLOODWAY
PR-11	RHT & Lark Drive (Horse Creek)	Gauge - Precipitation, Water Level, Flow Rates and Temperature of road if possible	51087C_761	SFHA with unpublished BFE	A	-
PR-12	Wilkinson Road (Upham Brook)	Gauge - Water level and Flow Rates	51087C_1040	SFHA with BFE & floodway	AE	FLOODWAY
PR-13	Chamberlayne Road (Chickahomi	Gauge - Precipitation, Water Level	51087C_1472	SFHA with BFE no floodway	AE	-

	ny River @ countyline)	and Flow Rates (VDOT)				
PR-16	Creighton Road (Chickahominy River @ countyline)	Gauge - Precipitation, Water Level and Flow Rates	51087C_1472	SFHA with BFE no floodway	AE	-
PR-18	Doran Road (Fourmile Creek)	Gauge - Precipitation, Water Level, Flow Rates and Temperature of road if possible	51087C_240	SFHA with BFE & floodway	AE	FLOODWAY
PR-19	Kingsland Road	Gauge - Precipitation, Water Level and Flow Rates	51087C_240	SFHA with BFE & floodway	AE	FLOODWAY
PR-20	Portugee Road (White Oak Swamp)	Gauge - Precipitation, Water Level, Flow Rates and Temperature of road if possible	51087C_1409	SFHA with unpublished BFE	A	-

TASK 2: INSTALLATION OF MONITORING EQUIPMENT

- **Activities**: Install precipitation gages; install stream gauges; set up data loggers and telemetry systems.
- **Responsible**: USGS Technical Team.
- **Timeframe**: January 2025 - June 2025.
- **Partners**: Henrico County, USGS.
- **Deliverables**: Installed Precipitation and Stream gauges.

TASK 3: DEVELOPMENT OF WEB APPLICATION

- **Activities**: Design and develop the web application; integrate real-time data feeds.
- **Responsible**: USGS IT Team
- **Timeframe**: January 2025 - June 2025
- **Partners**: Henrico County, USGS
- **Deliverables**: Operational Web Application

TASK 4: DATA COLLECTION AND ANALYSIS

- **Activities**: Collect real-time hydrologic data; analyze data for flood prediction and management
- **Responsible**: USGS Hydrologists
- **Timeframe**: July 2025 - June 2028
- **Partners**: Henrico County, USGS
- **Deliverables**: Real-Time Hydrologic Data

TASK 5: ONGOING MAINTENANCE AND SUPPORT

- **Activities**: Regular maintenance of monitoring equipment; update and maintain the web application
- **Responsible**: USGS Technical Team
- **Timeframe**: July 2025 - June 2028
- **Partners**: Henrico County, USGS
- **Deliverables**: Continued operation of gauge network

MAINTENANCE PLAN

All maintenance for the stream gauge network will be handed by USGS in accordance with their federal agency guidelines. USGS is well suited to this task as the gold standard in streamflow monitoring nationwide. A fact sheet outlined their maintenance tasks has been included with the scope of work narrative. Henrico County has a signed agreement with USGS to fund the stream gauge network for at least the next five years. However, Henrico County is committed to continuing the stream gauge network into the future and intends to renew the five-year agreement with USGS.

Table 3: Project Schedule

Task #	Task Name	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Jun-28
Task 1	**Project Planning and Coordination**	X	X	X	X	X	X	X	X
Task 2	**Site Selection and Preparation**	X	X	X	X	X	X		
Task 3	**Installation of Monitoring Equipment**	X	X	X	X	X	X		
Task 4	**Development of Web Application**	X	X	X	X	X	X		
Task 5	**Data Collection and Analysis**							X	X

Task #	Task Name	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Jun-28
Task 6	**Community Engagement and Education**							X	X
Task 7	**Ongoing Maintenance and Support**							X	X

Evaluation

a. Indicators of success.

The following indicates measures of success for the Henrico County Stream Gauge Network.

Table 4: Measures of Success

Performance Output	Measurement
Complete installation of 21 new monitoring stations (7 standalone precipitation gages, 5 standalone stream gauges, and 9 co-located precipitation gages and stream gauges).	Number of stations successfully installed and operational by the end of the first fiscal year (June 30, 2025).
Continuous collection and public availability of hydrologic data from all monitoring stations.	Percentage of time data is available on the USGS National Water Information System (NWISWeb) within 1 hour of collection.
Creation and maintenance of a web application to serve hydrologic data specific to Henrico County.	Completion and launch of the web application by the end of the first fiscal year (June 30, 2025), and user satisfaction ratings collected through feedback surveys.
Effective use of collected data for floodplain management and emergency response.	Number of flood management decisions and emergency responses informed by the monitoring data.

b. Data that will be collected and how the data will be used to measure success.

The project will collect precipitation and streamflow data using advanced monitoring equipment, with data available in near real-time on the USGS National Water Information System. Success will be measured by the installation and operational status of monitoring stations, data availability, accuracy of measurements, and the effective use of data for flood management and emergency response. Community feedback and adherence to the project timeline and budget will also be key indicators of success.

c. How was cost effectiveness evaluated and measured against the expected outcomes?

Cost-effectiveness for the hydrologic monitoring network project was evaluated by comparing the costs of implementing and operating the network against the expected benefits and outcomes. This involved analyzing the costs of equipment, installation, maintenance, and data management against the anticipated improvements in flood management, community safety, and data availability.

The evaluation included:

- Cost Analysis: Detailed accounting of all project expenses, including initial setup and ongoing operational costs.
- Outcome Measurement: Assessment of the project's impact on flood risk reduction, data accuracy, and community engagement.
- Cost-Effectiveness Ratio: Calculation of the cost per unit of effectiveness, such as cost per monitoring station installed or cost per data point collected.
- Comparison with Alternatives: Evaluation of the proposed network against other potential solutions or existing systems to determine the most efficient use of resources.

By using these methods, the project ensured that the investment would yield significant benefits in terms of improved flood management and community resilience, justifying the costs involved.

d. What products, services, meetings, outreach efforts etc. will be conducted and how will success be measured?

The project will produce 21 hydrologic monitoring stations, a web application, and continuous hydrologic data, with success measured by installation completion, data availability, and user satisfaction. Services include data collection and network maintenance, evaluated by data accuracy and adherence to schedules. Stakeholder engagement will also be measured by the quality of collaboration and feedback received.

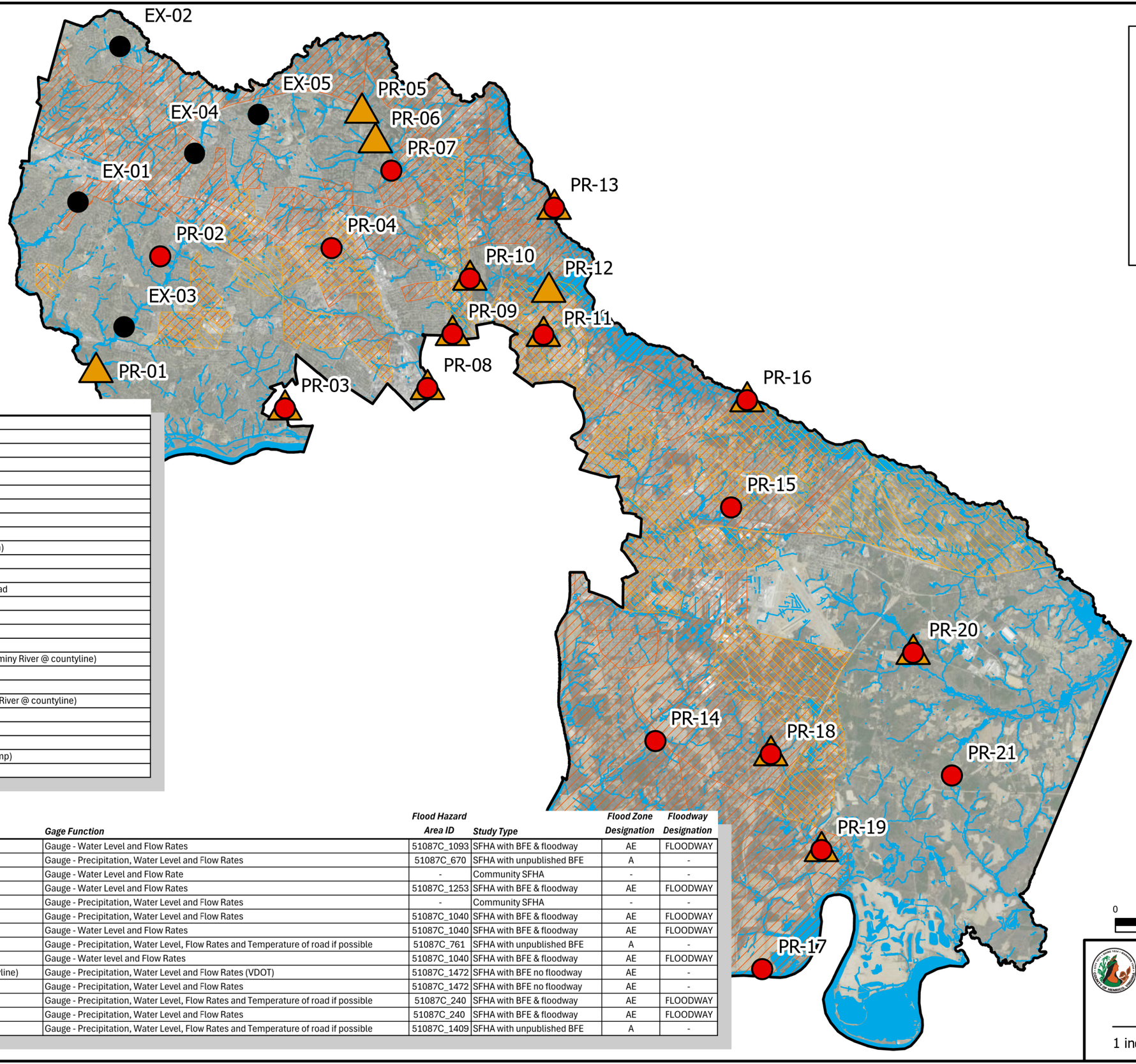
e. Project progress monitoring plan to ensure project meets the requirements of the agreement and is delivered on time. Outline how delays or other findings may be used to modify or improve outcomes/deliverables.

Throughout the period of performance, the County and USGS will track progress of the project development and ensure reporting is completed and deliverables submitted on time. The project will be monitored through monthly progress reviews, quarterly budget reviews, and stakeholder feedback. Delays or issues will be addressed by adjusting timelines, reallocating resources, and implementing continuous improvement measures, as needed. This plan ensures the project meets the agreement requirements and is delivered on time, while being adaptable to challenges.

Supporting Documentation

- Census Block Data (.xlsx)
- Detailed Project Map (.pdf)
- Letters of Support from the VA Department of Emergency Management (VDEM) (.pdf)
- Hazard Mitigation Plan (.pdf)
- Comprehensive Plan (.pdf)

- Floodplain Ordinance (.pdf)
- Appendix C Checklist (.pdf)
- USGS Maintenance Fact Sheet (.pdf)



Legend

- Communities of Color
- Low Income Communities

Henrico Co Gages

- Existing
- Precipitation
- Water Level

Gage Status	*Gage ID*	*Gage Name*
Existing	EX-01	Wellesley Lake Dam
Existing	EX-02	Wyndham Lake Dam
Existing	EX-03	Canterbury Lake Dam
Existing	EX-04	Cox Road Dam
Existing	EX-05	Echo Lake Dam
Proposed	PR-01	River Rd
Proposed	PR-02	Deep Run Park
Proposed	PR-03	U of R Drive
Proposed	PR-04	County Offices - Parham Road
Proposed	PR-05	Old Washington Hwy (North Run)
Proposed	PR-06	Mountain Road (North Run)
Proposed	PR-07	Woodman Depot
Proposed	PR-08	Westwood Trail near CSX Railroad
Proposed	PR-09	Spring Park (Upham Brook)
Proposed	PR-10	Hillard Road (North Run)
Proposed	PR-11	RHT & Lark Drive (Horse Creek)
Proposed	PR-12	Wilkinson Road (Upham Brook)
Proposed	PR-13	Chamberlayne Road (Chickahominy River @ countyline)
Proposed	PR-14	Varina Library
Proposed	PR-15	Eastern Henrico Rec Center
Proposed	PR-16	Creighton Road (Chickahominy River @ countyline)
Proposed	PR-17	Varina on the James
Proposed	PR-18	Doran Road (Fourmile Creek)
Proposed	PR-19	Kingsland Road
Proposed	PR-20	Portugee Road (White Oak Swamp)
Proposed	PR-21	Darbytown

Gage Number	*Location Description*	*Gage Function*	*Flood Hazard Area ID*	*Study Type*	*Flood Zone Designation*	*Floodway Designation*
PR-01	River Rd	Gauge - Water Level and Flow Rates	51087C_1093	SFHA with BFE & floodway	AE	FLOODWAY
PR-03	U of R Drive	Gauge - Precipitation, Water Level and Flow Rates	51087C_670	SFHA with unpublished BFE	A	-
PR-05	Old Washington Hwy (North Run)	Gauge - Water Level and Flow Rate	-	Community SFHA	-	-
PR-06	Mountain Road (North Run)	Gauge - Water Level and Flow Rates	51087C_1253	SFHA with BFE & floodway	AE	FLOODWAY
PR-08	Westwood Trail near CSX Railroad	Gauge - Precipitation, Water Level and Flow Rates	-	Community SFHA	-	-
PR-09	Spring Park (Upham Brook)	Gauge - Precipitation, Water Level and Flow Rates	51087C_1040	SFHA with BFE & floodway	AE	FLOODWAY
PR-10	Hillard Road (North Run)	Gauge - Water Level and Flow Rates	51087C_1040	SFHA with BFE & floodway	AE	FLOODWAY
PR-11	RHT & Lark Drive (Horse Creek)	Gauge - Precipitation, Water Level, Flow Rates and Temperature of road if possible	51087C_761	SFHA with unpublished BFE	A	-
PR-12	Wilkinson Road (Upham Brook)	Gauge - Water level and Flow Rates	51087C_1040	SFHA with BFE & floodway	AE	FLOODWAY
PR-13	Chamberlayne Road (Chickahominy River @ countyline)	Gauge - Precipitation, Water Level and Flow Rates (VDOT)	51087C_1472	SFHA with BFE no floodway	AE	-
PR-16	Creighton Road (Chickahominy River @ countyline)	Gauge - Precipitation, Water Level and Flow Rates	51087C_1472	SFHA with BFE no floodway	AE	-
PR-18	Doran Road (Fourmile Creek)	Gauge - Precipitation, Water Level, Flow Rates and Temperature of road if possible	51087C_240	SFHA with BFE & floodway	AE	FLOODWAY
PR-19	Kingsland Road	Gauge - Precipitation, Water Level and Flow Rates	51087C_240	SFHA with BFE & floodway	AE	FLOODWAY
PR-20	Portugee Road (White Oak Swamp)	Gauge - Precipitation, Water Level, Flow Rates and Temperature of road if possible	51087C_1409	SFHA with unpublished BFE	A	-

N

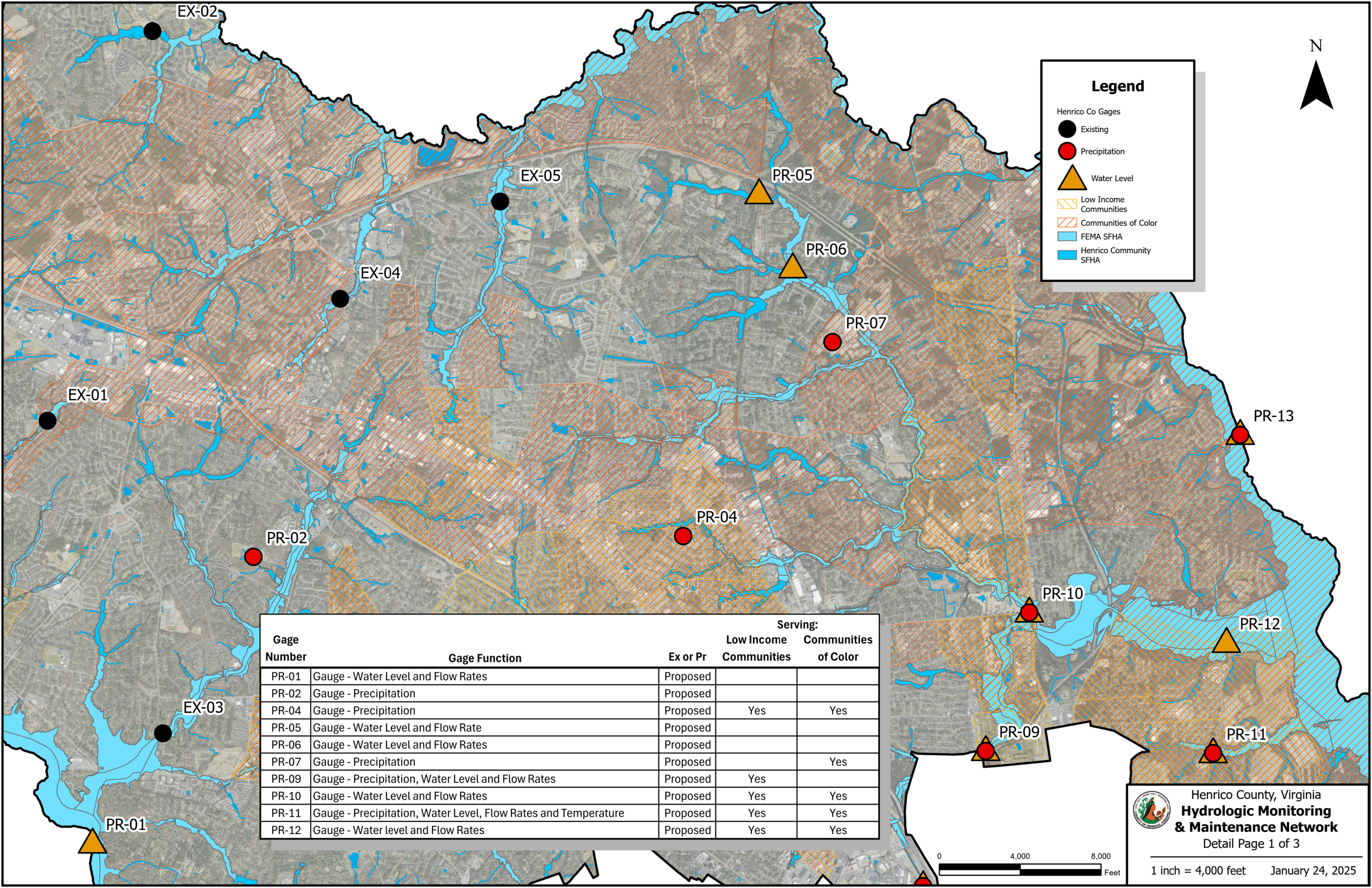
0 12,500 25,000 Feet

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

KEY MAP

1 inch = 12,000 feet January 24, 2025



Gage Number	Gage Function	Ex or Pr	Serving: Low Income Communities	Serving: Communities of Color
PR-01	Gauge - Water Level and Flow Rates	Proposed		
PR-02	Gauge - Precipitation	Proposed		
PR-04	Gauge - Precipitation	Proposed	Yes	Yes
PR-05	Gauge - Water Level and Flow Rate	Proposed		
PR-06	Gauge - Water Level and Flow Rates	Proposed		
PR-07	Gauge - Precipitation	Proposed		Yes
PR-09	Gauge - Precipitation, Water Level and Flow Rates	Proposed	Yes	
PR-10	Gauge - Water Level and Flow Rates	Proposed	Yes	Yes
PR-11	Gauge - Precipitation, Water Level, Flow Rates and Temperature	Proposed	Yes	Yes
PR-12	Gauge - Water level and Flow Rates	Proposed	Yes	Yes

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

Detail Page 1 of 3

1 inch = 4,000 feet

January 24, 2025

PR-08

PR-03

PR-16

PR-15

N

Legend

Henrico Co Gages

- Existing
- Precipitation
- Water Level

- Low Income Communities
- Communities of Color
- FEMA SFHA
- Henrico Community SFHA

Gage Number	Gage Function	Ex or Pr	Serving: Low Income Communities	Serving: Communities of Color
PR-03	Gauge - Precipitation, Water Level and Flow Rates	Proposed		Yes
PR-08	Gauge - Precipitation, Water Level and Flow Rates	Proposed		
PR-15	Gauge - Precipitation	Proposed	Yes	Yes
PR-16	Gauge - Precipitation, Water Level and Flow Rates	Proposed		

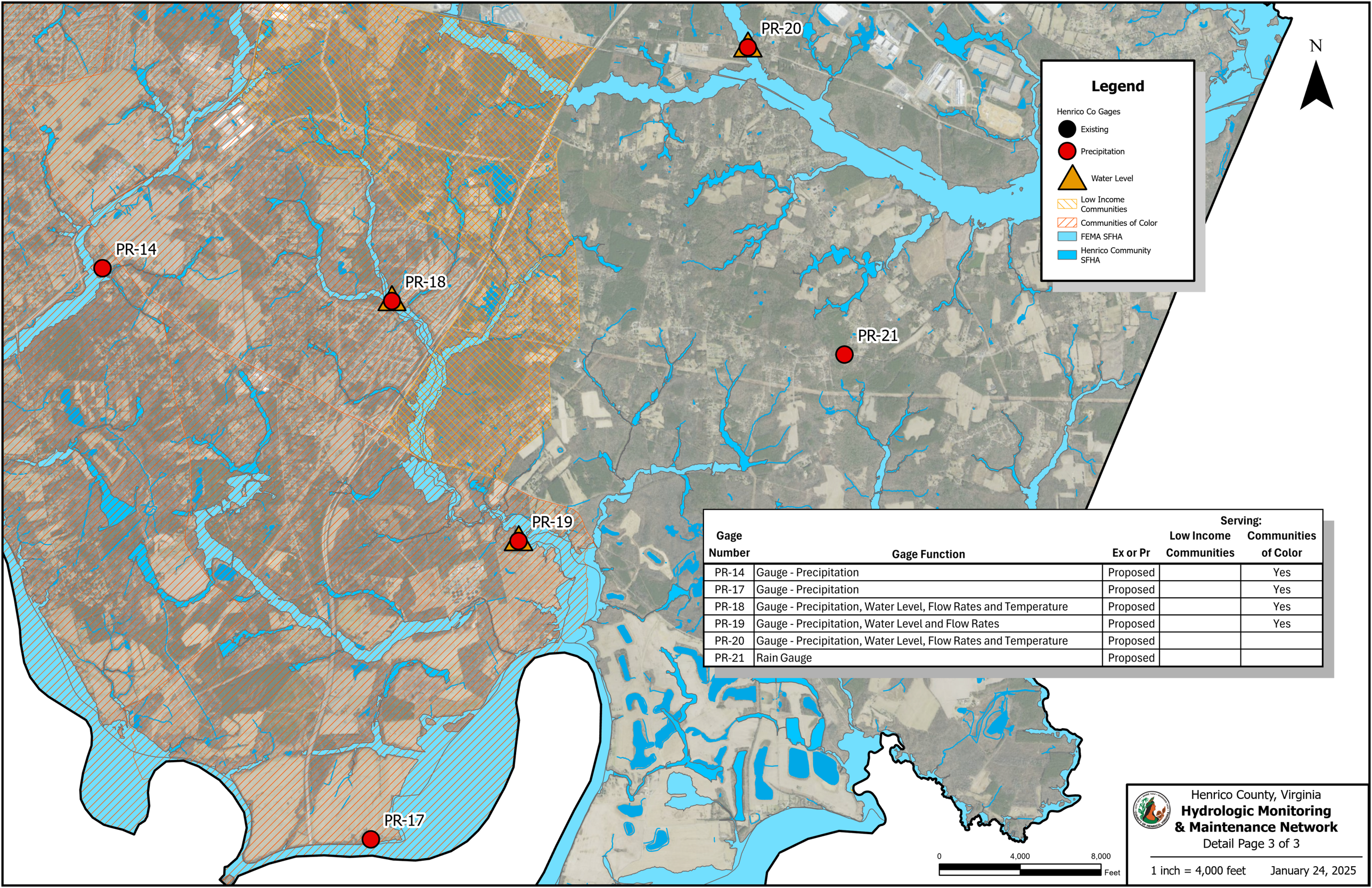
0 4,000 8,000 Feet

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

Detail Page 2 of 3

1 inch = 4,000 feet January 24, 2025



Gage Number	Gage Function	Ex or Pr	Serving: Low Income Communities	Serving: Communities of Color
PR-14	Gauge - Precipitation	Proposed		Yes
PR-17	Gauge - Precipitation	Proposed		Yes
PR-18	Gauge - Precipitation, Water Level, Flow Rates and Temperature	Proposed		Yes
PR-19	Gauge - Precipitation, Water Level and Flow Rates	Proposed		Yes
PR-20	Gauge - Precipitation, Water Level, Flow Rates and Temperature	Proposed		
PR-21	Rain Gauge	Proposed		

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

Detail Page 3 of 3

1 inch = 4,000 feet

January 24, 2025

USGS
science for a changing world

U.S. Geological Survey Streamgage Operation and Maintenance Cost Evaluation

...from the National Streamflow Information Program

This Fact-Sheet is one in a series that highlights information or recent research findings from the USGS National Streamflow Information Program (NSIP). The investigations and scientific results reported in this series require a nationally consistent streamgage network with stable long-term monitoring sites and a rigorous program of data collection, quality assurance, management, archiving, and synthesis. NSIP produces multipurpose, unbiased surface-water information that is readily accessible to all.

To help meet the goal of providing earth-science information to the Nation, the U.S. Geological Survey (USGS) operates and maintains the largest streamgage network in the world, with over 7,600 active streamgages in 2010. This network is operated in cooperation with over 850 Federal, tribal, State, and local funding partners. The streamflow information provided by the USGS is used for the protection of life and property; for the assessment, allocation, and management of water resources; for the design of roads, bridges, dams, and water works; for the delineation of flood plains; for the assessment and evaluation of habitat; for understanding the effects of land-use, water-use, and climate changes; for evaluation of water quality; and for recreational safety and enjoyment.

USGS streamgages are managed and operated to rigorous national standards, allowing analyses of data from streamgages in different areas and spanning long time periods, some with more than 100 years of data. About 90 percent of USGS streamgages provide streamflow information real-time on the web. Physical measurements of streamflow are made at streamgages multiple times a year, depending on flow conditions, to ensure the highest level of accuracy possible. In addition, multiple reviews and quality assurance checks are performed before the data is finalized.

In 2006, the USGS reviewed all activities, operations, equipment, support, and costs associated with operating and maintaining a streamgage program (Norris and others, 2008). A summary of the percentages of costs associated with activities required to operate a streamgage on an annual basis are presented in figure 1. This information represents what it costs to fund a "typical" USGS streamgage and how those funds are utilized. It should be noted that some USGS streamgages have higher percentages for some categories than do others depending on location and conditions. Forty-one percent of the funding for the typical USGS streamgage is for labor costs of the USGS staff responsible for the measurement of the streamflow in the field and the time in the office to quality assure and finalize the data (fig. 1). It is reasonable that funding for the entire national streamgage network would closely follow the percentages shown in figure 1 as to how the funds are invested in the network. However, actual costs are specific to a particular streamgage and can vary substantially depending on location and operational issues.

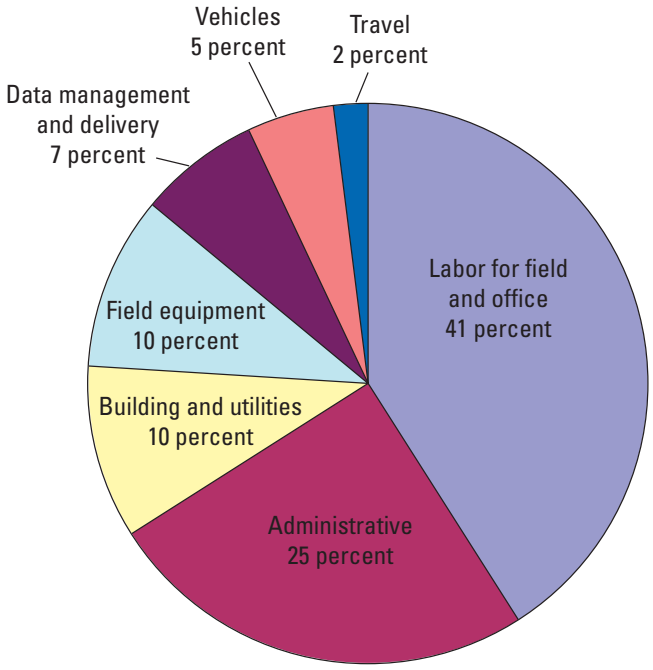


Figure 1. Percentage of operation and maintenance funding invested in various activities for a typical USGS streamgage.

Reference Cited

Norris and others, 2008, Qualitative comparison of streamflow information programs of the U.S. Geological Survey and three non-Federal agencies: U.S. Geological Survey Open-File Report 2007–1426, 12 p.

USGS Streamflow Information can be found at:

- *http://waterdata.usgs.gov/nwis*
- *http://water.usgs.gov/waterwatch*
- *http://water.usgs.gov/nsip*

by J. Michael Norris

Streamgage Operation and Maintenance Tasks

Labor for Field and Office:

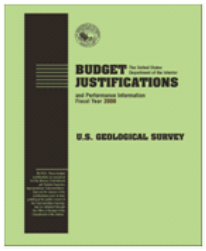
Field

- Routine visits to streamgages
- Emergency repair visits to streamgages
- Visits during flooding
- Maintenance and inspection visits
- Surveying visits
- Streamflow measurements
- Analysis of the discharge computations (field and office)
- Technical training

Office

- Stage data edits
- Development and maintenance of rating curves
- Analysis of rating curve-shifts from changing channel conditions
- Monitoring real-time information for instrumentation problems
- Review of records for rating-curve and discharge computations
- Quality assurance of the data
- Finalization and publication of the streamflow information
- Safety and administrative training

Administrative:



- Safety program management
- National and local management and technical oversight of the program
- Local quality assurance
- Facility costs
- Personnel management
- Purchasing and contracts
- Financial management
- Salary of hydrographers/supervisors
- Salary of administrative support required by the program
- Funding-partner interactions (over 850 nationwide)
- USGS communications (with Congress, the public, and media)
- Development of funding agreements

Building and Utilities:

- Secure storage space for files
- Vehicle parking space, boat storage
- Shop space, laboratory space, warehouse space

- Office space for the streamgage program staff
- Heating, cooling, trash, water, gas, and electric power for office space and streamgages

Field Equipment:

- Gage houses, data loggers, stage or velocity sensors, telemetry equipment, and other equipment for streamgage operation
- Boats and motors, boat maintenance, snowmobiles, all-terrain vehicles, and annual repair and maintenance costs
- Generators, survey equipment, field laptop computers, and hand and power tools
- Equipment for measuring streamflow (meters, Acoustic Doppler Current Profilers, bridge cranes, and automated loggers)
- Safety equipment such as traffic-control equipment and confined-space safety equipment
- Waders, personal floatation devices, and cell phone

Data Management and Delivery:

- Telemetry (satellite up-links, phone lines, etc.)

- Local Information Technology infrastructure, including servers, computers, printers, plotters, and scanners
- Information Technology support, support of the data base, Web access, data archival and retrieval, and network communications

Vehicles:

- Purchasing or leasing field vehicles
- Fuel and vehicle maintenance

Travel:

- Lodging and per diem for staff during visits to streamgages

Appendix C: Checklist All Categories

☑ **Detailed map of the project area(s) (Projects/Studies)**

- A project map showing the gauge locations is included in the scope of work narrative.

☑ **FIRMette of the project area(s) (Projects/Studies)**

- Because this project is countywide and impacts several FIRM panels, individual FIRMettes were not included. Instead, a list of all FIRM panels for gauge locations has been included, including the designated flood zone for each, and the project area map shows the Special Flood Hazard Area (SFHA) boundaries.

☑ **Historic flood damage data and/or images (Projects/Studies)**

- Historic flood damage data is available in the County's Hazard Mitigation Plan in Table 5.3: History of Flood Events and Damages, 2011 – 2020 on page 86, and flood history prior to 2011 can be found in Appendix F. Additionally, repetitive loss and severe repetitive loss information for Henrico County can be found in the County's Hazard Mitigation Plan in Table 5.7 Repetitive Flood Losses and Severe Repetitive Flood Losses on page 95. A repetitive loss area map is included in the Hazard Mitigation Plan, but a newer map has been provided in the Scope of Work Narrative. Based on information provided to Henrico County by FEMA, the County's number of repetitive loss properties should be 24, not the 25 that is listed in the Hazard Mitigation Plan.

☑ **A link to or a copy of the current floodplain ordinance:**

- The current version of the County's floodplain ordinance, last amended on March 26, 2024, is available on the County's website here: https://henrico.gov/pdfs/countyattorney/Chpt010Environment.pdf

☑ **Non-Fund financed maintenance and management plan for project extending a minimum of 10 years from project close**

- All maintenance for the stream gauge network will be handed by USGS in accordance with their federal agency guidelines. A fact sheet outlined their maintenance tasks has been included with the scope of work narrative. Henrico County has a signed agreement with USGS to fund the stream gauge network for at least the next five years. However, Henrico County is committed to continuing the stream gauge network into the future and intends to renew the five-year agreement with USGS.

☑ **A link to or a copy of the current comprehensive plan**

- The current adopted County comprehensive plan, Henrico County Vision 2026, is available online here: https://henrico.gov/planning/2026-comprehensive-plan/
- The County is currently undergoing a 2045 comprehensive plan update. More information is available here: https://www.henriconext.us/about

☑ **Social vulnerability index score(s) for the project area from VFRIS SVI Layer**

- According to VFRIS, the county has an average 0.144 SVI. A table including all Census Block scores and their average has been attached to this application.

☐ **If applicant is not a town, city, or county, letters of support from affected localities**

- N/A

☑ **Letter of support from impacted stakeholders**

- A letter of support from the Virginia Department of Emergency Management is included.

☑ **Budget Narrative**

- Included

☐ **Supporting Documentation, including the Benefit-Cost Analysis tool/narrative (for projects over $2 million)**

- N/A

☑ **Authorization to request funding from the Fund from governing body or chief executive of the local government**

- A copy of the approved Board Paper authorizing this request for funding is included.

☑ **Signed pledge agreement from each contributing organization**

- Copy of the funding agreements with USGS are included.

☑ **Detailed budget and narrative for all costs**

- Included

Application to Develop a Stream Guage Network

BUDGET NARRATIVE

Community Flood Preparedness Fund
2024 Funding, Round 5 | Study

Henrico County, Virginia
CID: 510077
January 24, 2025

TABLE OF CONTENTS

BUDGET NARRATIVE 1

- Estimated Total Project Cost 1
- Amount of Funds Requested from the Fund 1
- Amount of Funds Available 2
- Authorization to Request Funding 2
- Supporting Documentation 2

Budget Narrative

Estimated Total Project Cost

The estimated total project cost is $1,124,170.00.

Amount of Funds Requested from the Fund

The total amount of requested grant assistance is $562,085.00 (50% of the Project Total), and the estimated local CFPF match is $562,085.00 (50% of the Project Total).

Because the application period for this grant round was extended, and because there is not a set date for when DCR will issue awards, the installation of the gauge network may begin prior to award issuance. For this reason, the County is requesting up to $84,313.00 (15% of the requested grant assistance) as Pre-Award Costs. However, the installation schedule will depend on when equipment is received by USGS and when site preparation has been completed (e.g. tree clearing), if applicable, so installation of some or all gauges could still occur after awards have been issued. This $84,313.00 is included in the requested $562,085.00. Henrico County is requesting that this be considered as Pre-Award Costs in the event that installation does occur prior to award issuance; however, if installation does not occur prior to award issuance, these costs should be included as Post-Award Costs and still eligible for reimbursement.

Table 1: Estimated Project Cost and Source of Funds

	Project Total	County Match (50%)	CFPF Requested Funds (50%)
Total Installation Costs	$ 290,000.00	$ 145,000.00	$ 145,000.00
Total Operation Costs	$ 834,170.00	$ 417,085.00	$ 417,085.00
Total Costs	$ 1,124,170.00	$ 562,085.00	$ 562,085.00

Table 2: Estimated Project Cost – Yearly and Task Breakdown

	Year 1 (2025)	Year 1 CFPF Amount	Year 2 (2026)	Year 2 CFPF Amount	Year 3 (2027)	Year 3 CFPF Amount
Total Installation Costs	$290,000	**$145,000**	*$0*	***$0***	*$0*	***$0***
Total Operation Costs	$45,200	**$22,600**	$388,680	**$194,340**	$400,290	**$200,145**
Operation Costs for Stream Gauges	*$0*	***$0***	*$342,380*	***$171,190***	*$352,890*	***$176,445***
*Operation Costs for Dam Gauges**	*$45,200*	***$22,600***	*$46,300*	***$23,150***	*$47,400*	***$23,700***
Total Yearly Costs	$335,200	**$167,600**	388,680	**$194,340**	400,290	**200,145**

*USGS and Henrico County had an agreement in place, signed in 2021, to cover the dam gauges, which was incorporated into the agreement signed in 2024. Both agreements have been provided as supporting documentation because the 2024 agreement does not break out the specific dam gauge costs. Costs for the dam gauges were broken out annually through 2026 in the original agreement. Each year, USGS increased this cost by $1,100, so the 2027 cost identified above was

determined by adding $1,100 to the 2026 cost and confirmed with the 2027 costs included in the 2024 agreement.

Table 3: Estimated Project Pre-Award and Post-Award Cost Breakdown

				Percent of Grant Award
Total Pre-Award Costs	**$84,313**	*Total Possible Installation Costs*	$145,000	*26%*
Total Post-Award Cost	**$477,772**	*Installation Costs Pre-Award*	*$84,312.75*	*15%*
Total CFPF Amount	**$562,085**	*Installation Costs Post-Award*	$60,687.25	*11%*

Amount of Funds Available

Henrico County has budgeted millions of dollars over the next three years for the Department of Public Works to address drainage, flooding, and other initiatives impacting its creeks and streams, as outlined in Table 4 below. While this funding is intended to be used for a variety of projects, it will also be used to cover the local match costs of this this project. Relevant pages from the approved FY25 budget have been included as an attachment to this application.

The complete approved budget is available on the Henrico County website here: https://henrico.gov/pdfs/finance/ProposedBudgetFY25/Henrico%20County%20Proposed%20Budget%202024%20-%202025.pdf

Table 4: Budgeting Funding for Drainage, Flooding, and Creeks and Streams for FY25-27

	FY25	**FY25-27**
Countywide Drainage Improvements	$7,500,000	$30,000,000
Minor Drainage Improvements	$500,000	$1,500,000
Countywide Creeks and Streams	$750,000	$2,250,000
Total	$8,750,000	$33,750,000

Authorization to Request Funding

The Board of Supervisors authorized this request for funding on October 22, 2024. A copy of the approved Board Paper is included in this application.

Supporting Documentation

- Approved Board Paper Authorizing Funding (.pdf)
- Detailed Budget Breakdown (Appendix B) (.xlsx)
- Henrico County FY25 Approved Budget Excerpts (.pdf)
- USGS Joint Funding Agreement with Henrico County (.pdf)

COUNTY OF HENRICO, VIRGINIA
BOARD OF SUPERVISORS
MINUTE

Agenda Item No. 314-24
Page No. 1 of 1

Agenda Title: RESOLUTION – Authorization to Submit Application – Virginia Community Flood Preparedness Fund – Countywide

For Clerk's Use Only:	BOARD OF SUPERVISORS ACTION			
Date: 10/22/2024	Moved by (1) Schmitt	Seconded by (1) Rogish		
(✓) Approved	(2)	(2)		
( ) Denied	REMARKS: APPROVED			
( ) Amended				
( ) Deferred to:				

	YES	NO	OTHER
Cooper, R.	✓		
Nelson, T.	✓		
Rogish, J.	✓		
Roundtree, M.	✓		
Schmitt, D.	✓		

WHEREAS, the Virginia Community Flood Preparedness Fund ("Fund") allocates grants for implementing flood prevention and protection projects and studies in areas that are subject to recurrent flooding; and,

WHEREAS, the Fund requires a local match of 50% for this project type; and,

WHEREAS, the County must submit an application through the Virginia Department of Conservation and Recreation; and,

WHEREAS, the application would seek a grant for $562,085 to install and maintain stream and precipitation gauges to expand the County and statewide gauge networks in order to collect necessary data to better prepare for and address drainage and flooding issues throughout the County.

NOW, THEREFORE, BE IT RESOLVED that the Board of Supervisors authorizes the Director of Public Works to apply for a Fund grant for the project described above.

COMMENT: The Director of Public Works recommends approval of the Board paper, and the County Manager concurs.

By Agency Head _____ By County Manager _____

Copy to: _____

A Copy Teste: _____
Clerk, Board of Supervisors

Date: _____

CAPITAL IMPROVEMENT PROGRAM

Project Identification & Summary Information

HENRICO COUNTY, VIRGINIA
FY 25 THROUGH FY 34

Office of Management and Budget

County of Henrico
Capital Improvement Program
FY25 through FY34
Table of Contents

FIVE-YEAR CIP REQUEST SUMMARY

Recommended Capital Budget Plan 1
Five-Year CIP Summary by Department 2
Five-Year CIP Summary by Revenue Source 2
Five-Year CIP Summary by Project Type 3
Approved Bond Referendum Summary 4

FIVE-YEAR CIP BY FUND WITH RECOMMENDED FY24 FUNDING

Capital Projects Fund 5
Enterprise Fund – Public Utilities 8

CIP YEARS SIX THROUGH TEN

FY2029 through FY33 Proposed Projects 9

FY24 THROUGH FY28 DEPARTMENT CIP REQUESTS

FUND 21:

Education 11
Electoral Board 25
Fire 27
General Services 35
Information Technology 47
Mental Health 51
Police 53
Public Library 59
Public Safety 63
Public Utilities – Solid Waste 67
Public Works 71
Recreation 87
Sheriff 101
Sports and Entertainment Authority 105

FUND 51:

Public Utilities 107

APPENDICES

Appendix A –Cash Proffers 155
Appendix B – Project Number Index 157

Capital Improvement Program Five Year Summary FY25 through FY34

Capital Projects Fund - *Department Requests by Fiscal Year and Priority Number*

Public Works

Project		Priority	Recommended FY25	Request FY25	Request FY26	Request FY27	Request FY28	Request FY29	Request FY30-FY34	Total Ten Year
Public Works - Environmental										
07046	Chesapeake Bay TMDL/MS4	1	2,348,000	2,348,000	2,348,000	2,348,000	2,348,000	2,348,000	-	11,740,000
09539	Countywide BMP Maintenance	2	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	-	5,000,000
09537	Countywide Drainage Improvements	3	7,500,000	5,000,000	12,500,000	12,500,000	12,500,000	5,000,000	-	47,500,000
00363	Minor Drainage Improvements	4	500,000	500,000	500,000	500,000	500,000	500,000	-	2,500,000
08932	Countywide Creeks and Streams	5	750,000	750,000	750,000	750,000	750,000	750,000	-	3,750,000
09100	DPW Land Acquisitions	6	500,000	500,000	500,000	500,000	500,000	500,000	-	2,500,000
	Department Subtotal		**12,598,000**	**10,098,000**	**17,598,000**	**17,598,000**	**17,598,000**	**10,098,000**	-	**72,990,000**
Public Works - Transportation Network										
06837	Countywide Pedestrian Improvements	1	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	-	25,000,000
Asst	Highway Interchanges Projects	2	0	27,400,000	27,400,000	27,400,000	27,400,000	27,400,000	306,000,000	443,000,000
Asst	Roadway Projects	3	0	138,940,000	138,940,000	138,940,000	138,940,000	138,940,000	607,900,000	1,302,600,000
Asst	Multimodal Projects	4	0	57,160,000	57,160,000	57,160,000	57,160,000	57,160,000	149,500,000	435,300,000
NEW	Countywide Dam Repairs and Maintenance	5	500,000	500,000	500,000	500,000	500,000	500,000	-	2,500,000
NEW	Countywide Alley Improvements and Vacation	6	500,000	500,000	500,000	500,000	500,000	500,000	-	2,500,000
	CVTA Reserve	7	25,000,000	-	-	-	-	-	-	0
	Department Subtotal		**31,000,000**	**229,500,000**	**229,500,000**	**229,500,000**	**229,500,000**	**229,500,000**	**1,063,400,000**	**2,210,900,000**
		Department Total	**43,598,000**	**239,598,000**	**247,098,000**	**247,098,000**	**247,098,000**	**239,598,000**	**1,063,400,000**	**2,283,890,000**

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
VA/WV Water Science Center
1730 E. Parham Rd.
Richmond, VA 23228

October 22, 2024

Mr. Michael Aust
Floodplain & Dam Safety Manager
Henrico County, VA
4301 E Parham Road
Henrico, VA 23228-2745

Dear Mr. Aust:

Enclosed is our standard joint-funding agreement 25LMJFAVA117 between the U.S. Geological Survey VA/WV Water Science Center and Henrico County, VA to Implement and Operate a Hydrologic Monitoring Network in Henrico County, Virginia, during the period November 1, 2024, through June 30, 2029 in the amount of $1,949,800 from your agency. U.S. Geological Survey contributions for this agreement are $0, but we (USGS) will purchase sensing and telemetry equipment and site infrastructure at a value of $320,000.00. Please sign and return the agreement to Paige Nossaman at pnossaman@usgs.gov.

Federal law requires that we have a signed agreement before we start or continue work. Please return the signed agreement by **November 30, 2024**. If, for any reason, the agreement cannot be signed and returned by the date shown above, please contact Jeremy White at (304) 347-5130 or email jswhite@usgs.gov to make alternative arrangements.

This is a fixed cost agreement to be billed quarterly via Down Payment Request (automated Form DI-1040). Please allow 30-days from the end of the billing period for issuance of the bill. If you experience any problems with your invoice(s), please contact Paige Nossaman at phone number (304) 347-5130 or pnossaman@usgs.gov.

The results of all work performed under this agreement will be available for publication by the U.S. Geological Survey. We look forward to continuing this and future cooperative efforts in these mutually beneficial water resources studies.

Sincerely,

DOUGLAS MOYER
Digitally signed by DOUGLAS MOYER
Date: 2024.10.22 14:49:35 -04'00'

Douglas Moyer
Chief Science Officer

Enclosure
25LMJFAVA117

Form 9-1366
(May 2018)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000006916
Agreement #: 25LMJFAVA117
Project #: LM009QC
TIN #: 54-6001344

Fixed Cost Agreement YES[X] NO[ ]

THIS AGREEMENT is entered into as of October 1, 2024, by the U.S. GEOLOGICAL SURVEY, VA/WV Water Science Center, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the Henrico County, VA party of the second part.

1. The parties hereto agree that subject to the availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation for negotiated deliverables (see attached), herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50, and 43 USC 50b.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) include In-Kind-Services in the amount of $0.00

(a) $0 by the party of the first part during the period November 1, 2024 to June 30, 2029

(b) $1,949,800 by the party of the second part during the period November 1, 2024 to June 30, 2029

(c) Contributions are provided by the party of the first part through other USGS regional or national programs, in the amount of: $0

Description of the USGS regional/national program:

(d) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

(e) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.

4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.

5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.

6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

8. The maps, records or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program, and if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at cost, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records or reports published by either party shall contain a statement of the cooperative relations between the parties. The Parties acknowledge that scientific information and data developed as a result of the Scope of Work (SOW) are subject to applicable USGS review, approval, and release requirements, which are available on the USGS Fundamental Science Practices website (https://www.usgs.gov/office-of-science-quality-and-integrity/fundamental-science-practices).

Form 9-1366
(May 2018)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000006916
Agreement #: 25LMJFAVA117
Project #: LM009QC
TIN #: 54-6001344

9. Billing for this agreement will be rendered **quarterly**. Invoices not paid within 60 days from the billing date will bear Interest, Penalties, and Administrative cost at the annual rate pursuant the Debt Collection Act of 1982, (codified at 31 U.S.C. § 3717) established by the U.S. Treasury.

USGS Technical Point of Contact

Name:	Jeremy White Supervisory Hydro Tech
Address:	11 Dunbar Street Charleston, WV 25301
Telephone:	(304) 347-5130
Fax:	(304) 347-5133
Email:	jswhite@usgs.gov

Customer Technical Point of Contact

Name:	Michael Aust Design Division Director
Address:	4301 E Parham Road Henrico, VA 23228-2745
Telephone:	(804) 380-4389
Fax:	(n/a)
Email:	aus019@henrico.gov

USGS Billing Point of Contact

Name:	Paige Nossaman Budget Analyst
Address:	11 Dunbar Street Charleston, WV 25301
Telephone:	(304) 347-5130
Fax:	(304) 347-5133
Email:	pnossaman@usgs.gov

Customer Billing Point of Contact

Name:	Monica Barnette Accountant
Address:	4301 E Parham Rd. Henrico, VA 23228-2745
Telephone:	(804) 501-4398
Fax:	(n/a)
Email:	bar01@henrico.gov

U.S. Geological Survey
United States
Department of Interior

Signature

By DOUGLAS MOYER Digitally signed by DOUGLAS MOYER Date: 2024.10.22 14:50:12 -04'00'

Name: Douglas Moyer

Title: Chief Science Officer

Henrico County, VA

Signatures

By _____ Date: 10/23/2024

Name: Terrell C Hughes

Title: Director of Public Works

By _____ Date: _____

Name:

Title:

By _____ Date: _____

Name:

Title:

APPROVED AS TO FORM

_____
COUNTY ATTORNEY

United States Department of the Interior

U. S. GEOLOGICAL SURVEY
12202 Sunrise Valley Drive
Reston, Virginia 20192

IN REPLY REFER TO:

Memorandum June 20, 2023

To: Michael H. Tupper
Regional Director, Northeast Region

From: Mark R. Bennett
Director, U.S. Geological Survey

Subject: Designation of Succession for the Virginia and West Virginia Water Science Center Director Position

The following positions in the U.S. Geological Survey will automatically succeed the Director of the Virginia and West Virginia Water Science Center in the absence of the incumbent and in the order listed.

The incumbent in all of the positions are hereby delegated the authority to perform all duties and responsibilities of the Virginia and West Virginia Water Science Center Director when required to ensure continued, uninterrupted direction and supervision to perform essential functions and activities of the office. The authority of the Virginia and West Virginia Water Science Center Director may be exercised only when an official in one of the following positions is reasonably certain that no superior in the list is able and available to exercise that authority, and when the nature of the situation requires immediate action.

Individuals exercising the authority of the Virginia and West Virginia Water Science Center Director will be relieved of this responsibility as soon as a superior on the list is available, or when an official with the requisite authority designates a permanent or Acting Center Director. Individuals exercising the authority of the Virginia and West Virginia Water Science Center Director will keep a record of important actions taken and the period during which the authority was exercised. Officials serving in an acting capacity are not permitted in this line of succession.

Position One:	VA and WV WSC Chief Operations Officer
Position Two:	VA and WV WSC Chief Science Officer
Position Three:	VA and WV WSC Supervisory Hydrologist, WUA Chief
Position Four:	VA and WV WSC Supervisory Hydrologist, Studies Chief

cc: Bureau Emergency Management Coordinator

Proposal to Implement and Operate a Hydrologic Monitoring Network in Henrico County, Virginia

Virginia and West Virginia Water Science Center

Henrico County, Virginia, is situated in the central part of the state, adjacent to the city of Richmond. The county's landscape is characterized by flat to gently rolling terrain, with elevations ranging from around 50 to 400 feet. Notable water bodies, including the James River to the south and the Chickahominy River to the north, provide both recreational opportunities and ecological benefits.

Henrico County land use includes a diverse mix of residential, commercial, and industrial development, along with significant agricultural areas. Key urban centers, such as Short Pump and Lakeside, support commercial activities, while substantial land is dedicated to residential neighborhoods, contributing to a suburban environment.

Flooding is a notable concern, especially in areas adjacent to rivers and in low-lying regions. To address this, Henrico County has implemented floodplain management strategies aimed at mitigating flood risks. These include regulations on land use in flood-prone areas, the development of stormwater management systems, and the preservation of floodplains to maintain their natural hydrological functions. The county also emphasizes community education and preparedness initiatives to enhance resilience against potential flooding events.

Moreover, changing climate patterns are increasingly affecting Henrico County, with rising temperatures, altered precipitation patterns, and more frequent extreme weather events. These changes can exacerbate flooding risks and strain water resources, prompting the county to enhance its planning frameworks and adaptive strategies. Local authorities are working to integrate climate resilience into their policies, focusing on sustainable development practices and infrastructure improvements to better prepare for the impacts of a changing climate.

A comprehensive, county-wide, hydrologic monitoring network is needed to inform floodplain management, flood-risk reduction, and emergency management, and to inform potential future analysis of how changing climate and land-use patterns affect hydrology county-wide. This proposal outlines such a network.

Objectives

1. Install and operated a county-wide network of precipitation gages,
    - Install and operated a county-wide network of streamgages,
2. Develop and maintain a county-specific web application to serve hydrologic data of specific interest to Henrico County staff and residents, and
3. Provide all data publicly in near-realtime.

Approach

Monitoring Locations

Preferred monitoring locations have been provided by Henrico County staff (Fig. 1). The proposed network includes 7 standalone precipitation gages, 5 standalone streamgages, and 9 co-located precipitation gages and streamgages, for a total of 21 new monitoring locations. These stations will be

added to the existing network of 5 co-located reservoir level and precipitation gages operated by USGS for Henrico County.

The proposed new monitoring locations shall be considered preliminary. Site reconnaissance will be conducted as a first step to initiating the proposed monitoring network. Findings from this on-the-ground effort may dictate needs for adjustments to the locations and site types to accommodate technical, logistical, and other requirements or constraints. Any adjustments needed will be made in consultation with Henrico County staff, and efforts will be made to reduce any potential impact on the agreed upon budget.

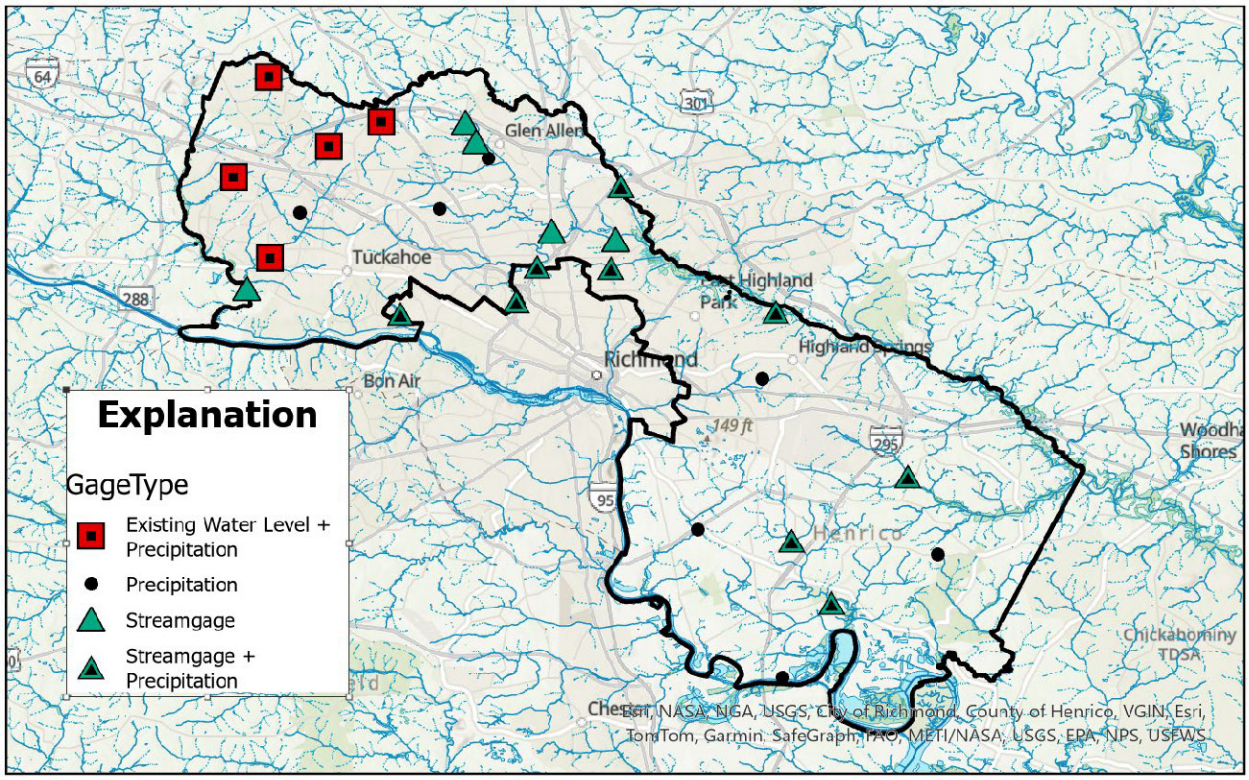


Figure 1. Map of proposed monitoring locations.

Streamflow Monitoring

Standard USGS streamgages will be operated at 14 locations (standalone + co-located). Streamflow will be measured according to published USGS methods for the operation of streamgages (Sauer, 2002; Turnipseed and others, 2010); this will include 5-minute interval measurements of stage (water level) coupled with periodic manual measurements of streamflow to generate a streamflow rating curve to support computation of a continuous streamflow time series. Periodic and targeted-condition manual measurements of streamflow will be made over the full program duration to capture variability and change in hydrologic and geomorphic conditions – this is critical to ensuring the accuracy of streamflow data, particularly in these small and dynamic streams.

Standard streamgages will consist of a water-level sensor, datalogger and satellite telemetry unit, and solar-charged DC power supply. Site conditions as some locations, particularly on low-gradient streams such as the Chickahominy River, may require an additional velocity sensor to support flow measurement. The water-level sensor, either a non-submersible pressure transducer non-contact radar sensor, will meet USGS requirements for sensor accuracy (0.01 ft; U.S. Geological Survey, 1996). Data telemetry will be accomplished using GOES satellite telemetry – this is the standard telemetry system used by USGS streamgages, providing reliable data relay with redundant ground stations across the nation to reliably

serve data. Data will be uploaded and publicly served on the USGS National Water Information System web interface (NWISWeb; waterdata.usgs.gov) within 1-hour of collection. The solar-charged DC power system will provide necessary power to operate the sensors and to support the data logger and telemetry system. All streamside monitoring equipment will be housed in a vandal-resistant shelter, similar to examples shown in Figure 2, constructed in accordance with local specifications.

Figure 2. Photographs of streamside and bridge-mounted streamgages.

Precipitation Monitoring

Understanding the timing and intensity of precipitation is necessary for understanding the hydrologic system and responses to changes in stream channels and watersheds. Urbanization and impervious cover increase peak streamflow (Lee and Hearney, 2003) and changes to the frequency and intensity of rain events can exacerbate those effects. Precipitation monitoring will be conducted using a weighing-type gage (such as the Ott Pluvio^{2}L) following published USGS procedures (U.S. Geological Survey, 2009). A weighing-type gage is preferable over other gages such as a tipping bucket because it overcomes inaccuracies in very intense precipitation events. A precise measurement of the precipitation inputs to the watershed is vital for understanding numerous hydrological metrics. This precipitation gage will provide cumulative precipitation accumulation and intensity data, on 5-minute intervals. The raingages will be either a standalone station consisting of the weighing-type gage, datalogger and telemetry unit, and solar-charged DC power system, likely similar to that shown in Figure 3, or the weighing-type gage will be added to streamgage instrumentation, depending on site configuration. Precipitation data will be uploaded and publicly served on NWISWeb within 1-hour of collection.

Figure 3. Photograph of a precipitation monitoring station.

County-specific Data Delivery

The USGS NWISWeb system provides numerous tools for public access to USGS-collected hydrologic data. Of particular utility for most users, the National Water Dashboard (dashboard.waterdata.usgs.gov) is a modern map-based interface that provide intuitive access to realtime data while also providing advanced features to add context to the hydrologic data. To facilitate ease of access to County-specific monitoring

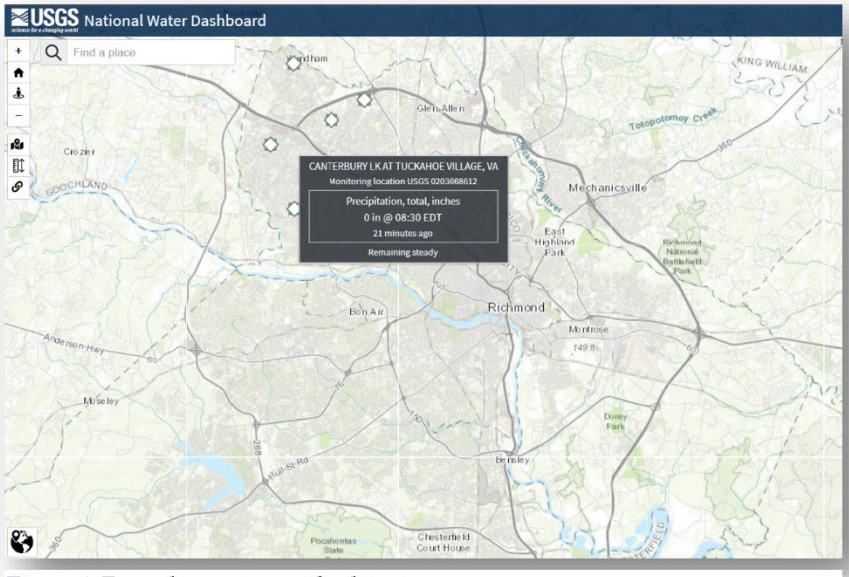


Figure 4. Example county-specific data viewer.

stations, a webpage will be developed to describe the monitoring network and provide simplified access to the USGS-operated stations in Henrico County, similar to that shown in Figure 4 for the current reservoir-level and precipitation monitoring stations.

Timeline

Provided timely approval of a Joint Funding Agreement, site reconnaissance and installation will occur in state fiscal year 2025 (ending June 30, 2025). Development of the website and county-specific data display will also be complete at this time. Station operation and maintenance will be conducted in state fiscal years 2026-2029, fulfilling a 5-year agreement term. Additional agreement terms are anticipated to be pursued at the completion of this initial term.

Deliverables

Deliverables include all data collected, to be publicly served and permanently archived on the USGS National Water Information System, and a web application to provide simplified access to those data for Henrico County monitoring stations specifically.

Funding and In-Kind Support

Funding required for this effort includes station instrumentation, installation, and operation and maintenance, as well as staff salary for the development of the web application. USGS will contribute the cost of all required instrumentation, at a value of $320,000, and remaining costs will be funded by Henrico County.

Startup costs include station siting, reconnaissance, installation, and instrumentation, and development of the website (Table 1). Annual operation and maintenance (O&M) costs include all costs for site operation, data processing, and data delivery (Table 2) – annual O&M costs will increase annually to account for inflationary increases in materials and labor.

Henrico County and USGS currently have a Joint Funding Agreement to support 5 co-located reservoir level and precipitation monitoring stations. All existing plus new work will be combined into a single new agreement, and the existing agreement will be terminated upon start of the new agreement. The total costs

to be included in the new agreement at shown in Table 3. Payments already made under the current agreement that overlap with the new agreement will be credited.

Table 1. Startup costs per task.

Task	County Cost	USGS Equipment Contribution	Total Cost	Quantity	Sub-Total	County Sub-Total
Streamgage + Precipitation Install	$15,000	$20,000	$35,000	9	$315,000	$135,000
Streamgage Install	$15,000	$14,000	$29,000	5	$145,000	$75,000
Precipitation Install	$10,000	$10,000	$20,000	7	$140,000	$70,000
Web development	$10,000	$0	10000	1	$10,000	$10,000
					$610,000	**$290,000**

Table 2. Annual operation and maintenance costs for the initial year of monitoring - year 2. Note that annual costs will increase to account for inflation.

Site Type	Annual Cost (Year 2)	Quantity	Total
Streamgage	$19,140	5	$95,700
Standalone Precipitation	$6,350	7	$44,450
Streamgage + Precipitation	$22,470	9	$202,230
			$342,380

Table 3. Annual costs for existing plus new monitoring activities.

State Fiscal Year	County Cost	USGS Equipment (in-kind services)
2025	$335,200	$320,000
2026	$388,680	$0
2027	$400,290	$0
2028	$412,250	$0
2029	$424,680	$0
Total	**$1,961,100**	**$320,000**

Potential Future Directions

The proposed hydrologic monitoring network will provide a critical hydrologic data collection foundation that will immediately benefit County operations. Additionally, this foundation could be leveraged in the future to provide additional benefit to the County. For example, the infrastructure being established has expansion capacity that could include additional data collection elements such as water-quality parameters, additional meteorologic parameters, and roadway condition parameters. Also, the data to be collected could inform many different studies to better inform the County of how hydrologic and meteorologic conditions are changing over time in response to climate change, land-use change, and other factors.

References

Lee, J., Heaney, J, 2003, Estimation of Urban Imperviousness and its Impacts on Storm Water Systems. *Journal of Water Resources Planning Management, 129*(5), 419-426.

Sauer, V.B., 2002, Standards for the Analysis and Processing of Surface-Water Data and Information Using Electronic Methods: U.S. Geological Survey Water-Resources Investigations Report 01–4044, 91

Turnipseed, D.P., and Sauer, V.B., 2010, Discharge measurements at gaging stations: U.S. Geological Survey Techniques and Methods book 3, chap. A8, 87 p. (Also available at http://pubs.usgs.gov/tm/tm3-a8/.)

U.S. Geological Survey, 1996, Policy Concerning Accuracy of Stage Data, Office of Surface Water Technical Memorandum No. 96.05, online at https://water.usgs.gov/admin/memo/SW/sw96.05.html

U.S. Geological Survey, 2009, Collection, Quality, and Presentation of Precipitation Data, Office of Surface Water Technical Memorandum No. 2006.01, online at https://water.usgs.gov/admin/memo/SW/sw06.012_Revised_122009.pdf

Contacts

Questions or comments, please contact:

Shaun Wicklein
smwikle@usgs.gov

John Jastram
jdjastra@usgs.gov

Form 9-1366
(May 2018)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000006916
Agreement #: 22LMJFAVA000117
Project #: LM009QC
TIN #: 54-6001344

Fixed Cost Agreement YES[X] NO[ ]

THIS AGREEMENT is entered into as of the October 1, 2021, by the U.S. GEOLOGICAL SURVEY, VA/WV Water Science Center, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the Henrico County party of the second part.

1. The parties hereto agree that subject to the availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation Water Resource Investigations (per attachment), herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50, and 43 USC 50b.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) include In-Kind-Services in the amount of $0.00

(a) $0 by the party of the first part during the period October 1, 2021 to June 30, 2026

(b) $274,575 by the party of the second part during the period October 1, 2021 to June 30, 2026

(c) Contributions are provided by the party of the first part through other USGS regional or national programs, in the amount of: $0

Description of the USGS regional/national program:

(d) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

(e) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.

4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.

5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.

6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

8. The maps, records or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program, and if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at cost, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records or reports published by either party shall contain a statement of the cooperative relations between the parties. The Parties acknowledge that scientific information and data developed as a result of the Scope of Work (SOW) are subject to applicable USGS review, approval, and release requirements, which are available on the USGS Fundamental Science Practices website (https://www.usgs.gov/about/organization/science-support/science-quality-and-integrity/fundamental-science-practices).

Form 9-1366
(May 2018)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000006916
Agreement #: 22LMJFAVA000117
Project #: LM009QC
TIN #: 54-6001344

9. Billing for this agreement will be rendered quarterly. Invoices not paid within 60 days from the billing date will bear Interest, Penalties, and Administrative cost at the annual rate pursuant the Debt Collection Act of 1982, (codified at 31 U.S.C. § 3717) established by the U.S. Treasury.

USGS Technical Point of Contact

Name:	Jeremy White Supervisory Hydro Tech
Address:	11 Dunbar Street Charleston, WV 25301
Telephone:	(304) 347-5130
Fax:	(304) 347-5133
Email:	jswhite@usgs.gov

Customer Technical Point of Contact

Name:	Kristin Owen Floodplain & Dam Safety Manager
Address:	4301 E Parham Road Henrico, VA 23228-2745
Telephone:	(804) 501-7460
Fax:	
Email:	owe042@henrico.us

USGS Billing Point of Contact

Name:	Paige Keaton Budget Analyst
Address:	11 Dunbar Street Charleston, WV 25301
Telephone:	(304) 347-5130
Fax:	(304) 347-5133
Email:	pkeaton@usgs.gov

Customer Billing Point of Contact

Name:	Kayla Shelton Office Assistant
Address:	PO Box 90775 Henrico, VA 23273
Telephone:	(804) 501-4287
Fax:	
Email:	She088@henrico.us

U.S. Geological Survey
United States
Department of Interior

Signature

MARK BENNETT Digitally signed by MARK BENNETT Date: 2021.10.25 11:38:38 -04'00'

By _____ **Date:** 09/24/2021

Name: Mark Bennett

Title: Director

Henrico County

Signatures

By _____ **Date:** 11/3/2021

Name: Todd Hughes

Title: Dir. of Public Works / County Engineer

By _____ **Date:** _____

Name:

Title:

By _____ **Date:** _____

Name:

Title:

APPROVED AS TO FORM

Alyssa D Brown 10/29/21

ASSISTANT COUNTY ATTORNEY

5-year Funding Summary
Henrico County, Virginia
U.S. Geological Survey
Water Monitoring Program

State Fiscal Year	Cooperator Cost	USGS Contribution	Annual Operating Cost
2022	$ 95,975	$ 90,000	$185,975
2023	$ 43,000	$ -	$43,000
2024	$ 44,100	$ -	$44,100
2025	$ 45,200	$ -	$45,200
2026	$ 46,300	$ -	$46,300
Total	**$274,575**	**$90,000**	**$364,575**

TABLE OF CONTENTS

BUDGET NARRATIVE 1

- Estimated Total Project Cost 1
- Amount of Funds Requested from the Fund 1
- Amount of Funds Available 2
- Authorization to Request Funding 2
- Supporting Documentation 2

Budget Narrative

Estimated Total Project Cost

The estimated total project cost is $1,124,170.00.

Amount of Funds Requested from the Fund

The total amount of requested grant assistance is $562,085.00 (50% of the Project Total), and the estimated local CFPF match is $562,085.00 (50% of the Project Total).

Because the application period for this grant round was extended, and because there is not a set date for when DCR will issue awards, the installation of the gauge network may begin prior to award issuance. For this reason, the County is requesting up to $84,313.00 (15% of the requested grant assistance) as Pre-Award Costs. However, the installation schedule will depend on when equipment is received by USGS and when site preparation has been completed (e.g. tree clearing), if applicable, so installation of some or all gauges could still occur after awards have been issued. This $84,313.00 is included in the requested $562,085.00. Henrico County is requesting that this be considered as Pre-Award Costs in the event that installation does occur prior to award issuance; however, if installation does not occur prior to award issuance, these costs should be included as Post-Award Costs and still eligible for reimbursement.

Table 1: Estimated Project Cost and Source of Funds

	Project Total	County Match (50%)	CFPF Requested Funds (50%)
Total Installation Costs	$ 290,000.00	$ 145,000.00	$ 145,000.00
Total Operation Costs	$ 834,170.00	$ 417,085.00	$ 417,085.00
Total Costs	$ 1,124,170.00	$ 562,085.00	$ 562,085.00

Table 2: Estimated Project Cost – Yearly and Task Breakdown

	Year 1 (2025)	Year 1 CFPF Amount	Year 2 (2026)	Year 2 CFPF Amount	Year 3 (2027)	Year 3 CFPF Amount
Total Installation Costs	$290,000	**$145,000**	*$0*	***$0***	*$0*	***$0***
Total Operation Costs	$45,200	**$22,600**	$388,680	**$194,340**	$400,290	**$200,145**
Operation Costs for Stream Gauges	*$0*	***$0***	*$342,380*	***$171,190***	*$352,890*	***$176,445***
*Operation Costs for Dam Gauges**	*$45,200*	***$22,600***	*$46,300*	***$23,150***	*$47,400*	***$23,700***
Total Yearly Costs	$335,200	**$167,600**	388,680	**$194,340**	400,290	**200,145**

*USGS and Henrico County had an agreement in place, signed in 2021, to cover the dam gauges, which was incorporated into the agreement signed in 2024. Both agreements have been provided as supporting documentation because the 2024 agreement does not break out the specific dam gauge costs. Costs for the dam gauges were broken out annually through 2026 in the original agreement. Each year, USGS increased this cost by $1,100, so the 2027 cost identified above was

determined by adding $1,100 to the 2026 cost and confirmed with the 2027 costs included in the 2024 agreement.

Table 3: Estimated Project Pre-Award and Post-Award Cost Breakdown

				Percent of Grant Award
Total Pre-Award Costs	**$84,313**	*Total Possible Installation Costs*	$145,000	*26%*
Total Post-Award Cost	**$477,772**	*Installation Costs Pre-Award*	*$84,312.75*	*15%*
Total CFPF Amount	**$562,085**	*Installation Costs Post-Award*	$60,687.25	*11%*

Amount of Funds Available

Henrico County has budgeted millions of dollars over the next three years for the Department of Public Works to address drainage, flooding, and other initiatives impacting its creeks and streams, as outlined in Table 4 below. While this funding is intended to be used for a variety of projects, it will also be used to cover the local match costs of this this project. Relevant pages from the approved FY25 budget have been included as an attachment to this application.

The complete approved budget is available on the Henrico County website here: https://henrico.gov/pdfs/finance/ProposedBudgetFY25/Henrico%20County%20Proposed%20Budget%202024%20-%202025.pdf

Table 4: Budgeting Funding for Drainage, Flooding, and Creeks and Streams for FY25-27

	FY25	**FY25-27**
Countywide Drainage Improvements	$7,500,000	$30,000,000
Minor Drainage Improvements	$500,000	$1,500,000
Countywide Creeks and Streams	$750,000	$2,250,000
Total	$8,750,000	$33,750,000

Authorization to Request Funding

The Board of Supervisors authorized this request for funding on October 22, 2024. A copy of the approved Board Paper is included in this application.

Supporting Documentation

- Approved Board Paper Authorizing Funding (.pdf)
- Detailed Budget Breakdown (Appendix B) (.xlsx)
- Henrico County FY25 Approved Budget Excerpts (.pdf)
- USGS Joint Funding Agreement with Henrico County (.pdf)

Table 5.7 Repetitive Flood Losses and Severe Repetitive Flood Losses				
Community	**Repetitive Flood Loss Detailed Data**			
Henrico County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	25	$1,765,976.35	99	$17,838.14
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	5	$717,634.39	40	$17,940.86
Hopewell City	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	1	$38,658.56	2	$19,329.28
New Kent County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	3	$272,374.43	10	$27,237.44
Petersburg City	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	11	$530,383.70	31	$17,109.15
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	2	$101,438.10	9	$11,270.89
Prince George County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	3	$179,261.10	10	$17,926.11
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	2	$144,808.10	8	$18,101.02
Richmond City	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	63	$8,019,552.70	162	$49,503.41
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	1	$1,386,405.53	13	$106,646.58
Stony Creek Town	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	4	$47,479.36	8	$5,934.92
Sussex County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	3	$31,120.50	6	$5,186.75

COUNTY OF HENRICO, VIRGINIA
BOARD OF SUPERVISORS
MINUTE

Agenda Item No. 314-24
Page No. 1 of 1

Agenda Title: RESOLUTION – Authorization to Submit Application – Virginia Community Flood Preparedness Fund – Countywide

For Clerk's Use Only:	BOARD OF SUPERVISORS ACTION			
Date: 10/22/2024	Moved by (1) Schmitt	Seconded by (1) Rogish		
(✓) Approved	(2)	(2)		
( ) Denied	REMARKS: APPROVED			
( ) Amended				
( ) Deferred to:				

	YES	NO	OTHER
Cooper, R.	✓		
Nelson, T.	✓		
Rogish, J.	✓		
Roundtree, M.	✓		
Schmitt, D.	✓		

WHEREAS, the Virginia Community Flood Preparedness Fund ("Fund") allocates grants for implementing flood prevention and protection projects and studies in areas that are subject to recurrent flooding; and,

WHEREAS, the Fund requires a local match of 50% for this project type; and,

WHEREAS, the County must submit an application through the Virginia Department of Conservation and Recreation; and,

WHEREAS, the application would seek a grant for $562,085 to install and maintain stream and precipitation gauges to expand the County and statewide gauge networks in order to collect necessary data to better prepare for and address drainage and flooding issues throughout the County.

NOW, THEREFORE, BE IT RESOLVED that the Board of Supervisors authorizes the Director of Public Works to apply for a Fund grant for the project described above.

COMMENT: The Director of Public Works recommends approval of the Board paper, and the County Manager concurs.

By Agency Head _____ By County Manager _____

Copy to: _____

A Copy Teste: _____
Clerk, Board of Supervisors

Date: _____

Chapter 10 - ENVIRONMENT

*__Cross reference—__ Unsafe buildings, § 6-25 et seq.; spot blight abatement, § 6-104 et seq.; pollution of waters in parks, § 14-39.

Article I. FLOODPLAIN MANAGEMENT

Division 1: Purpose and Applicability

Sec. 10-1. Purpose and Applicability

The purpose of this article is to promote and protect the health, safety, and general welfare of county residents and to minimize losses due to flood hazards through provisions designed to:

(a) prevent development and land disturbing activities from increasing flood or drainage hazards;
(b) protect new buildings and major improvements to buildings from flood damage;
(c) protect human life and health from the hazards of flooding;
(d) lessen the burden on taxpayers for future flood and drainage control projects, repairs to flood-damaged public facilities and utilities and flood rescue and relief operations; and
(e) make federally subsidized flood insurance available for property within the county.

This article applies to privately and publicly owned lands within areas designated as a Special Flood Hazard Area (SFHA) and areas adjacent to SFHAs, as outlined in this article. No development shall occur within the SFHA and areas adjacent to SFHAs except in accordance with the provisions of this article.
State law reference: Code of Virginia § 15.2-984.

Sec. 10-2. Compliance and Liability

(a) No land shall hereafter be developed, and no structure shall be located, relocated, constructed, reconstructed, enlarged, or structurally altered, except in full compliance with the provisions of this article and any other applicable laws and regulations.
(b) The degree of flood protection sought by this article is deemed reasonable for regulatory purposes and is based on acceptable engineering study methods. However, compliance with this article will not guarantee total protection from flooding or flood damages due to heavy rainfalls, increases in flood heights due to man-made or natural causes such as debris blockage of bridge openings, or other causes.
(c) The county and its officers and employees shall not be responsible for flood damages that result from reliance on this article or any administrative decision related to its enforcement.

Division 2. Definitions

Sec. 10-3. Definitions

The following words, terms and phrases, when used in this article, have the meanings ascribed to them in this section, except where the context clearly indicates a different meaning:

500-year Floodplain: The land at risk for flooding from a 0.2 percent (500-year) flood in any given year. This area may be identified as a Shaded X Zone or Shaded X5 Zone on the Floodplain Maps.
Accessory or Appurtenant Structure: A structure which is on the same parcel of property as the principal structure and the use of which is incidental to the use of the principal structure. An accessory structure is considered

nonresidential for the purposes of this article and may include detached garages, sheds, barns, or greenhouses.

Addition: An extension or increase in the floor area or height of an existing building or structure.

Agricultural Structure: A structure that is used exclusively in connection with the production, harvesting, storage, raising, or drying of agricultural commodities and livestock, including aquatic animals or plants associated with aquaculture activities. An agricultural structure does not include any structure used for human habitation.

Alteration of a Watercourse: A dam, impoundment, channel relocation, change in channel alignment, channelization, change in cross-sectional area of the channel or the channel capacity, or any other change associated with development which may increase the base flood elevation.

ASCE 24: Published by the American Society of Civil Engineers (ASCE), ASCE 24, *Flood Resistant Design and Construction* is a referenced standard in the Uniform Statewide Building Code that provides minimum requirements and expected performance for the siting, design, and construction of buildings and structures in flood hazard areas that are subject to building code requirements.

Base Flood: The flood having a one percent chance of being equaled or exceeded in any given year. This may also be referred to as the 100-year flood.

Base Flood Elevation (BFE): The water surface elevation of the base flood as shown either on (1) the most recent Federal Emergency Management Agency Flood Insurance Rate Map or Flood Insurance Study or (2) the county's most recent Comprehensive Drainage Map, whichever is higher. For areas without mapped base flood elevations, the developer shall use the 100-year flood elevations and floodway information from federal and state sources when available or, if such information is not available, flood elevations derived from sufficiently detailed hydrologic and hydraulic computations by a professional engineer who certifies the correct use of currently accepted technical concepts.

Basement: Any area of the building having its floor subgrade (below ground level) on all sides.

Community Special Flood Hazard Area: Also referred to as the Community SFHA, the land subject to a one percent or greater chance of flooding in any given year, based on 100-acre drainage areas or less, as identified on the county's current Comprehensive Drainage Maps. These areas do not include and are in addition to FEMA Special Flood Hazard Areas.

Conditional Letter of Map Revision (CLOMR): Either (1) a formal review and comment from FEMA stating that a proposed project complies with the minimum NFIP requirements for the project with respect to delineation of FEMA SFHAs or (2) a letter from the county engineer that provides conditional approval of a study, based on as-built conditions, that changes the location of the Community SFHA. A CLOMR does not revise the Floodplain Maps.

County Comprehensive Drainage Map. The most recent map approved by and maintained by the county engineer on the county's GIS designating the 100-year floodplain in the county. The county engineer may amend the County Comprehensive Drainage Map at any time upon review of additional engineering studies of floodplain areas.

Critical Facility: A structure or other improvement that, because of its function, size, service area, or uniqueness, has the potential to result in serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if it is destroyed or damaged or if its functionality is impaired. Critical facilities include health and safety facilities, utilities, government facilities, and hazardous materials facilities.

Dam Break Inundation Zone: The area downstream of a dam that would be inundated or otherwise directly affected by the failure of the dam. A dam's dam break inundation zone shall be as shown on the dam break inundation zone map for that dam filed with the Virginia Department of Conservation and Recreation.

Dam: A manmade structure across a watercourse used to restrain water.

Development: Any man-made change to improved or unimproved real estate, including buildings or other structures, as well as mining, dredging, filling, grading, paving, excavation or drilling operations, and storage of equipment or materials.

Dry Floodproofing: A combination of measures that results in a structure and its attendant utilities and equipment being watertight with all elements substantially impermeable and with structural components having the capacity to resist flood loads.

Elevated Building: A non-basement building built to have the lowest floor elevated above the ground level by means of solid foundation perimeter walls, pilings, or columns, such as posts and piers.

Encroachment: The advance or infringement of uses, fill, excavation, buildings, permanent structures, or development into a floodplain which may impede or alter the flow capacity of a floodplain. Building renovations within the existing building footprint area are not considered an Encroachment.

Erosion: The process of the gradual wearing away of land masses.

FEMA: Federal Emergency Management Agency.

FEMA Special Flood Hazard Area: Also referred to as the FEMA SFHA, the land in the floodplain within a community subject to a one percent or greater chance of flooding in any given year as designated by FEMA. The area may be designated on a Flood Insurance Rate Map as Zones A, AO, AH, A1-30, AE, A99, AR, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, or V1-30, VE, or V.

Flood Insurance Rate Map (FIRM): An official map of a community, on which the Federal Insurance Administrator has delineated both the FEMA SFHAs and the risk premium zones applicable to the community. A FIRM that has been made available digitally is called a Digital Flood Insurance Rate Map (DFIRM).

Flood Insurance Study (FIS): An examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations, or an examination, evaluation, and determination of mudslide (*i.e.*, mudflow) and/or flood-related erosion hazards.

Flood or Flooding: Defined as either:

(a) a general and temporary condition of partial or complete inundation of normally dry land areas from: (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudslides (*i.e.*, mudflows) which are proximately caused by flooding as defined in paragraph (a)(2) of this definition and are akin to a river of liquid and flowing mud on the surfaces of normally dry land areas, as when earth is carried by a current of water and deposited along the path of the current.

(b) the collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as a flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in a partial or complete inundation of normally dry land.

Flood Damage-Resistant Materials: Any construction materials capable of withstanding direct and prolonged contact with floodwaters without sustaining any damage that requires more than cosmetic repair.

Floodplain Administrator: The person appointed to administer, implement, and enforce the provisions of this article. This person is also known as the Floodplain and Dam Safety Manager.

Floodplain Management: The operation of an overall program of corrective and preventive measures for reducing flood damage, including emergency preparedness plans, flood control works, and floodplain management regulations.

Floodplain Maps: The current Flood Insurance Rate Maps and Flood Insurance Study for Henrico County prepared by the Federal Emergency Management Agency, Federal Insurance Administration, effective April 25, 2024, and the current County Comprehensive Drainage Map, effective December 18, 2007, and subsequent revisions or amendments thereto.

Floodplain or Flood-Prone Area: Any land area susceptible to being inundated by water from any source other than a dam break.

Floodproofing: Any combination of structural and non-structural additions, changes, or adjustments to structures which reduce or prevent flood damage to real estate or improved real property, water and sanitary facilities, structures, and their contents.

Floodway: The channel of a river or other watercourse and the adjacent land areas that must be reserved to discharge the base flood without cumulatively increasing the water surface elevation. The Floodway is part of the SFHA. This may also be referred to as the Regulatory Floodway.

Freeboard: A factor of safety usually expressed in feet above a flood level for purposes of floodplain management. Freeboard tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed.

Functionally Dependent Use: A use which cannot perform its intended purpose unless it is located or carried out in close proximity to water. The term only includes docking facilities, port facilities that are necessary for the loading and unloading of cargo or passengers, and ship building and ship repair facilities. The term does not include long-term storage or related manufacturing facilities.

GIS: Geographic Information System.

Habitable Building: A structure designed primarily for or used for human habitation. This includes houses, condominiums, townhomes, restaurants, retail establishments, manufacturing buildings, commercial buildings, office buildings, manufactured homes, and similar uses. It does not include Accessory Structures.

Highest Adjacent Grade: The highest natural elevation of the ground surface next to the walls of a proposed structure prior to construction.

Historic Structure: Any structure that is: (a) listed individually in the National Register of Historic Places maintained by the U. S. Department of Interior or preliminarily determined by the U. S. Secretary of the Interior as meeting the requirements for individual listing on the National Register, or (b) certified or preliminarily determined by the U. S. Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district, or (c) individually listed on a state inventory of historic places in states with historic preservation programs which have been approved by the U. S. Secretary of the Interior, or (d) individually listed on a local inventory of historic places in communities with historic preservation programs that have been certified either: (1) by an approved state program as determined by the U. S. Secretary of the Interior or (2) directly by the U. S. Secretary of the Interior in states without approved programs.

Hydrologic and Hydraulic Engineering Analysis: Analyses performed by a licensed professional engineer in accordance with standard engineering practices to determine the base flood, other frequency floods, flood elevations, floodway information and boundaries, and flood profiles.

Impounding Structure: A dam across a watercourse or a manmade structure outside a watercourse used or to be used to retain or store waters or other materials as defined by Code of Virginia § 10.1-604. The term includes (i) all dams that are 25 feet or greater in height and that create an impoundment capacity of 15 acre-feet or greater and (ii) all dams that are six feet or greater in height and that create an impoundment capacity of 50 acre-feet or greater. The term "impounding structure" does not include: (a) dams licensed by the State Corporation Commission that are subject to a safety inspection program, (b) dams owned or licensed by the United States government, (c) dams operated primarily for agricultural purposes which are less than 25 feet in height or which create a maximum impoundment capacity smaller than 100 acre-feet, (d) water or silt retaining dams approved pursuant to Code of Virginia § 45.1-222 or § 45.1-225.1, or (e) obstructions in a canal used to raise or lower water.

Increased Cost of Compliance (ICC) Coverage: Covers expenses that a property owner must incur above the cost to repair physical damage a building actually sustains from a flooding event to comply with mitigation requirements of state or local floodplain management ordinances or laws. Acceptable mitigation measures are higher elevation, greater floodproofing, relocation, demolition, or any combination thereof.

Land Disturbing Activity: Any clearing, grading, excavating, transporting, or filling of land.

Letter of Map Amendment (LOMA): An amendment to the Flood Insurance Rate Map approved by FEMA based on technical data that establishes that a specific property is not located in a FEMA SFHA. However, a LOMA is site specific and is not shown on the Floodplain Maps.

Letter of Map Change (LOMC): A Letter of Map Change is (1) an official FEMA letter that amends or revises an effective Flood Insurance Rate Map or Flood Insurance Study or (2) an official county letter that amends or revises the most recent County Comprehensive Drainage Map.

Letter of Map Revision (LOMR): A revision to the Floodplain Maps based on technical data that shows a change or changes to flood zones or flood elevations or floodplain and floodway delineations or planimetric features. This includes (1) a revision approved by FEMA to revise a FEMA SFHA on a Flood Insurance Rate Map or Flood Insurance Study or (2) a revision approved by the county engineer to revise a Community SFHA on the most recent County Comprehensive Drainage Map.

Levee System: A flood protection system which consists of a levee or levees and associated structures, such as closure and drainage devices, which are constructed and operated in accordance with sound engineering practices.

Levee: A man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water to provide protection from temporary flooding.

Lowest Adjacent Grade: The lowest natural elevation of the ground surface next to the walls of a structure.

Lowest Floor: The lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement area is not considered a building's lowest floor if such enclosure does not violate the applicable enclosure requirements in Sec. 10-10(b) of this article.

Manufactured Home: A structure, transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when attached to the required utilities. The term Manufactured Home does not include a recreational vehicle. A Manufactured Home may be considered a Residential or Non-Residential Building depending on its use.

Market Value: The value of a building, excluding land value, that is determined by an appraiser certified in Virginia. The tax value of the building may be used for this value.

Mean Sea Level: For purposes of the National Flood Insurance Program, the National Geodetic Vertical Datum (NGVD) of 1929 or other datum to which base flood elevations shown on a community's Floodplain Maps are referenced.

Mechanical Equipment: Includes electrical, heating, ventilation, plumbing, and air conditioning equipment, and other service facilities.

Mixed-Use Building: A building that has both residential and non-residential uses.

Mudslide: A condition where there is a river, flow, or inundation of liquid mud down a hillside usually as a result of a loss of brush cover and the subsequent accumulation of water on the ground preceded by a period of unusually heavy or sustained rain. A Mudslide (*i.e.*, mudflow) may occur as a distinct phenomenon while a landslide is in progress and will be recognized as such by the Administrator only if the mudflow, and not the landslide, is the proximate cause of damage that occurs.

New Construction: Structures for which the start of construction commenced on or after the effective date of a floodplain management regulation adopted by a community and includes any subsequent improvements to such structures.

NFIP: National Flood Insurance Program.

Non-Residential Building: A building or accessory structure where the primary use is commercial or not for human habitation.

No-Rise Certification: A certification statement signed by a professional engineer licensed to practice in the Commonwealth of Virginia certifying that a proposed project will not increase the base flood elevations in the community.

Post-FIRM: Construction or other development for which the "start of construction" occurred on or after the effective date of the initial Flood Insurance Rate Map.

Pre-FIRM: Construction or other development for which the "start of construction" occurred before the effective date of the initial Flood Insurance Rate Map.

Principally Above Ground: At least fifty-one percent of the actual cash value of the structure, less land value, is above ground.

Prolonged Contact with Floodwaters: Partial or total inundation by floodwaters for 72 hours or more.

Recreational Vehicle: A vehicle which is: (a) built on a single chassis; (b) 400 square feet or less when measured at the largest horizontal projection; (c) designed to be self-propelled or permanently towable by a light duty truck; and (d) designed primarily for use as temporary living quarters for recreational, camping, travel, or seasonal use rather than as a permanent dwelling.

Repetitive Loss Structure: A building covered by a contract for flood insurance that has incurred flood-related damages on two occasions in a 10-year period for which the cost of the repair, on the average, equaled or exceeded 25 percent of the market value of the structure at the time of each flood event and at the time of the second flood event had increased costs of compliance coverage in the contract for flood insurance.

Residential Building: A non-commercial building designed for habitation by one or more families or a mixed-use building, including any building or portion of a building occupied or designed to be occupied exclusively for residential purposes. The term includes guesthouses, cabins, and sleeping units but does not include a tent, recreational vehicle, hotel or motel, boardinghouse, hospital, or other accommodation used for transient occupancy.

Riverine: Relating to, formed by, or resembling a river (including tributaries), stream, brook, etc.

Severe Repetitive Loss Structure: A structure that is covered under a contract for flood insurance made available under the NFIP and has incurred flood related damage for which four or more separate claims payments have been made under flood insurance coverage with each such claim exceeded $5,000 and the cumulative amount of such claims payments exceeded $20,000. The term also includes a structure covered by flood insurance made available under the NFIP for which at least two separate claims payments have been made under such coverage and the cumulative amount of such claims payments exceeds the market value of the insured structure.

Special Flood Hazard Area (SFHA): Land subject to a one percent or greater chance of flooding in any given year. This area includes both FEMA Special Flood Hazard Areas and Community Special Flood Hazard Areas and may also be referred to as the 100-year floodplain.

Start of Construction: The date the building permit is issued for construction, repair, reconstruction, rehabilitation, addition placement, or other improvements, provided the actual start of such activity was within 180 days of the permit date. The actual start means either the first placement of permanent construction of a structure on a site, such as the pouring of slab or footings, the installation of piles, the construction of columns, or any work beyond the stage of excavation, or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation, such as clearing, grading, and filling, or the installation of streets and/or walkways. It also does not include excavation for a basement, footings, piers, or foundations, the erection of temporary forms, or the installation on the property of accessory buildings, such as garages or sheds that are not occupied as dwelling units or as parts of the main structure. For a substantial improvement, the actual start of construction means the first alteration of any wall, ceiling, floor, or other structural part of a building, whether or not that alteration affects the external dimensions of the building. This definition does not apply to new construction or substantial improvements under the Coastal Barrier Resources Act (Pub. L. 97-348).

Structure: A walled and roofed building that is principally above ground. Walled is considered "two or more outside rigid walls" and roofed is "a fully secured roof." This may also be referred to as a building.

Substantial Damage: Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

Substantial Improvement: Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the Start of Construction of the improvement. This term includes improvements to structures which have incurred Substantial Damage, regardless of the amount of the actual repair work performed. For the purposes of this article, the relocation of

a residential structure within the SFHA is deemed a substantial improvement. This term does not, however, include any improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum improvements necessary to assure safe living conditions.

Substantially Impermeable: Use of flood damage-resistant materials and techniques for dry floodproofing portions of a structure, which result in a space free of cracks, openings, or other channels that permit unobstructed passage of water and seepage during flooding and which results in a maximum accumulation of 4 in. of water depth in such space during a period of 24 hours.

Uniform Statewide Building Code (USBC): The current edition of the Virginia Uniform Statewide Building Code as authorized by the Code of Virginia, § 36-98.

Variance: A grant of relief from any requirement of this article. Variances may only be granted in compliance with the provisions of Division 5 of this article.

Violation: The failure of a structure or other development to be fully compliant with this article.

Water Surface Elevation (WSE): The height of floods of various magnitudes and frequencies in the floodplains of coastal or riverine areas. These heights are shown on maps by reference to the National Geodetic Vertical Datum (NGVD) of 1929 (or other datum, where specified),

Watercourse: A lake, river, creek, stream, wash, channel, or other topographic feature on or over which waters flow at least periodically. Watercourse includes specifically designated areas in which substantial flood damage may occur.

Wet Floodproofing: Floodproofing method that relies on the use of flood damage-resistant materials and construction techniques in areas of a structure that are below the elevation required by this article and are intentionally allowed to flood.

Division 3: Administration and Interpretation

Sec. 10-4. Designation of the Floodplain Administrator

The Floodplain Administrator is responsible for administering and implementing this article. However, the Floodplain Administrator may implement this article by:

(a) delegating his or her duties and responsibilities in this article to qualified technical personnel, plan examiners, inspectors, and other employees.
(b) entering into a written agreement or written contract with a community or private sector entity to carry out specific provisions of these requirements. Administration of any part of this article by another entity shall not relieve the community of its responsibilities pursuant to the participation requirements of the National Flood Insurance Program as set forth in the Code of Federal Regulations at 44 C.F.R. 59.22.

Sec. 10-5. Duties and Responsibilities of the Floodplain Administrator

The duties and responsibilities of the Floodplain Administrator shall include:

(a) reviewing applications for permits to determine whether proposed activities will be located in the SFHA.
(b) interpreting floodplain boundaries and providing available BFE and flood hazard information.
(c) reviewing applications to determine whether proposed activities will be reasonably safe from flooding and requiring new construction and substantial improvements to meet the requirements of these requirements.
(d) reviewing applications to determine whether all necessary permits have been obtained from the federal, state, or local agencies from which prior or concurrent approval is required. These permits shall

include permits from state agencies for any construction, reconstruction, repair, or alteration of a dam, reservoir, or waterway obstruction (including bridges, culverts, structures), any alteration of a watercourse, or any change of the course, current, or cross-section of a stream or body of water, including any change to the 100-year frequency floodplain of free-flowing non-tidal waters of the Commonwealth.

(e) verifying that applicants proposing an alteration of a watercourse have notified impacted adjacent communities, the Virginia Department of Conservation and Recreation (Division of Dam Safety and Floodplain Management), and other appropriate agencies, such as the Virginia Department of Environmental Quality and the U.S. Army Corps of Engineers, and have submitted copies of such notifications to FEMA.

(f) approving applications and issuing permits to develop in the SFHA if the requirements of this article have been met.

(g) inspecting, or causing to be inspected, buildings, structures, and other development for which permits have been issued to determine compliance with these requirements.

(h) reviewing Elevation Certificates and Floodproofing Certificates and requiring incomplete or deficient certificates to be corrected.

(i) submitting to FEMA, or requiring applicants to do so, data and information necessary to maintain FIRMs, including hydrologic and hydraulic engineering analyses prepared by or for the county, within six months after such data and information becomes available if the analyses indicate changes in BFEs or boundary changes.

(j) maintaining and permanently keeping records that are necessary for the administration of these requirements, including:

(1) FISs, FIRMs, and LOMCs; and

(2) Documentation supporting issuance and denial of permits, Elevation Certificates, documentation of the elevation to which structures have been floodproofed, inspection records, required design certifications, variances, and records of enforcement actions taken to correct violations of these requirements.

(k) enforcing the provisions of these requirements, investigating violations, issuing notices of violations or stop work orders, and requiring permit holders to take corrective action as needed to comply with this article.

(l) creating, and amending as necessary, a Technical Guidance Manual to help explain the application of this article using charts and other written materials.

(m) advising the county engineer, county manager, board of supervisors, and others regarding the intent of these requirements.

(n) administering the requirements related to proposed work on existing buildings that may be substantially damaged:

(1) making determinations as to whether damaged structures in the SFHA are substantially damaged.

(2) coordinating with federal, state, and local agencies to assist with substantial damage determinations.

(3) making reasonable efforts to notify owners of substantially damaged structures of their need to obtain permits to repair, rehabilitate, or reconstruct.

(4) prohibiting the non-compliant repair of substantially damaged buildings except for emergency measures to secure a property or temporarily stabilize a building or structure to prevent additional damage.

(o) issuing public service announcements and other information related to permit requests and repair of damaged structures.
(p) providing owners of damaged structures information about the proper repair of damaged structures in SFHAs.
(q) assisting property owners with documentation required to file claims for Increased Cost of Compliance coverage under NFIP flood insurance policies.
(r) notifying FEMA when the corporate boundaries of the county have been modified.
(s) completing and submitting a report concerning participation in the NFIP at the request of FEMA.
(t) considering known flood, mudslide, and flood-related erosion hazards in official actions regarding land management and use throughout the county, even if those hazards have not been specifically delineated via mapping or surveying.
(u) maintaining records of all variance actions, including notifications and justifications for the granting of variances. All issued variances shall be recorded in the annual or biennial report as requested by FEMA.

Sec. 10-6. Use and Interpretation of Floodplain Maps

The county's Floodplain Maps shall include the current effective FEMA FIRMs and the current effective County Comprehensive Drainage Maps in the county's online GIS. The Floodplain Administrator shall make interpretations, where needed, as to the exact location of SFHAs, floodplain boundaries, floodway boundaries, and BFEs.

The following shall apply to the use and interpretation of floodplain maps and data:

(a) Where available topography information, such as GIS maps, LiDAR, and field surveys, indicates that adjacent ground elevations:
    (1) are below the BFE, even in areas not delineated as SFHA, the area shall be considered as SFHA and subject to the requirements of this article;
    (2) are above the BFE and the area is labelled as SFHA on the floodplain maps, the area shall be regulated as SFHA unless the applicant obtains an approved LOMC.
    The Floodplain Administrator may require field survey information to verify adjacent ground elevations from a licensed land surveyor or professional engineer.
(b) Where BFE and floodway data have not been identified, including in areas where SFHAs have not been identified, any other reasonable flood hazard data available from a federal, state, or other source shall be reviewed and used. The Floodplain Administrator is authorized to require the applicant to determine the BFE and/or floodway in accordance with accepted hydrologic and hydraulic engineering practices, and the determination must be made by a licensed professional engineer.
(c) BFEs and designated floodplain or floodway boundaries for effective SFHAs that are more restrictive shall take precedence over BFEs and floodplain or floodway boundaries created by any other source unless a CLOMR has been approved. Other sources of data shall be reasonably used if such sources show increased BFEs and/or wider floodplain or floodway boundaries than have been adopted for the effective SFHA.
(d) If a Preliminary FIRM and/or a Preliminary Flood Insurance Study has been provided by FEMA:
    (1) Upon the issuance of a Letter of Final Determination by FEMA, the preliminary flood hazard data shall be used and shall replace the effective SFHA for the purposes of administering these regulations.

(2) Prior to the issuance of a Letter of Final Determination by FEMA, the use of preliminary flood hazard data shall be deemed the best available data pursuant to Sec. 10-6(b) and used where no BFEs and/or floodplain or floodway areas are provided on the effective Floodplain Maps.
(3) Prior to issuance of a Letter of Final Determination by FEMA, the use of preliminary flood hazard data is permitted where the preliminary BFEs, floodplain or floodway areas exceed the BFEs and/or designated floodplains or floodway widths on the effective Floodplain Maps. Such preliminary data may be subject to change and/or appeal to FEMA.

Sec. 10-7. SFHA Boundary Changes

The county may revise the delineation of any SFHA when (1) natural or man-made changes have occurred, (2) detailed studies have been conducted by the U. S. Army Corps of Engineers or another qualified entity, or (3) an owner or developer documents the need for a boundary change. The revision must be documented in an approved LOMR.

Division 4: Permit and Development Standards

Sec. 10-8. Floodplain Development Permit Requirements

A Floodplain Development Permit is necessary for any use, activity, or development within a SFHA. All development must strictly comply with this article and other applicable requirements. The application must show compliance with all legal requirements before issuance of such permit, and the Floodplain Administrator shall review all sites to verify they are reasonably safe from flooding. Under no circumstances may any use, activity, or development adversely affect the capacity of the channels or floodways of any watercourse, drainage ditch, or any other drainage facility or system.

The following specific requirements must be met before any development in the floodplain occurs:

(a) The applicant shall submit the application fee, application form, and required information for a Floodplain Development Permit to the Floodplain Administrator. All applications must state the elevation of the lowest floor for all structures to be elevated or the elevation to which the structures will be floodproofed in an Elevation Certificate (FEMA Form 086-0-33).
(b) On receiving the application, the Floodplain Administrator shall determine whether the application is complete. If the Floodplain Administrator determines the application is incomplete, the Floodplain Administrator shall provide written notice of the submission deficiencies and shall not process the application further. When the Floodplain Administrator determines that the application is complete, the Floodplain Administrator shall review the application for compliance with this article.
(c) The Floodplain Administrator must issue a Floodplain Development Permit and include any conditions necessary to ensure compliance with this article.

Sec. 10-9. Development Standards – General

The following provisions apply to all permitted development:

(a) Development shall not cause an increase in the BFE, reduce the flood-carrying capacity of any watercourse, drainage ditch, or other drainage facility or system, or similar adverse impacts. The applicant shall submit a No-Rise Certificate, signed and sealed by a licensed professional engineer, with sufficient supporting technical data such as a hydrologic and hydraulic analysis, as determined

by the Floodplain Administrator. Compensatory storage may be utilized to satisfy the no rise requirement for any type of development if engineering data shows the site is hydraulically equivalent and the Floodplain Administrator approves the plans for each compensatory storage area.

(b) Fill may not be placed in the SFHA, including the placement of fill to remove a lot from the SFHA in order to construct a building or structure.

(c) Mechanical equipment shall be designed and/or located to prevent water from entering or accumulating within its components during conditions of flooding.

(d) New and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the system.

(e) New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of flood waters into the system and discharges from the system into flood waters.

(f) On-site waste disposal systems shall be located and constructed to avoid their impairment or contamination during flooding.

(g) Any repair, replacement, or reconstruction of a damaged or destroyed building or structure must comply with the requirements of Sec. 10-13.

(h) An owner or developer must obtain a permit from the U. S. Corps of Engineers, the Virginia Department of Environmental Quality, and the Virginia Marine Resources Commission (as applicable) prior to any proposed alteration or relocation of any channel or watercourse within the county. Furthermore, the applicant shall notify all affected adjacent jurisdictions, the Virginia Department of Conservation and Recreation (Division of Dam Safety and Floodplain Management), and FEMA when altering or relocating any channel or watercourse mapped in a FEMA SFHA.

(i) Any alteration or relocation of any channel or watercourse must maintain the flood carrying capacity of the channel or watercourse.

(j) There shall be no encroachment, including fill, new construction, substantial improvements, or other development within the floodway unless hydrologic and hydraulic analysis performed in accordance with standard engineering practices show the encroachment will not result in any increase to the BFE. The Floodplain Administrator may require a CLOMR and/or a LOMR.

(k) New or substantially improved Critical Facilities and new or substantially improved residential structures may not be located inside the SFHA.

(l) A new Critical Facility may be located in the 500-year floodplain if the building or structure is outside the SFHA and its lowest floor is elevated to either the BFE plus two feet or the 500-year flood elevation plus one foot, whichever is greater.

(m) New or substantially improved residential structures may not be located closer to a SFHA than 15 feet.

(n) New buildings or structures other than Critical Facilities or residential structures may be constructed in the SFHA if the elevation of the lowest floor, including mechanical equipment, is a minimum of two feet above the BFE.

(o) New construction or substantial improvements located in the 500-year floodplain or that are closer to the SFHA than 40 feet shall have the lowest floor, including mechanical equipment, elevated a minimum of one foot above the BFE.

Sec. 10-10. Elevation and Construction Standards

(a) New construction and substantial improvements, including manufactured homes, shall be:

(1) built in accordance with this article and the USBC, and anchored to prevent flotation, collapse, or lateral movement of the structure,

(2) constructed with materials and utility equipment resistant to flood damage, and

(3) constructed with methods and practices that minimize flood damage.

(b) *Enclosures Below the Lowest Floor:* Fully enclosed areas of new construction or substantially improved structures which are below the lowest floor shall:
(1) not be designed or used for human habitation,
(2) be used solely for parking of vehicles, building access, or limited storage of maintenance equipment for the premises. Access to the enclosed area shall be the minimum necessary to allow for parking of vehicles (garage door) or limited storage of maintenance equipment (standard exterior door), or entry to the living area (stairway or elevator).
(3) be constructed entirely of flood resistant materials;
(4) include measures to automatically equalize hydrostatic flood forces on walls by allowing for the entry and exit of floodwaters. To meet this requirement, flood openings must meet the following minimum design criteria:
a. there must be a minimum of two openings on different sides of each enclosed area subject to flooding.
b. the total net area of all openings must be at least one square inch for each square foot of enclosed area subject to flooding.
c. there must be openings to allow floodwaters to automatically enter and exit each enclosed area if a building has more than one enclosed area.
d. the bottom of all required openings shall be no higher than one foot above the adjacent grade.
e. openings may be equipped with screens, louvers, or other opening coverings or devices that permit the automatic flow of floodwaters in both directions without manual operation or human intervention.

(c) *Accessory Structures*: Detached accessory structures used only for parking of vehicles and/or storage may be permitted with the lowest floor below the BFE if the following conditions are met:
(1) the structure is not larger than 600 square feet - approximately the size of a one-story two-car garage and walls.
(2) the structure has flood openings in compliance with the requirements of Sec. 10-10(b)(4) to protect the structure from hydrostatic pressure.
(3) the structure is anchored to resist flotation, collapse, and lateral movement.
(4) flood damage-resistant materials are used below the BFE.
(5) mechanical, electrical, and utility equipment is elevated or dry-floodproofed to or above the BFE. Dry-floodproofing must be certified by a licensed professional engineer or architect.

(d) *Elevation Certificates:* An Elevation Certificate (FEMA Form 086-0-33) must be submitted and approved by the Floodplain Administrator after the lowest floor of a new building or structure has been completed and before further construction has begun. In addition, an Elevation Certificate must be submitted and approved by the Floodplain Administrator after construction is completed to ensure compliance with this article prior to the issuance of a certificate of occupancy or temporary certificate of occupancy. Another certification may be required to certify corrected as-built construction. Failure to submit the Elevation Certificate or failure to make required corrections shall be cause to withhold the issuance of a certificate of occupancy or temporary certificate of occupancy.

(e) *Recreational Vehicles:* Recreational vehicles may not be parked within the SFHA for more than 180 consecutive days and must be fully licensed and ready for highway use. For purposes of this subsection, a recreational vehicle is ready for highway use if it is on wheels or a jacking system, is

attached to the site only by quick disconnect-type utilities and security devices, and has no permanently attached additions.

(f) *Storage of Materials and Equipment:* Storage of hazardous materials is prohibited in the SFHA. Storage of other materials and equipment may be permitted in the SFHA if the materials and equipment will not become debris during a flood by being elevated at or above the BFE or anchored to resist flotation or located in an enclosure or being removable from the site prior to a flood. To treat the materials or equipment as being removable from the site, the owner must provide (1) a copy of the contract with a trucking company to ensure the availability of removal equipment when needed, or (2) evidence of removal equipment on the property if a trucking company will not be used. In either case, the owner must provide a written designation of a location outside the SFHA to which the materials or equipment will be removed.

(g) *Dryland Access:* New roads, driveways, and parking areas located in the SFHA must be designed and constructed so that they will not be overtopped by more than six inches of water during the 100-year flood.

(h) *Swimming Pools:* Accessory swimming pools may be permitted in the SFHA if they are constructed in accordance with this article, the USBC, and ASCE 24.

(i) *Tanks:* The placement of gas and liquid storage tanks must be in compliance with the USBC and ASCE 24.

(j) *Stormwater Management Facilities*: New stormwater management facilities may not be constructed within the SFHA. Stormwater management facilities located adjacent to the SFHA that discharge into it must meet the requirements in Sec. 10-9(a).

(k) *Temporary Structures:* Before issuance of a Floodplain Development Permit by the Floodplain Administrator for a temporary structure, all applicants must submit a plan for removal of the structure in the event of a flood-related severe weather notification (hurricane, tropical storm, flood, flash flood, etc.) which includes the following information:

(1) certification that the requirements of Sec. 10-9(a) and Sec. 10-9(b) have been met;

(2) a specified time period for the temporary use. The time period may not exceed three months and is renewable for up to one additional year;

(3) the name, address, and phone number of the individual responsible for the removal of the structure;

(4) the amount of time prior to the event when the structure will be removed;

(5) a copy of a contract with a trucking company to ensure the availability of removal equipment when needed or evidence of removal equipment on the property if a trucking company will not be used. In either case, the owner must provide a written designation of a location outside the SFHA to which the structure will be removed.

(l) *Temporary Encroachments:* Temporary encroachments into the SFHA may be exempt from the requirements of Sec. 10-9(a) and Sec. 10-9(b) if a Floodplain Development permit is issued. Temporary encroachments include sediment control devices, temporary stream crossings, haul roads and construction entrances, storage of equipment, and soil stockpiling. The following conditions must be met to qualify for the exemption:

(1) The proposed temporary encroachment shall not be in place more than three months and is renewable for up to one additional year with written approval from the Floodplain Administrator. Temporary sediment control devices may be kept in place longer than one year if required by the appropriate regulatory agency; and,

(2) Supporting documentation, including a hydrologic and hydraulic analysis (if required by the Floodplain Administrator) must be submitted by a licensed professional engineer indicating

that the proposed project will not impact any existing buildings or overtop any roadway surfaces.

Sec. 10-11. Dams and Other Water-Impounding Structures

Construction of a dam or other water-impounding structure to impound water shall comply with the following requirements:

(a) The construction's effect upon the BFE above the dam or water-impounding structure shall not endanger human life or property.
(b) The dam or water-impounding structure shall be designed and constructed in accordance with the requirements of the Virginia Dam Safety Act, § 10.1-604 et seq. of the Code of Virginia, as amended, its implementing regulations, and any requirements of the county engineer to minimize hazards below the dam resulting from failure of the dam or water-impounding structure.

Sec. 10-12. Subdivision Proposals

(a) Any subdivision proposal or other proposed development that exceed 50 lots or five acres, whichever is less, in an area where BFE data is not available or the SFHA has not been delineated shall include data using detailed methodologies, including a hydraulic and hydrologic analysis, comparable to those contained in a FIS. Once identified, those areas shall be subject to the requirements of this article.
(b) Any proposed subdivision in a SFHA shall include measures to reduce flood damage.
(c) Any proposed subdivision in a SFHA shall ensure that public utilities and facilities, such as sewer, gas, electrical and water systems, are located and constructed to minimize flood damage.
(d) Any proposed subdivision in a SFHA shall provide adequate drainage to reduce exposure to flood hazards.

Sec. 10-13. Existing Structures and Uses

(a) A structure or use that lawfully existed before the adoption of this article but does not satisfy the current requirements of this article may continue.
(b) An existing structure in the floodway may not be expanded or enlarged if the proposed expansion or enlargement would result in an increase in the BFE.
(c) If a modification, alteration, repair, reconstruction, or improvement to a structure in a floodplain would cost less than 50 percent of the market value of the structure, the modification, alteration, repair, reconstruction, or improvement must be designed to minimize flood damage. If such structure does not comply with the current requirements of this article, the modification, alteration, repair, reconstruction, or improvement must not increase the amount of nonconformity.
(d) A substantial improvement must meet the requirements of this article for new construction, and the entire structure must conform with the current USBC after the substantial improvement is completed. If a substantial improvement will be located in the 500-year floodplain or will be between 15 and 40 feet from the SFHA, the lowest floor of the substantial improvement, including mechanical equipment, must be elevated a minimum of one foot above the BFE.
(e) An existing residential structure may not be enlarged if any part of the enlarged structure will be in, or within 15 feet of, the SFHA.
(f) A residential structure may be relocated only if the new location of the structure is entirely outside the SFHA and the new location does not violate the provisions of this article.

Division 5. Appeals and Variances

Sec. 10-14. Variance Application Process

Applicants may seek a variance from the county engineer under Sec. 10-16 or an administrative variance from the Floodplain Administrator under Sec. 10-17.

Applications for variances shall be submitted to the county engineer and filed with the Floodplain Administrator. The Floodplain Administrator shall not accept any application without the required fee. If a variance application is filed because of a natural disaster that is the subject of a federal emergency declaration, the Floodplain Administrator may waive application and advertising fees and give the application expedited processing.

Sec. 10-15. Variance Requirements

No variance shall be granted unless the following minimum requirements are met:

(a) a showing of good and sufficient cause;
(b) a determination that failure to grant the variance would result in exceptional hardship to the applicant;
(c) a determination that such variance will not create or result in:
    (1) unacceptable or prohibited increases in flood heights;
    (2) additional threats to public safety;
    (3) extraordinary public expense;
    (4) nuisances;
    (5) fraud or victimization of the public; or
    (6) conflicts with other existing laws or ordinances;
(d) the granting of the variance will not be detrimental to other property in the vicinity;
(e) the circumstances giving rise to the variance application are not of a general or recurring nature;
(f) the need for the variance arises from the physical character of the property or from the use or development of adjacent property and not from the personal or financial situation of the applicant: and,
(g) the variance shall be the minimum necessary to provide relief.

Sec. 10-16. County Engineer Variance

The county engineer may grant a variance from the requirements of this article when strict application of this article would effectively prohibit or unreasonably restrict the use of the subject property. The variance may include reasonable conditions to obtain compliance with this article to the maximum extent practicable. Variances may be granted for a functionally dependent use if the development is protected by methods that minimize flood damage during the base flood and create no additional threats to public safety. Variances for repair or rehabilitation of historic structures may be granted upon a determination that the proposed repair or rehabilitation will not preclude the structure's continued designation as a historic structure and the variance is the minimum necessary to preserve the historic character and design of the structure.

However, the county engineer may not grant a variance for a proposed use, development, or activity within a floodway that will cause an increase of the BFE unless FEMA or the county engineer has issued a CLOMR.

Before granting a variance, the county engineer must determine that the variance application satisfies the requirements of Sec. 10-15 and consider the following additional factors:

(a) the danger to life and property due to increased flood heights or velocities caused by encroachments.
(b) the risk of injury to others if materials are swept onto other lands or transported in floods.
(c) the water supply and sanitation system proposed for the development and their ability to prevent disease, contamination, and unsanitary conditions.

(d) the susceptibility of the proposed facility to flood damage and the effect of such damage on individual owners.
(e) the importance to the community of the services that will be provided by the proposed facility.
(f) the availability of alternative locations for the proposed use that are not subject to flooding.
(g) the compatibility of the proposed use with existing reasonably anticipated development.
(h) the compatibility of the proposed use with the comprehensive plan and county floodplain management program.
(i) vehicular access to the property during floods.
(j) the expected heights, velocity, duration, rate of rise, and sediment transport of foreseeable flood waters on the property.
(k) any other factors particularly relevant to the purposes of this article.

Sec. 10-17. Administrative Variance

The Floodplain Administrator may grant administrative variances for the following uses, development, or redevelopment:

(a) minor filling in the SFHA necessary to protect or restore natural floodplain functions or to stabilize stream banks to protect public roads or utilities. The requirements of Sec. 10-9 must be met.
(b) dry-floodproofing of nonresidential structures in lieu of requiring higher elevation of the structure if the following conditions apply:
  (1) elevating the structure is not reasonably feasible because of the nature of the lot and/or the use of the structure, and
  (2) all areas of the building components below the elevation corresponding to the BFE plus three feet must be watertight with walls substantially impermeable to the passage of water, and use structural components having the capability of resisting hydrostatic and hydrodynamic loads and the effect of buoyancy; this must be designed and constructed in accordance with the VA USBC and ASCE 24 and be certified by a professional engineer or architect. The following is required regarding the certification:
    a. a Floodproofing Certificate (*FEMA Form 086-0-34*) with supporting data and an inspection and operational plan that includes, but is not limited to, installation, exercise, and maintenance of floodproofing measures must be provided, and
    b. said certification, operational plan, and inspection and maintenance plan shall be prepared by or under the direct supervision of a professional engineer or architect and certified by same. The Floodplain Administrator shall review the certificate data, operational plan, and inspection and maintenance plan submitted. Deficiencies detected by such review shall be corrected by the permit holder immediately and prior to the issuance of a Certificate of Occupancy or Temporary Certificate of Occupancy. In some instances, another certification may be required to certify corrected as-built construction. Failure to submit the certification or failure to make said corrections required shall be cause to withhold the issuance of a Certificate of Occupancy or Temporary Certificate of Occupancy.
(c) rebuilding of a residential structure within the SFHA or setback area that has been substantially damaged by some cause other than flooding if there is no site outside of the SFHA or setback area for relocation of the structure and the lowest floor, including mechanical equipment, is elevated to the BFE plus two feet. If the structure has an enclosure below the lowest floor, the requirements in Sec. 10-10(c) must be met.

(d) locating stormwater management facilities in the SFHA if a location outside of the SFHA is not feasible, and the following conditions have been met:
(1) the requirements in Sec. 10-9(a) and Sec. 10-9(b) have been met.
(2) engineering data shows that the proposed stormwater management facility will operate effectively for its intended purpose during a 10-year flood event or the required design storm for the project, whichever is greater, and will have structure stability during a 100-year flood event.

Sec. 10-18. Notification
If a variance is granted to construct a structure below the BFE, the Floodplain Administrator shall notify the applicant in writing that construction below the BFE will result in increased premium rates for flood insurance and increase risks to life and property.

Sec. 10-19. Appeal of Variance Decisions
An applicant aggrieved by a decision of the Floodplain Administrator may appeal the decision to the county engineer within 30 days of the decision. The county engineer may modify, reverse, or affirm the Floodplain Administrator's decision.

An aggrieved applicant may appeal a variance decision of the county engineer within 30 days of the county engineer's decision to the Henrico County Circuit Court.

Division 6. Enforcement
Sec. 10-20. Inspections
The Floodplain Administrator, or designee, is authorized to conduct inspections and conduct other investigations to determine whether the property and the use thereof conforms to the requirements of this article. Such inspections shall comply with constitutional search and seizure requirements.

Sec. 10-21. Violations
Violations of this article are unlawful, and any person convicted of a violation of this article shall be subject to the provisions of Sec. 1-13 of this Code. In addition, the county may declare any structure constructed, reconstructed, enlarged, altered, or relocated in noncompliance with this article to be a nuisance subject to abatement.

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ARTICLE II. STORMWATER MANAGEMENT

Division 1. Purpose, Definitions, and Applicability

Sec. 10-27. Purpose and authority.

(a) The purposes of this article are to promote and protect the health, safety, and general welfare of the citizens of Henrico County; to protect state waters, stream channels, and other natural resources from the potential impacts of development; and to establish procedures whereby state and federal requirements related to stormwater quality and quantity shall be administered and enforced.

(b) This article sets forth the county's provisions for complying with state requirements for erosion and sediment control, stormwater management, and protection of Chesapeake Bay Preservation Areas as well as for complying with federal requirements in the Clean Water Act. Authority and additional definitions for this article are provided by § 62.1-44.15:24 et seq. (Stormwater Management Act), § 62.1-44.15:51 et seq. (Erosion and Sediment Control Law), and § 62.1-44.15:67 et seq. (Chesapeake Bay Preservation Act) of the Code of Virginia, and the state regulations implementing these acts.

American Burying Beetle	Nicrophorus americanus	Federal Threatened
Virginia Piedmont Water Boatman	Sigara depressa	State Endangered
Swamp-pink	Helonias bullata	Federal Threatened, State Endangered
Narrow-leaved Spatterdock	Nuphar sagittifolia	State Threatened

Source: Virginia Natural Heritage Database Search, April 2022, online at: https://vanhde.org/species-search

Coastal wetlands absorb the erosive energy of waves, thus reducing further erosion. The vegetation provides a buffer to the shoreline from the wave action while the root systems provide support to help hold the soil together. Once plant material is removed or destroyed, the erosion potential increases dramatically. When any type of wetlands are filled in or drained, the areas designed by nature to control floodwaters from damaging storms, extreme high tides, and extreme precipitation are lost. In order to protect valuable natural communities and habitats for the rarest of plants and animals, Virginia through DCR has established natural area preserves. Existing natural area preserves in the region include: Cumberland Marsh in New Kent County; and Chub Sandhill in Sussex County.

Hazard History

Table 5.3 includes descriptions of major, recent flood events in the region. Events have been broken down by the date of occurrence and, when available, by individual community descriptions. Historical events pre-dating the 2011 version of this plan update can be found in Appendix F-2. The NCEI history reports minimal damages, no loss of life, and no injuries recorded in the 2016-2020 time period under examination; however, there were at least four water rescues during the period recorded in the database and others mentioned in news reports.

Table 5.3: History of Flood Events and Damages, 2011 – 2020*

Date	Damages
August 27, 2011	Hurricane Irene impacted the area with heavy rainfall and gusty winds which knocked power out to millions of people in the area. It took electrical crews several days to fully restore power in the planning area. Irene originated east of the Lesser Antilles and tracked north and northwest into the western Atlantic. The hurricane reached Category 3 intensity with maximum sustained winds of near 120 mph at its strongest point. The hurricane made an initial U.S. landfall in the eastern portions of the North Carolina Outer Banks on August 27, 2011, as a Category 1 hurricane. The storm then tracked north/northeast along the coast slowly weakening before making its final landfall in Brooklyn, New York on August 28 as a high-end tropical storm. Rainfall totals with the hurricane ranged from around two inches in western sections of the planning region to 5 to 9 inches in eastern sections closest to the coast. At its closest pass, Irene brought sustained winds of 30 to 45 mph with gusts of 60 to nearly 70 mph to the planning area. The winds downed power lines and trees throughout the area. A man was killed when a tree fell on his home near Colonial Heights. (Source: National Weather Service/Wakefield Office)
September 4, 2011	Tropical Storm Lee moved inland along the Mississippi/Louisiana Gulf Coast on September 4, 2011. The remnants of the weakening storm tracked northeast, producing rainfall over a wide swath extending from the Gulf Coast to New England.

Table 5.3: History of Flood Events and Damages, 2011 – 2020*	
Date	**Damages**
	Rainfall totals generally ranged from 4 to 8 inches in the planning area with the heaviest totals falling just east of Interstate 95. The rain fell on soils saturated only days earlier with Hurricane Irene's passage. The result was widespread flooding, particularly over the eastern sections of the planning region. Gusty winds in thunderstorms knocked down trees that had already been weakened from the hurricane resulting in thousands of power outages. (Source: National Weather Service/Wakefield Office)
May 18-19, 2018	Showers and thunderstorms associated with areas of low pressure along a frontal boundary produced heavy rain which caused lingering flooding across portions of central, south central, and eastern Virginia. Flooding occurred along the Chickahominy River, North Anna River, South Anna River, and Pamunkey River over a couple of days, with roads and low-lying areas near the river impacted the most. Numerous road closures in Charles City County, Chesterfield County (Otterdale Rd, Enon Church Rd off Rte 10), Dinwiddie County, Goochland County (Riddles Bridge Rd washed out), Hanover County (Horseshoe Bridge Rd, Greenwood Rd), Ashland, Henrico County (water rescue on Gayton Rd at Cedarbluff Dr, Patterson Ave, Old Springfield Rd, Laurel area, lanes of I-195 North near Broad St, Raintree area), New Kent County, Petersburg, Powhatan County, Prince George County, Richmond, Charles City County, and Hanover County. Canterbury Dam, a high hazard dam, overtopped in Henrico County causing significant impacts, including Pump Road being shut down. The county had to spend roughly $1M to fix the dam and provide overtopping protection.
June 2-3, 2018	Scattered showers and thunderstorms in advance of and along a frontal boundary produced heavy rain which caused flash flooding across portions of central Virginia. Flash flooding and many inundated roads reported in Henrico County with vehicle stuck in water on Cox Road, New Kent County with water on road at I-64, exit 220, Hanover County with a sinkhole reported near Huguenot Trail and Rte 288, Charles City County, and Hanover County with sinkhole at Crown Hill Road ($2000 damage) and Cross Corner Road washed out ($1000 damage).
June 7, 2019	Slow moving thunderstorms produced intense rainfall of 4 to 6 inches resulting in flash flooding on June 7th, causing flash flooding in Charles City County (portion of Rte 5 closed), Chesterfield County (portion of Turner Rd closed), Ashland (home flooded with $2000 damage), Hanover County (portions of East Patrick Henry Rd), Henrico County (flooding of roads in Glen Allen) and Wakefield (Hwy 460 closed at Main and Hwy 31, impacts to Virginia Diner and James River Equipment with $100,000 damage).
August 15, 2020	Scattered showers and thunderstorms associated with low pressure and a frontal boundary produced heavy rain which caused flash flooding across portions of central and southeast Virginia. Flooding reported in Chesterfield County (Old Hundred Rd, Mt Hermon Rd, water rescue at Otterdale Rd, Rte 10 in Chesterfield), Colonial Heights (2 water rescues), Hopewell, Petersburg, and northwest Prince George County.

**Flood history from 1950-2010 can be found in Appendix F-2.*
Source: NCEI, 2021

Table 5.4 provides the number of events and damage caused by recorded flood events for each jurisdiction. These results represent only events recorded by the NCEI storm events database for flood. Some of the events listed in the table may be regional in nature, impacting multiple jurisdictions. Significant tropical storm or hurricane events resulting in

TABLE F-2 NCEI FLOOD HISTORY

COUNTY OR CITY	LOCATION	DATE	FLOOD TYPE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE	NARRATIVE
CHARLES CITY COUNTY	CHARLES CITY	8/4/2000	Flash Flood	0	0	$ -	$ -	Heavy rain caused flooding at Route 607 and Church Lane near Adkins Store.
CHARLES CITY COUNTY	EAST PORTION	9/1/2000	Flash Flood	0	0	$ -	$ -	Several flooded roads across eastern half of county.
CHARLES CITY COUNTY	WEST PORTION	8/30/2004	Flash Flood	0	0	$ -	$ -	Rainfall amounts between 4 and 8 inches resulted in numerous road closures due to flooding.
CHESTERFIELD COUNTY	MIDLOTHIAN	1/19/1996	Flood	0	0	$ -	$ -	Street flooding in Richmond/portions of Chesterfield county. Few roads closed temporarily.
CHESTERFIELD COUNTY	COUNTYWIDE	9/16/1999	Flash Flood	0	0	$ 3,000,000	$ 50,000	Very heavy rain from Hurricane Floyd produced widespread flooding and flash flooding across much of central and eastern Virginia, and northeast North Carolina. Rainfall amounts generally ranged from near 7 inches from eastern Caroline county to Richmond City to Brunswick, Lunenburg and Mecklenburg counties, to 12 to 18 inches in much of the Virginia Tidewater. Numerous roads were washed out due to flooding. Many areas normally prone only to flooding of poor drainage and low lying areas experienced significant flash flooding. Primary routes out of service included US 460 near Wakefield, US 58 near Emporia and Franklin, and Interstate 95 south of Petersburg to Emporia. River flooding was extensive and prolonged in the Chowan River Basin. The Blackwater, Meherrin and Nottoway Rivers exceeded flood stage. Water levels in the city of Franklin were estimated to be several feet above the flood of record which occurred in August 1940. The flooding was considered to be a 500 year flood of record. Also, there were enormous agricultural/crop losses due to the flooding.
CHESTERFIELD COUNTY	BEACH	7/19/2000	Flash Flood	0	0	$ -	$ -	Heavy rain caused flooding and road closure of Bellson Park Drive at Route 360 near Brandermill.
CHESTERFIELD COUNTY	CHESTERFIELD	8/4/2000	Flash Flood	0	0	$ -	$ -	Heavy rain caused high standing water and closure of Hull Street at Courthouse Road in Chesterfield.
CHESTERFIELD COUNTY	CHESTERFIELD	6/1/2001	Flash Flood	0	0	$ -	$ -	Several roads closed.
CHESTERFIELD COUNTY	COUNTYWIDE	5/26/2003	Flash Flood	0	0	$ -	$ -	20 road closures countywide.
CHESTERFIELD COUNTY	MIDLOTHIAN	7/27/2004	Flash Flood	0	0	$ -	$ -	Street flooding on Hull Street and Genito Road.
CHESTERFIELD COUNTY	CHESTERFIELD	8/1/2004	Flash Flood	0	0	$ -	$ -	Clover Leaf Lakes Apartments on Starview Court evacuated due to high water of 4 to 4.5 feet.
CHESTERFIELD COUNTY	COUNTYWIDE	8/30/2004	Flash Flood	1	0	$ 2,000,000	$ -	Rainfall amounts between 4 and 8 inches resulted in numerous road closures due to flooding.
CHESTERFIELD COUNTY	BELLWOOD	6/23/2006	Flash Flood	0	0	$ -	$ -	Flash flooding caused the closure of Hopkins Road in the Beulah District.
CHESTERFIELD COUNTY	MIDLOTHIAN	7/5/2006	Flash Flood	0	0	$ -	$ -	Flooding on Route 288.
CHESTERFIELD COUNTY	BELLBLUFF	10/7/2006	Flash Flood	0	0	$ 60,000	$ -	Numerous roads closures to high water including Beulah Road.
CHESTERFIELD COUNTY	BEACH	8/17/2007	Flash Flood	0	0	$ -	$ -	Numerous roads were closed county wide.
CHESTERFIELD COUNTY	BELLBLUFF	8/17/2007	Flash Flood	0	0	$ -	$ -	One person had to be rescued from a car on Hopkins Road due to high water.
CHESTERFIELD COUNTY	MIDLOTHIAN	8/28/2008	Flash Flood	0	0	$ -	$ -	Numerous roads were closed due to high water or debris in the road across much of north central Chesterfield county.

COLONIAL HEIGHTS	COLONIAL HGTS	9/16/1999	Flash Flood	0	0	$ 1,200,000	$ -	Very heavy rain from Hurricane Floyd produced widespread flooding and flash flooding across much of central and eastern Virginia, and northeast North Carolina. Rainfall amounts generally ranged from near 7 inches from eastern Caroline county to Richmond City to Brunswick, Lunenburg and Mecklenburg counties, to 12 to 18 inches in much of the Virginia Tidewater. Numerous roads were washed out due to flooding. Many areas normally prone only to flooding of poor drainage and low lying areas experienced significant flash flooding. Primary routes out of service included US 460 near Wakefield, US 58 near Emporia and Franklin, and Interstate 95 south of Petersburg to Emporia. River flooding was extensive and prolonged in the Chowan River Basin. The Blackwater, Meherrin and Nottoway Rivers exceeded flood stage. Water levels in the city of Franklin were estimated to be several feet above the flood of record which occurred in August 1940. The flooding was considered to be a 500 year flood of record. Also, there were enormous agricultural/crop losses due to the flooding.
COLONIAL HEIGHTS	COLONIAL HGTS	5/26/2003	Flash Flood	0	0	$ -	$ -	Flooding along Old Town Creek which closed New Castle Drive. Flooding at the Hampton Court Housing Complex.
DINWIDDIE COUNTY	SUTHERLAND	10/18/1996	Flash Flood	0	0	$ -	$ -	Four to five inches of rain occurred within 6 hours between Sutherland, Dinwiddie, and McKenney. Several roads were closed due to high water including parts of Route 460.
DINWIDDIE COUNTY	COUNTYWIDE	9/16/1999	Flash Flood	0	0	$ 870,000	$ 420,000	Very heavy rain from Hurricane Floyd produced widespread flooding and flash flooding across much of central and eastern Virginia, and northeast North Carolina. Rainfall amounts generally ranged from near 7 inches from eastern Caroline county to Richmond City to Brunswick, Lunenburg and Mecklenburg counties, to 12 to 18 inches in much of the Virginia Tidewater. Numerous roads were washed out due to flooding. Many areas normally prone only to flooding of poor drainage and low lying areas experienced significant flash flooding. Primary routes out of service included US 460 near Wakefield, US 58 near Emporia and Franklin, and Interstate 95 south of Petersburg to Emporia. River flooding was extensive and prolonged in the Chowan River Basin. The Blackwater, Meherrin and Nottoway Rivers exceeded flood stage. Water levels in the city of Franklin were estimated to be several feet above the flood of record which occurred in August 1940. The flooding was considered to be a 500 year flood of record. Also, there were enormous agricultural/crop losses due to the flooding.
DINWIDDIE COUNTY	COUNTYWIDE	4/17/2000	Flash Flood	0	0	$ 20,000	$ -	Walker Mill Road washed out near the county line. Highway U.S. 1 also impassible due to high water west of Petersburg. County road 651 caved in due to rapid runoff.
DINWIDDIE COUNTY	DINWIDDIE	5/26/2003	Flash Flood	0	0	$ -	$ -	White Oak Road collapsed due to flooding.
DINWIDDIE COUNTY	COUNTYWIDE	8/30/2004	Flash Flood	1	0	$ 2,000,000	$ -	Rainfall amounts between 4 and 8 inches resulted in numerous road closures due to flooding.
DINWIDDIE COUNTY	FORD	9/1/2006	Flash Flood	0	0	$ -	$ -	Route 624 from Route 460 to Route 613 flooded.
DINWIDDIE COUNTY	CARSON	10/7/2006	Flash Flood	0	0	$ 11,000	$ -	Numerous roads closed.

EMPORIA	EMPORIA	9/16/1999	Flash Flood	0	0	$ 195,000	$ 55,000	Very heavy rain from Hurricane Floyd produced widespread flooding and flash flooding across much of central and eastern Virginia, and northeast North Carolina. Rainfall amounts generally ranged from near 7 inches from eastern Caroline county to Richmond City to Brunswick, Lunenburg and Mecklenburg counties, to 12 to 18 inches in much of the Virginia Tidewater. Numerous roads were washed out due to flooding. Many areas normally prone only to flooding of poor drainage and low lying areas experienced significant flash flooding. Primary routes out of service included US 460 near Wakefield, US 58 near Emporia and Franklin, and Interstate 95 south of Petersburg to Emporia. River flooding was extensive and prolonged in the Chowan River Basin. The Blackwater, Meherrin and Nottoway Rivers exceeded flood stage. Water levels in the city of Franklin were estimated to be several feet above the flood of record which occurred in August 1940. The flooding was considered to be a 500 year flood of record. Also, there were enormous agricultural/crop losses due to the flooding.
EMPORIA	EMPORIA	7/24/2000	Flash Flood	0	0	$ 10,000	$ -	Very heavy rain fell in Emporia, where 5.70 inches of rain was measured. Several residents were evacuated on Reese Street at Metcalf Branch. Standing high water was common in Emporia, with water above car doors on Market and Brink Roads.
EMPORIA	EMPORIA	9/3/2000	Flash Flood	0	0	$ -	$ -	Slow-moving thunderstorms dumped heavy rain which resulted in flooding at the intersection of Route 58 and Highway 619 near Emporia.
EMPORIA	EMPORIA	7/5/2006	Flash Flood	0	0	$ -	$ -	Two feet of water on Highway 58.
EMPORIA	EMPORIA	7/6/2006	Flash Flood	0	0	$ -	$ -	Flooding reported on Route 58 (Chapmans Ford Road).
GOOCHLAND COUNTY		1/19/1996	Flood	0	0	$ -	$ -	
GOOCHLAND COUNTY		3/20/2003	Flood	0	0	$ -	$ -	
GOOCHLAND COUNTY	MANAKIN	9/17/2004	Flash Flood	0	0	$ -	$ -	High water at Manakin and Hermitage Streets, and on Broad Street Road in town of Goochland.
GREENSVILLE COUNTY	COUNTYWIDE	9/16/1999	Flash Flood	1	0	$ 1,200,000	$ 800,000	
GREENSVILLE COUNTY	DAHLIA	8/3/2000	Flash Flood	0	0	$ -	$ -	Heavy rain caused flooding on Dahlia Road near Claresville.
GREENSVILLE COUNTY	MOONLIGHT	7/5/2006	Flash Flood	0	0	$ -	$ -	Two feet of water on Highway 58. Also, high water on Highway 301.
GREENSVILLE COUNTY	PLEASANT SHADE	7/6/2006	Flash Flood	0	0	$ -	$ -	Flooding reported on Highway 611 (Drybread Road).
HANOVER COUNTY		3/20/2003	Flood	0	0	$ -	$ -	
HANOVER COUNTY	ASHLAND	7/10/1998	Flash Flood	0	0	$ -	$ -	Slow moving thunderstorms produced rainfall amounts between 3.0 and 3.5 inches within 2 hours. This resulted in flash flooding in eastern portions of Hanover county. Several roads were reported under as much as six inches of water. Several accidents were reported near the intersection of Route 643 and Route 301 about 6 miles southeast of Ashland.
HANOVER COUNTY	COUNTYWIDE	9/16/1999	Flash Flood	0	0	$ 67,000	$ -	
HANOVER COUNTY	MECHANICSVILLE	8/4/2000	Flash Flood	0	0	$ -	$ -	Heavy rain caused flooding of secondary roads in Mechanicsville.
HANOVER COUNTY	EAST PORTION	6/1/2001	Flash Flood	0	0	$ -	$ -	Several reports of high water in the eastern portion of the county.
HANOVER COUNTY	COUNTYWIDE	8/30/2004	Flash Flood	2	0	$ 2,000,000	$ -	Rainfall amounts between 5 and 11 inches resulted in numerous road closures due to flooding.
HANOVER COUNTY	ASHLAND	9/17/2004	Flash Flood	0	0	$ -	$ -	High water reported on Greenwood Church Road, Rosmarin Road, Mountain Road, Auburn Mill Road, and Stone Horse Road.
HANOVER COUNTY	ASHLAND	6/26/2006	Flash Flood	0	0	$ -	$ -	Heavy rain caused flash flooding and closure of Mount Hermon Road.
HANOVER COUNTY	ASHLAND	6/3/2009	Flash Flood	0	0	$ -	$ -	Several businesses were flooded.
HENRICO COUNTY	EAST HIGHLAND PAR	9/8/1996	Flood	1	1	$ 5,000	$ -	
HENRICO COUNTY	RICHMOND HGTS	9/9/1999	Flash Flood	0	0	$ -	$ -	
HENRICO COUNTY	COUNTYWIDE	9/16/1999	Flash Flood	0	0	$ 600,000	$ -	
HENRICO COUNTY	EAST PORTION	6/1/2001	Flash Flood	0	0	$ -	$ -	High water eastern portion of the county. Several roads closed.

HENRICO COUNTY	SANDSTON	6/10/2004	Flash Flood	0	0	$ -	$ -	High water on Bikerstaff Road and 7400 block of Strath Road. Road washed out at Ocano Drive.
HENRICO COUNTY	COUNTYWIDE	8/30/2004	Flash Flood	1	0	$ 2,000,000	$ -	Rainfall amounts between 5 and 10 inches resulted in numerous road closures due to flooding.
HENRICO COUNTY	WHITE OAK SWAMP	10/7/2006	Flash Flood	0	0	$ -	$ -	Route 156 at Route 5 closed due to high water.
HENRICO COUNTY	WHITE OAK SWAMP	8/17/2007	Flash Flood	0	0	$ -	$ -	Several roads were closed due to high water.
HENRICO COUNTY	LEWIS GARDENS	6/3/2009	Flash Flood	0	0	$ -	$ -	There was up to one foot of water covering parts of Darbytown, Monichan and Charles City Roads.
HOPEWELL	HOPEWELL	8/16/2000	Flash Flood	0	0	$ -	$ -	Heavy rain caused flooding on City Point Road near South 25th Avenue in Hopewell.
NEW KENT COUNTY	QUINTON	9/8/1996	Flood	0	0	$ -	$ -	
NEW KENT COUNTY	COUNTYWIDE	9/16/1999	Flash Flood	0	0	$ 650,000	$ -	
NEW KENT COUNTY	LANEXA	8/4/2000	Flash Flood	0	0	$ -	$ -	Heavy rain caused flooding on Carter Road in Lanexa.
NEW KENT COUNTY	QUINTON	6/1/2001	Flash Flood	0	0	$ -	$ -	Five inches of rainfall and high water reported by spotter.
NEW KENT COUNTY	WEST PORTION	8/30/2004	Flash Flood	0	0	$ -	$ -	Rainfall amounts between 4 and 8 inches resulted in numerous road closures due to flooding.
NEW KENT COUNTY	NEW KENT	10/7/2006	Flash Flood	0	0	$ 3,000	$ -	Route 1002 at Route 60 closed due to high water.
PETERSBURG	PETERSBURG	9/16/1999	Flash Flood	0	0	$ 650,000	$ 200,000	
PETERSBURG	PETERSBURG	7/7/2005	Flash Flood	0	0	$ -	$ -	Numerous roads closed city-wide. Roads barricaded due to flooding.
POWHATAN COUNTY		1/19/1996	Flood	0	0	$ -	$ -	
POWHATAN COUNTY		3/20/2003	Flood	0	0	$ -	$ -	
POWHATAN COUNTY	POWHATAN	9/3/2000	Flash Flood	0	0	$ -	$ -	Slow-moving thunderstorms dumped heavy rain over portions of the eastern Virginia piedmont causing flooding of the intersection of Routes 522 and 60 near Powhatan.
POWHATAN COUNTY	POWHATAN	6/16/2004	Flash Flood	0	0	$ -	$ -	Numerous road closures in western half of county.
POWHATAN COUNTY	POWHATAN	6/16/2004	Flash Flood	0	0	$ -	$ -	Rainfall amounts between 4 and 5 inches continued to result in numerous road closures in the western half of county.
POWHATAN COUNTY	POWHATAN	9/17/2004	Flash Flood	0	0	$ -	$ -	Portions of Highway 60 flooded. Route 711 closed due to high water.
POWHATAN COUNTY	SUBLETTS	6/23/2006	Flash Flood	0	0	$ -	$ -	Flash flooding caused high water on Route 711 and Manakin Ferry Road and at Judes Ferry Road.
POWHATAN COUNTY	POWHATAN	6/26/2006	Flash Flood	0	0	$ -	$ -	Heavy rain caused flooding at Three Bridge Road between Red Lane and Academy Roads.
POWHATAN COUNTY	POWHATAN	8/16/2007	Flash Flood	0	0	$ -	$ -	Many roads were flooded across the county.
POWHATAN COUNTY	POWHATAN	9/26/2008	Flash Flood	0	0	$ -	$ -	Water was covering the roadway at the intersection of US 60 and VA-13 near Powhatan.
PRINCE GEORGE COUNTY	COUNTYWIDE	9/16/1999	Flash Flood	0	0	$ 1,400,000	$ 900,000	
PRINCE GEORGE COUNTY	TEMPLETON	9/15/2004	Flash Flood	0	0	$ -	$ -	Over a foot of water was observed on Fairwood Road.
PRINCE GEORGE COUNTY	PRINCE GEORGE	9/15/2004	Flash Flood	0	0	$ -	$ -	Considerable water over Route 460 was reported near Disputanta, with one of the lanes blocked due to the high water.
PRINCE GEORGE COUNTY	TEMPLETON	9/1/2006	Flash Flood	0	0	$ -	$ -	Route 607 at Route 622 flooded.
PRINCE GEORGE COUNTY	DISPUTANTA	10/7/2006	Flash Flood	0	0	$ 225,000	$ 200,000	Numerous roads closed including a section of HWY 460. High water caused significant crop damage.
PRINCE GEORGE COUNTY	TEMPLETON	10/7/2006	Flash Flood	0	0	$ -	$ -	Road closed at intersection of Templeton and Lansing Roads.
PRINCE GEORGE COUNTY	BURROWSVILLE	9/26/2008	Flash Flood	0	0	$ -	$ -	Water was covering portions of Brandon Road in far eastern Prince George county north of Route 10. Road in process of closure.
RICHMOND	RICHMOND	9/9/1999	Flash Flood	0	0	$ -	$ -	Slow-moving thunderstorms caused flooded roads. This flooding forced people to abandon vehicles.
RICHMOND	RICHMOND	9/16/1999	Flash Flood	0	0	$ 176,000	$ -	

RICHMOND	SOUTH PORTION	7/19/2000	Flash Flood	0	0	$ 5,000	$ -	Heavy rain overwhelmed storm drains on Maury Street in South Richmond and sent water cascading in the basement of the Richmond Department of Public Utilities' Field Operations and Maintenance Facility. As much as five feet of water filled the 10,000 square foot basement and damaged several computers and internal department records. Ten inches of water was reported across Belt Boulevard between Hull Street and Midlothian Turnpike.
RICHMOND	RICHMOND	8/4/2000	Flash Flood	0	0	$ -	$ -	Heavy rain led to high standing water in the Shockoe Bottom section of downtown Richmond.
RICHMOND	RICHMOND	8/11/2000	Flash Flood	0	0	$ -	$ -	Very heavy rain caused flooding and the closure of the intersection of West Canal and South Adams Streets in downtown Richmond. High water also closed Bainbridge Street at 20th Street.
RICHMOND	RICHMOND	6/6/2001	Flash Flood	0	0	$ -	$ -	I-95 north bound closed at Broad Street underpass where 2 feet of water covered the roadway.
RICHMOND	RICHMOND	6/10/2004	Flash Flood	0	0	$ -	$ -	In the Shockoe Bottom area, several restaurants were flooded along with street flooding.
RICHMOND	RICHMOND	7/27/2004	Flash Flood	0	0	$ -	$ -	Street flooding near the Boulevard and I-95.
RICHMOND	RICHMOND	8/30/2004	Flash Flood	3	0	$ 20,000,000	$ -	Rainfall amounts between 5 and 12 inches resulted in numerous road closures due to flooding. In addition, about 20 blocks of downtown Richmond were condemned due to the floodwaters. A brick building collapsed in the city's historic and low-lying Shockoe Bottom area, and several dozen buildings had extensive water damage after floodwaters reached depths of up to 10 feet.
RICHMOND	RICHMOND	9/17/2004	Flash Flood	0	0	$ -	$ -	Flooding reported on New Kent Road, Jennie Scher and Stoney Run Roads, Fairmount Road, and Mechanicsville Turnpike.
RICHMOND	RICHMOND	7/22/2005	Flash Flood	0	0	$ -	$ -	High water signs posted on numerous roads, mainly due to flooding of underpasses and low lying areas. Gilles Creek overflowing its banks in Richmond's east end.
RICHMOND	RICHMOND	8/15/2006	Flood	0	0	$ 20,000	$ -	Heavy rain caused urban street flooding in the Shockoe Bottom section of the city. Several residents and businesses received damage due to high water.
SURRY COUNTY		11/12/2009	Coastal Flood	0	0	$ 500,000	$ -	Several streets, homes and businesses were flooded in low lying areas of the county close or directly exposed to the James River. Many decks and piers were damaged or destroyed.
SURRY COUNTY	SURRY	1/19/1996	Flood	0	0	$ -	$ -	
SURRY COUNTY	COUNTYWIDE	9/15/1999	Flash Flood	0	0	$ -	$ -	
SURRY COUNTY	COUNTYWIDE	7/24/2000	Flash Flood	0	0	$ -	$ -	Secondary road bridges covered with water.
SURRY COUNTY	DENDRON	8/4/2000	Flash Flood	0	0	$ -	$ -	Heavy rain caused flooding on Route 31 between Dendron and Scotland. Flooding also occured on Route 10 in Surry.
SURRY COUNTY	CABIN PT	9/1/2000	Flash Flood	0	0	$ -	$ -	Route 10 under water near the Surry/Prince George county line.
SURRY COUNTY	BACONS CASTLE	7/25/2004	Flash Flood	0	0	$ -	$ -	Route 617 closed due to flooding.
SURRY COUNTY	SAVEDGE	7/29/2004	Flash Flood	0	0	$ -	$ -	Road closed on Route 611 near the intersection of Highway 40 due to flooding.
SURRY COUNTY	DENDRON	9/1/2006	Flash Flood	0	0	$ -	$ -	Route 630 flooded. Other streets flooded countywide.
SURRY COUNTY	SPRING GROVE	10/7/2006	Flash Flood	0	0	$ 750,000	$ 750,000	Numerous roads closed including parts of HWY 10 and HWY 40. High water also resulted in significant crop damage.
SURRY COUNTY	MOORINGS	10/7/2006	Flash Flood	0	0	$ -	$ -	Route 31 and New Design Road closed due to high water.
SUSSEX COUNTY	COUNTYWIDE	9/16/1999	Flash Flood	0	0	$ 4,400,000	$ 1,000,000	
SUSSEX COUNTY	LITTLETON	7/24/2000	Flash Flood	0	0	$ -	$ -	Highway 35 closed between Littleton and county border due to high water.

SUSSEX COUNTY	NEWVILLE	9/1/2000	Flash Flood	0	0	$ -	$ -	Persistant heavy rain occurred as slow-moving thunderstorms moved across sections of southeast Virginia. The heavy rain caused flooding and forced road closures on Autodam Road near Route 40 in Newville.
SUSSEX COUNTY	HOMEVILLE	9/3/2000	Flash Flood	0	0	$ -	$ -	Slow-moving thunderstorms dumped heavy rain on portions of southeast Virginia and caused flooding of Route 35 near Homeville.
SUSSEX COUNTY	WAVERLY	7/5/2006	Flash Flood	0	0	$ -	$ -	Numerous roads closed due to high water, including at the intersection of Highway 40 and Highway 460. Also, flooding reported at the intersection of Route 604 and Route 615, and on Route 604 one half mile east of Route 603.
SUSSEX COUNTY	SUSSEX	7/6/2006	Flash Flood	0	0	$ -	$ -	Route 626 and Optimist Road closed due to flooding.
SUSSEX COUNTY	WAKEFIELD	9/1/2006	Flash Flood	0	0	$ -	$ -	Route 615 at Route 604 flooded.
SUSSEX COUNTY	WAKEFIELD	10/7/2006	Flash Flood	0	0	$ 60,000	$ 50,000	Numerous roads closed including a section of HWY 460. High water laso resulted in significant crop damage.
SUSSEX COUNTY	WAVERLY	10/7/2006	Flash Flood	0	0	$ -	$ -	Numerous roads closed.
SUSSEX COUNTY	WAVERLY	9/26/2008	Flash Flood	0	0	$ -	$ -	Heavy rain produced street flooding in Waverly at the intersection of US 460 and Route 40. Water on the roadway was 1 to 2 feet in depth prompting partial closure.
SUSSEX COUNTY	WAVERLY	9/26/2008	Flash Flood	0	0	$ -	$ -	Ponded water was six inches deep across Route 40 on the northeast side of Waverly 45 minutes after rain ended.
SUSSEX COUNTY	WAKEFIELD ARPT	9/26/2008	Flash Flood	0	0	$ -	$ -	Ponded water was six inches deep across Route 604 west of Route 31 over an hour after rain ended.
SUSSEX COUNTY	WAKEFIELD ARPT	9/26/2008	Flash Flood	0	0	$ -	$ -	Six inches or more of water was flowing across a large portion of Route 615 from Swollen Creek.
TOTALS				**10**	**1**	**$ 44,077,000**	**$ 4,425,000**	

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
VA/WV Water Science Center
1730 E. Parham Rd.
Richmond, VA 23228

October 22, 2024

Mr. Michael Aust
Floodplain & Dam Safety Manager
Henrico County, VA
4301 E Parham Road
Henrico, VA 23228-2745

Dear Mr. Aust:

Enclosed is our standard joint-funding agreement 25LMJFAVA117 between the U.S. Geological Survey VA/WV Water Science Center and Henrico County, VA to Implement and Operate a Hydrologic Monitoring Network in Henrico County, Virginia, during the period November 1, 2024, through June 30, 2029 in the amount of $1,949,800 from your agency. U.S. Geological Survey contributions for this agreement are $0, but we (USGS) will purchase sensing and telemetry equipment and site infrastructure at a value of $320,000.00. Please sign and return the agreement to Paige Nossaman at pnossaman@usgs.gov.

Federal law requires that we have a signed agreement before we start or continue work. Please return the signed agreement by **November 30, 2024**. If, for any reason, the agreement cannot be signed and returned by the date shown above, please contact Jeremy White at (304) 347-5130 or email jswhite@usgs.gov to make alternative arrangements.

This is a fixed cost agreement to be billed quarterly via Down Payment Request (automated Form DI-1040). Please allow 30-days from the end of the billing period for issuance of the bill. If you experience any problems with your invoice(s), please contact Paige Nossaman at phone number (304) 347-5130 or pnossaman@usgs.gov.

The results of all work performed under this agreement will be available for publication by the U.S. Geological Survey. We look forward to continuing this and future cooperative efforts in these mutually beneficial water resources studies.

Sincerely,

DOUGLAS MOYER
Digitally signed by DOUGLAS MOYER
Date: 2024.10.22 14:49:35 -04'00'

Douglas Moyer
Chief Science Officer

Enclosure
25LMJFAVA117

Form 9-1366
(May 2018)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000006916
Agreement #: 25LMJFAVA117
Project #: LM009QC
TIN #: 54-6001344

Fixed Cost Agreement YES[X] NO[ ]

THIS AGREEMENT is entered into as of October 1, 2024, by the U.S. GEOLOGICAL SURVEY, VA/WV Water Science Center, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the Henrico County, VA party of the second part.

1. The parties hereto agree that subject to the availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation for negotiated deliverables (see attached), herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50, and 43 USC 50b.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) include In-Kind-Services in the amount of $0.00

(a) $0 by the party of the first part during the period November 1, 2024 to June 30, 2029

(b) $1,949,800 by the party of the second part during the period November 1, 2024 to June 30, 2029

(c) Contributions are provided by the party of the first part through other USGS regional or national programs, in the amount of: $0

Description of the USGS regional/national program:

(d) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

(e) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.

4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.

5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.

6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

8. The maps, records or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program, and if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at cost, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records or reports published by either party shall contain a statement of the cooperative relations between the parties. The Parties acknowledge that scientific information and data developed as a result of the Scope of Work (SOW) are subject to applicable USGS review, approval, and release requirements, which are available on the USGS Fundamental Science Practices website (https://www.usgs.gov/office-of-science-quality-and-integrity/fundamental-science-practices).

Form 9-1366
(May 2018)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000006916
Agreement #: 25LMJFAVA117
Project #: LM009QC
TIN #: 54-6001344

9. Billing for this agreement will be rendered **quarterly**. Invoices not paid within 60 days from the billing date will bear Interest, Penalties, and Administrative cost at the annual rate pursuant the Debt Collection Act of 1982, (codified at 31 U.S.C. § 3717) established by the U.S. Treasury.

USGS Technical Point of Contact

Name:	Jeremy White Supervisory Hydro Tech
Address:	11 Dunbar Street Charleston, WV 25301
Telephone:	(304) 347-5130
Fax:	(304) 347-5133
Email:	jswhite@usgs.gov

Customer Technical Point of Contact

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Address:	4301 E Parham Road Henrico, VA 23228-2745
Telephone:	(804) 380-4389
Fax:	(n/a)
Email:	aus019@henrico.gov

USGS Billing Point of Contact

Name:	Paige Nossaman Budget Analyst
Address:	11 Dunbar Street Charleston, WV 25301
Telephone:	(304) 347-5130
Fax:	(304) 347-5133
Email:	pnossaman@usgs.gov

Customer Billing Point of Contact

Name:	Monica Barnette Accountant
Address:	4301 E Parham Rd. Henrico, VA 23228-2745
Telephone:	(804) 501-4398
Fax:	(n/a)
Email:	bar01@henrico.gov

U.S. Geological Survey
United States
Department of Interior

Signature

By DOUGLAS MOYER Digitally signed by DOUGLAS MOYER Date: 2024.10.22 14:50:12 -04'00'

Name: Douglas Moyer

Title: Chief Science Officer

Henrico County, VA

Signatures

By _____ Date: 10/23/2024

Name: Terrell C Hughes

Title: Director of Public Works

By _____ Date: _____

Name:

Title:

By _____ Date: _____

Name:

Title:

APPROVED AS TO FORM

_____
COUNTY ATTORNEY

United States Department of the Interior

U. S. GEOLOGICAL SURVEY
12202 Sunrise Valley Drive
Reston, Virginia 20192

IN REPLY REFER TO:

Memorandum June 20, 2023

To: Michael H. Tupper
Regional Director, Northeast Region

From: Mark R. Bennett
Director, U.S. Geological Survey

Subject: Designation of Succession for the Virginia and West Virginia Water Science Center Director Position

The following positions in the U.S. Geological Survey will automatically succeed the Director of the Virginia and West Virginia Water Science Center in the absence of the incumbent and in the order listed.

The incumbent in all of the positions are hereby delegated the authority to perform all duties and responsibilities of the Virginia and West Virginia Water Science Center Director when required to ensure continued, uninterrupted direction and supervision to perform essential functions and activities of the office. The authority of the Virginia and West Virginia Water Science Center Director may be exercised only when an official in one of the following positions is reasonably certain that no superior in the list is able and available to exercise that authority, and when the nature of the situation requires immediate action.

Individuals exercising the authority of the Virginia and West Virginia Water Science Center Director will be relieved of this responsibility as soon as a superior on the list is available, or when an official with the requisite authority designates a permanent or Acting Center Director. Individuals exercising the authority of the Virginia and West Virginia Water Science Center Director will keep a record of important actions taken and the period during which the authority was exercised. Officials serving in an acting capacity are not permitted in this line of succession.

Position One:	VA and WV WSC Chief Operations Officer
Position Two:	VA and WV WSC Chief Science Officer
Position Three:	VA and WV WSC Supervisory Hydrologist, WUA Chief
Position Four:	VA and WV WSC Supervisory Hydrologist, Studies Chief

cc: Bureau Emergency Management Coordinator

Proposal to Implement and Operate a Hydrologic Monitoring Network in Henrico County, Virginia

Virginia and West Virginia Water Science Center

Henrico County, Virginia, is situated in the central part of the state, adjacent to the city of Richmond. The county's landscape is characterized by flat to gently rolling terrain, with elevations ranging from around 50 to 400 feet. Notable water bodies, including the James River to the south and the Chickahominy River to the north, provide both recreational opportunities and ecological benefits.

Henrico County land use includes a diverse mix of residential, commercial, and industrial development, along with significant agricultural areas. Key urban centers, such as Short Pump and Lakeside, support commercial activities, while substantial land is dedicated to residential neighborhoods, contributing to a suburban environment.

Flooding is a notable concern, especially in areas adjacent to rivers and in low-lying regions. To address this, Henrico County has implemented floodplain management strategies aimed at mitigating flood risks. These include regulations on land use in flood-prone areas, the development of stormwater management systems, and the preservation of floodplains to maintain their natural hydrological functions. The county also emphasizes community education and preparedness initiatives to enhance resilience against potential flooding events.

Moreover, changing climate patterns are increasingly affecting Henrico County, with rising temperatures, altered precipitation patterns, and more frequent extreme weather events. These changes can exacerbate flooding risks and strain water resources, prompting the county to enhance its planning frameworks and adaptive strategies. Local authorities are working to integrate climate resilience into their policies, focusing on sustainable development practices and infrastructure improvements to better prepare for the impacts of a changing climate.

A comprehensive, county-wide, hydrologic monitoring network is needed to inform floodplain management, flood-risk reduction, and emergency management, and to inform potential future analysis of how changing climate and land-use patterns affect hydrology county-wide. This proposal outlines such a network.

Objectives

1. Install and operated a county-wide network of precipitation gages,
    - Install and operated a county-wide network of streamgages,
2. Develop and maintain a county-specific web application to serve hydrologic data of specific interest to Henrico County staff and residents, and
3. Provide all data publicly in near-realtime.

Approach

Monitoring Locations

Preferred monitoring locations have been provided by Henrico County staff (Fig. 1). The proposed network includes 7 standalone precipitation gages, 5 standalone streamgages, and 9 co-located precipitation gages and streamgages, for a total of 21 new monitoring locations. These stations will be

added to the existing network of 5 co-located reservoir level and precipitation gages operated by USGS for Henrico County.

The proposed new monitoring locations shall be considered preliminary. Site reconnaissance will be conducted as a first step to initiating the proposed monitoring network. Findings from this on-the-ground effort may dictate needs for adjustments to the locations and site types to accommodate technical, logistical, and other requirements or constraints. Any adjustments needed will be made in consultation with Henrico County staff, and efforts will be made to reduce any potential impact on the agreed upon budget.

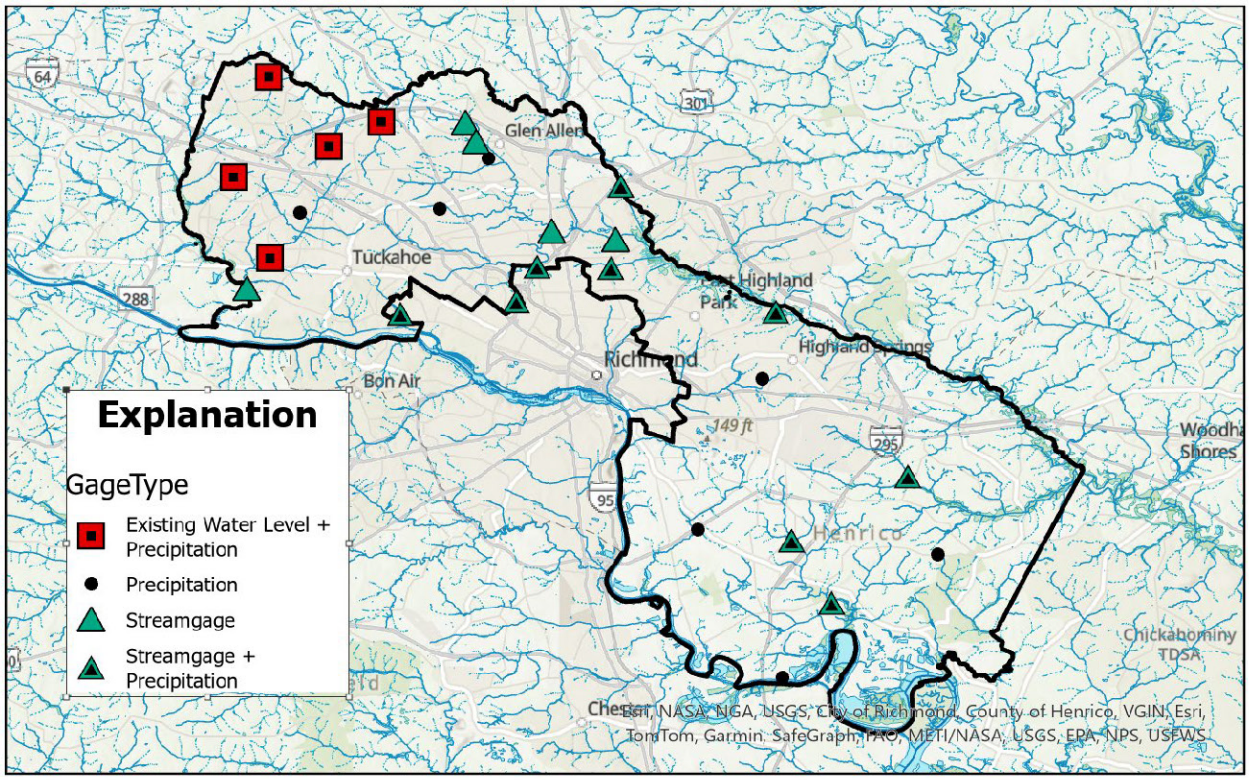

Figure 1. Map of proposed monitoring locations.

Streamflow Monitoring

Standard USGS streamgages will be operated at 14 locations (standalone + co-located). Streamflow will be measured according to published USGS methods for the operation of streamgages (Sauer, 2002; Turnipseed and others, 2010); this will include 5-minute interval measurements of stage (water level) coupled with periodic manual measurements of streamflow to generate a streamflow rating curve to support computation of a continuous streamflow time series. Periodic and targeted-condition manual measurements of streamflow will be made over the full program duration to capture variability and change in hydrologic and geomorphic conditions – this is critical to ensuring the accuracy of streamflow data, particularly in these small and dynamic streams.

Standard streamgages will consist of a water-level sensor, datalogger and satellite telemetry unit, and solar-charged DC power supply. Site conditions as some locations, particularly on low-gradient streams such as the Chickahominy River, may require an additional velocity sensor to support flow measurement. The water-level sensor, either a non-submersible pressure transducer non-contact radar sensor, will meet USGS requirements for sensor accuracy (0.01 ft; U.S. Geological Survey, 1996). Data telemetry will be accomplished using GOES satellite telemetry – this is the standard telemetry system used by USGS streamgages, providing reliable data relay with redundant ground stations across the nation to reliably

serve data. Data will be uploaded and publicly served on the USGS National Water Information System web interface (NWISWeb; waterdata.usgs.gov) within 1-hour of collection. The solar-charged DC power system will provide necessary power to operate the sensors and to support the data logger and telemetry system. All streamside monitoring equipment will be housed in a vandal-resistant shelter, similar to examples shown in Figure 2, constructed in accordance with local specifications.

Figure 2. Photographs of streamside and bridge-mounted streamgages.

Precipitation Monitoring

Understanding the timing and intensity of precipitation is necessary for understanding the hydrologic system and responses to changes in stream channels and watersheds. Urbanization and impervious cover increase peak streamflow (Lee and Hearney, 2003) and changes to the frequency and intensity of rain events can exacerbate those effects. Precipitation monitoring will be conducted using a weighing-type gage (such as the Ott Pluvio^{2}L) following published USGS procedures (U.S. Geological Survey, 2009). A weighing-type gage is preferable over other gages such as a tipping bucket because it overcomes inaccuracies in very intense precipitation events. A precise measurement of the precipitation inputs to the watershed is vital for understanding numerous hydrological metrics. This precipitation gage will provide cumulative precipitation accumulation and intensity data, on 5-minute intervals. The raingages will be either a standalone station consisting of the weighing-type gage, datalogger and telemetry unit, and solar-charged DC power system, likely similar to that shown in Figure 3, or the weighing-type gage will be added to streamgage instrumentation, depending on site configuration. Precipitation data will be uploaded and publicly served on NWISWeb within 1-hour of collection.

Figure 3. Photograph of a precipitation monitoring station.

County-specific Data Delivery

The USGS NWISWeb system provides numerous tools for public access to USGS-collected hydrologic data. Of particular utility for most users, the National Water Dashboard (dashboard.waterdata.usgs.gov) is a modern map-based interface that provide intuitive access to realtime data while also providing advanced features to add context to the hydrologic data. To facilitate ease of access to County-specific monitoring

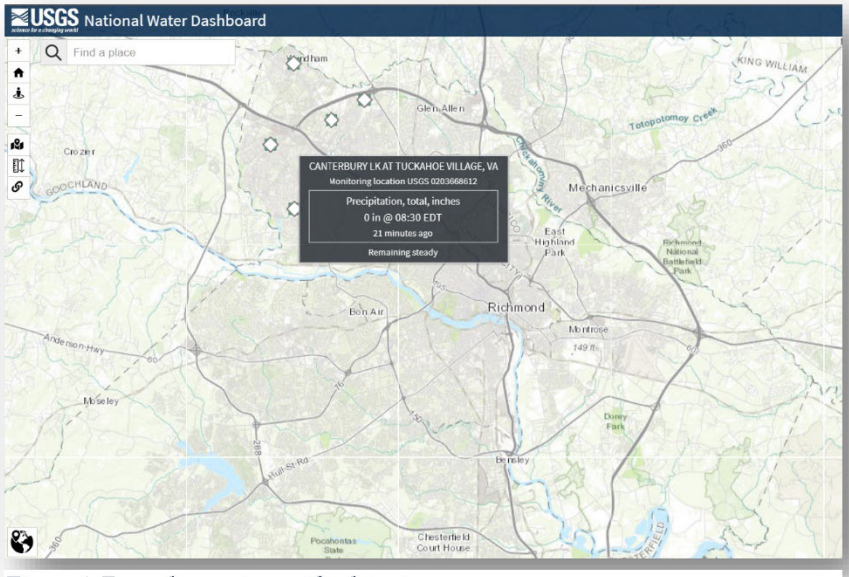

Figure 4. Example county-specific data viewer.

stations, a webpage will be developed to describe the monitoring network and provide simplified access to the USGS-operated stations in Henrico County, similar to that shown in Figure 4 for the current reservoir-level and precipitation monitoring stations.

Timeline

Provided timely approval of a Joint Funding Agreement, site reconnaissance and installation will occur in state fiscal year 2025 (ending June 30, 2025). Development of the website and county-specific data display will also be complete at this time. Station operation and maintenance will be conducted in state fiscal years 2026-2029, fulfilling a 5-year agreement term. Additional agreement terms are anticipated to be pursued at the completion of this initial term.

Deliverables

Deliverables include all data collected, to be publicly served and permanently archived on the USGS National Water Information System, and a web application to provide simplified access to those data for Henrico County monitoring stations specifically.

Funding and In-Kind Support

Funding required for this effort includes station instrumentation, installation, and operation and maintenance, as well as staff salary for the development of the web application. USGS will contribute the cost of all required instrumentation, at a value of $320,000, and remaining costs will be funded by Henrico County.

Startup costs include station siting, reconnaissance, installation, and instrumentation, and development of the website (Table 1). Annual operation and maintenance (O&M) costs include all costs for site operation, data processing, and data delivery (Table 2) – annual O&M costs will increase annually to account for inflationary increases in materials and labor.

Henrico County and USGS currently have a Joint Funding Agreement to support 5 co-located reservoir level and precipitation monitoring stations. All existing plus new work will be combined into a single new agreement, and the existing agreement will be terminated upon start of the new agreement. The total costs

to be included in the new agreement at shown in Table 3. Payments already made under the current agreement that overlap with the new agreement will be credited.

Table 1. Startup costs per task.

Task	County Cost	USGS Equipment Contribution	Total Cost	Quantity	Sub-Total	County Sub-Total
Streamgage + Precipitation Install	$15,000	$20,000	$35,000	9	$315,000	$135,000
Streamgage Install	$15,000	$14,000	$29,000	5	$145,000	$75,000
Precipitation Install	$10,000	$10,000	$20,000	7	$140,000	$70,000
Web development	$10,000	$0	10000	1	$10,000	$10,000
					$610,000	**$290,000**

Table 2. Annual operation and maintenance costs for the initial year of monitoring - year 2. Note that annual costs will increase to account for inflation.

Site Type	Annual Cost (Year 2)	Quantity	Total
Streamgage	$19,140	5	$95,700
Standalone Precipitation	$6,350	7	$44,450
Streamgage + Precipitation	$22,470	9	$202,230
			$342,380

Table 3. Annual costs for existing plus new monitoring activities.

State Fiscal Year	County Cost	USGS Equipment (in-kind services)
2025	$335,200	$320,000
2026	$388,680	$0
2027	$400,290	$0
2028	$412,250	$0
2029	$424,680	$0
Total	**$1,961,100**	**$320,000**

Potential Future Directions

The proposed hydrologic monitoring network will provide a critical hydrologic data collection foundation that will immediately benefit County operations. Additionally, this foundation could be leveraged in the future to provide additional benefit to the County. For example, the infrastructure being established has expansion capacity that could include additional data collection elements such as water-quality parameters, additional meteorologic parameters, and roadway condition parameters. Also, the data to be collected could inform many different studies to better inform the County of how hydrologic and meteorologic conditions are changing over time in response to climate change, land-use change, and other factors.

References

Lee, J., Heaney, J, 2003, Estimation of Urban Imperviousness and its Impacts on Storm Water Systems. *Journal of Water Resources Planning Management, 129*(5), 419-426.

Sauer, V.B., 2002, Standards for the Analysis and Processing of Surface-Water Data and Information Using Electronic Methods: U.S. Geological Survey Water-Resources Investigations Report 01–4044, 91

Turnipseed, D.P., and Sauer, V.B., 2010, Discharge measurements at gaging stations: U.S. Geological Survey Techniques and Methods book 3, chap. A8, 87 p. (Also available at http://pubs.usgs.gov/tm/tm3-a8/.)

U.S. Geological Survey, 1996, Policy Concerning Accuracy of Stage Data, Office of Surface Water Technical Memorandum No. 96.05, online at https://water.usgs.gov/admin/memo/SW/sw96.05.html

U.S. Geological Survey, 2009, Collection, Quality, and Presentation of Precipitation Data, Office of Surface Water Technical Memorandum No. 2006.01, online at https://water.usgs.gov/admin/memo/SW/sw06.012_Revised_122009.pdf

Contacts

Questions or comments, please contact:

Shaun Wicklein
smwikle@usgs.gov

John Jastram
jdjastra@usgs.gov

Form 9-1366
(May 2018)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000006916
Agreement #: 22LMJFAVA000117
Project #: LM009QC
TIN #: 54-6001344

Fixed Cost Agreement YES[X] NO[ ]

THIS AGREEMENT is entered into as of the October 1, 2021, by the U.S. GEOLOGICAL SURVEY, VA/WV Water Science Center, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the Henrico County party of the second part.

1. The parties hereto agree that subject to the availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation Water Resource Investigations (per attachment), herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50, and 43 USC 50b.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) include In-Kind-Services in the amount of $0.00

(a) $0 by the party of the first part during the period October 1, 2021 to June 30, 2026

(b) $274,575 by the party of the second part during the period October 1, 2021 to June 30, 2026

(c) Contributions are provided by the party of the first part through other USGS regional or national programs, in the amount of: $0

Description of the USGS regional/national program:

(d) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

(e) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.

4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.

5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.

6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

8. The maps, records or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program, and if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at cost, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records or reports published by either party shall contain a statement of the cooperative relations between the parties. The Parties acknowledge that scientific information and data developed as a result of the Scope of Work (SOW) are subject to applicable USGS review, approval, and release requirements, which are available on the USGS Fundamental Science Practices website (https://www.usgs.gov/about/organization/science-support/science-quality-and-integrity/fundamental-science-practices).

Form 9-1366
(May 2018)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000006916
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9. Billing for this agreement will be rendered quarterly. Invoices not paid within 60 days from the billing date will bear Interest, Penalties, and Administrative cost at the annual rate pursuant the Debt Collection Act of 1982, (codified at 31 U.S.C. § 3717) established by the U.S. Treasury.

USGS Technical Point of Contact

Name:	Jeremy White Supervisory Hydro Tech
Address:	11 Dunbar Street Charleston, WV 25301
Telephone:	(304) 347-5130
Fax:	(304) 347-5133
Email:	jswhite@usgs.gov

Customer Technical Point of Contact

Name:	Kristin Owen Floodplain & Dam Safety Manager
Address:	4301 E Parham Road Henrico, VA 23228-2745
Telephone:	(804) 501-7460
Fax:	
Email:	owe042@henrico.us

USGS Billing Point of Contact

Name:	Paige Keaton Budget Analyst
Address:	11 Dunbar Street Charleston, WV 25301
Telephone:	(304) 347-5130
Fax:	(304) 347-5133
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Name:	Kayla Shelton Office Assistant
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Telephone:	(804) 501-4287
Fax:	
Email:	She088@henrico.us

U.S. Geological Survey
United States
Department of Interior

Signature

MARK BENNETT Digitally signed by MARK BENNETT Date: 2021.10.25 11:38:38 -04'00'

By _____ **Date:** 09/24/2021

Name: Mark Bennett

Title: Director

Henrico County

Signatures

By _____ **Date:** 11/3/2021

Name: Todd Hughes

Title: Dir. of Public Works / County Engineer

By _____ **Date:** _____

Name:

Title:

By _____ **Date:** _____

Name:

Title:

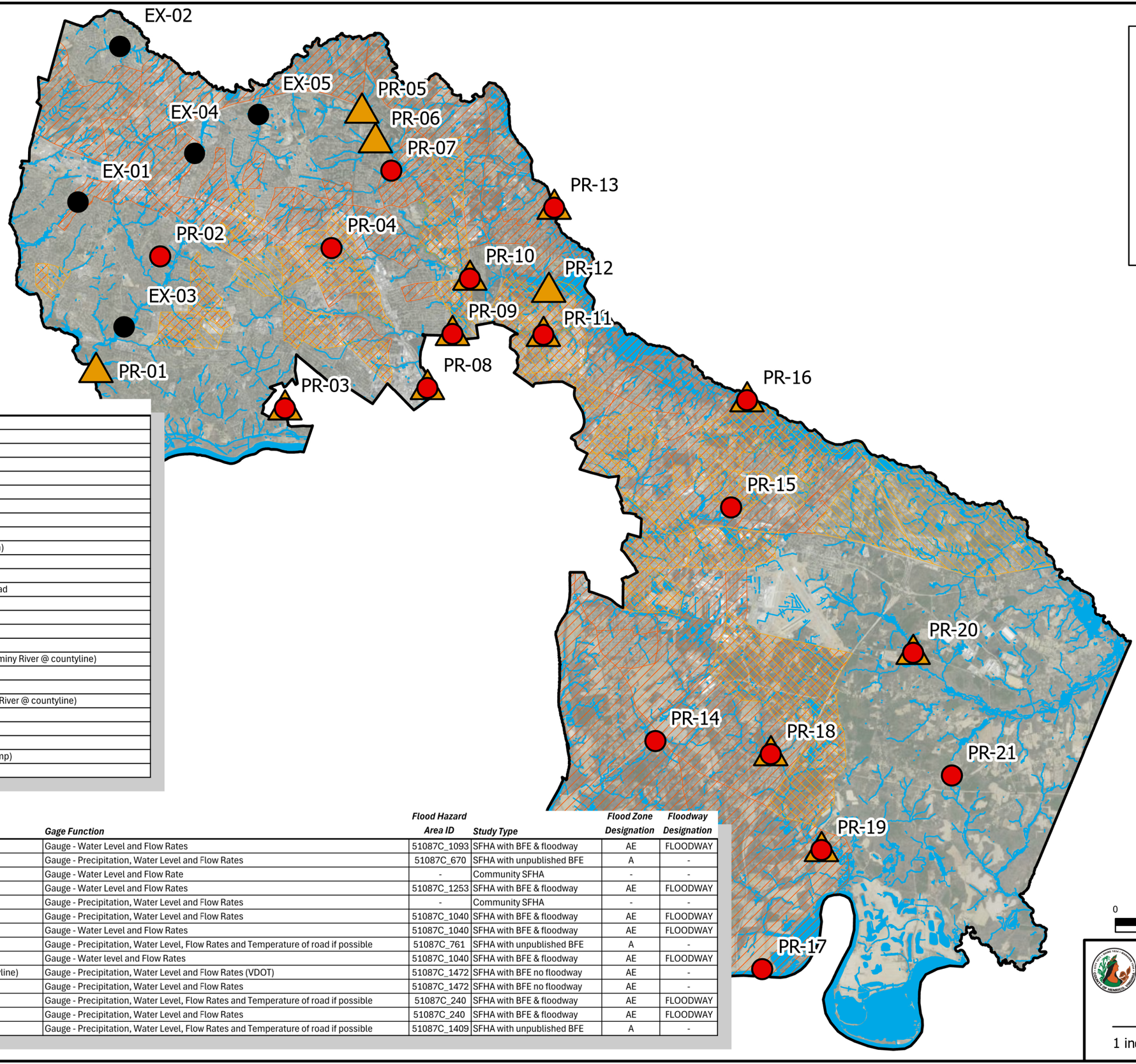
APPROVED AS TO FORM

Alyssa D Brown 10/29/21

ASSISTANT COUNTY ATTORNEY

5-year Funding Summary
Henrico County, Virginia
U.S. Geological Survey
Water Monitoring Program

State Fiscal Year	Cooperator Cost	USGS Contribution	Annual Operating Cost
2022	$ 95,975	$ 90,000	$185,975
2023	$ 43,000	$ -	$43,000
2024	$ 44,100	$ -	$44,100
2025	$ 45,200	$ -	$45,200
2026	$ 46,300	$ -	$46,300
Total	**$274,575**	**$90,000**	**$364,575**



Legend

- Communities of Color
- Low Income Communities

Henrico Co Gages

- Existing
- Precipitation
- Water Level

Gage Status	*Gage ID*	*Gage Name*
Existing	EX-01	Wellesley Lake Dam
Existing	EX-02	Wyndham Lake Dam
Existing	EX-03	Canterbury Lake Dam
Existing	EX-04	Cox Road Dam
Existing	EX-05	Echo Lake Dam
Proposed	PR-01	River Rd
Proposed	PR-02	Deep Run Park
Proposed	PR-03	U of R Drive
Proposed	PR-04	County Offices - Parham Road
Proposed	PR-05	Old Washington Hwy (North Run)
Proposed	PR-06	Mountain Road (North Run)
Proposed	PR-07	Woodman Depot
Proposed	PR-08	Westwood Trail near CSX Railroad
Proposed	PR-09	Spring Park (Upham Brook)
Proposed	PR-10	Hillard Road (North Run)
Proposed	PR-11	RHT & Lark Drive (Horse Creek)
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Proposed	PR-19	Kingsland Road
Proposed	PR-20	Portugee Road (White Oak Swamp)
Proposed	PR-21	Darbytown

Gage Number	*Location Description*	*Gage Function*	*Flood Hazard Area ID*	*Study Type*	*Flood Zone Designation*	*Floodway Designation*
PR-01	River Rd	Gauge - Water Level and Flow Rates	51087C_1093	SFHA with BFE & floodway	AE	FLOODWAY
PR-03	U of R Drive	Gauge - Precipitation, Water Level and Flow Rates	51087C_670	SFHA with unpublished BFE	A	-
PR-05	Old Washington Hwy (North Run)	Gauge - Water Level and Flow Rate	-	Community SFHA	-	-
PR-06	Mountain Road (North Run)	Gauge - Water Level and Flow Rates	51087C_1253	SFHA with BFE & floodway	AE	FLOODWAY
PR-08	Westwood Trail near CSX Railroad	Gauge - Precipitation, Water Level and Flow Rates	-	Community SFHA	-	-
PR-09	Spring Park (Upham Brook)	Gauge - Precipitation, Water Level and Flow Rates	51087C_1040	SFHA with BFE & floodway	AE	FLOODWAY
PR-10	Hillard Road (North Run)	Gauge - Water Level and Flow Rates	51087C_1040	SFHA with BFE & floodway	AE	FLOODWAY
PR-11	RHT & Lark Drive (Horse Creek)	Gauge - Precipitation, Water Level, Flow Rates and Temperature of road if possible	51087C_761	SFHA with unpublished BFE	A	-
PR-12	Wilkinson Road (Upham Brook)	Gauge - Water level and Flow Rates	51087C_1040	SFHA with BFE & floodway	AE	FLOODWAY
PR-13	Chamberlayne Road (Chickahominy River @ countyline)	Gauge - Precipitation, Water Level and Flow Rates (VDOT)	51087C_1472	SFHA with BFE no floodway	AE	-
PR-16	Creighton Road (Chickahominy River @ countyline)	Gauge - Precipitation, Water Level and Flow Rates	51087C_1472	SFHA with BFE no floodway	AE	-
PR-18	Doran Road (Fourmile Creek)	Gauge - Precipitation, Water Level, Flow Rates and Temperature of road if possible	51087C_240	SFHA with BFE & floodway	AE	FLOODWAY
PR-19	Kingsland Road	Gauge - Precipitation, Water Level and Flow Rates	51087C_240	SFHA with BFE & floodway	AE	FLOODWAY
PR-20	Portugee Road (White Oak Swamp)	Gauge - Precipitation, Water Level, Flow Rates and Temperature of road if possible	51087C_1409	SFHA with unpublished BFE	A	-

N

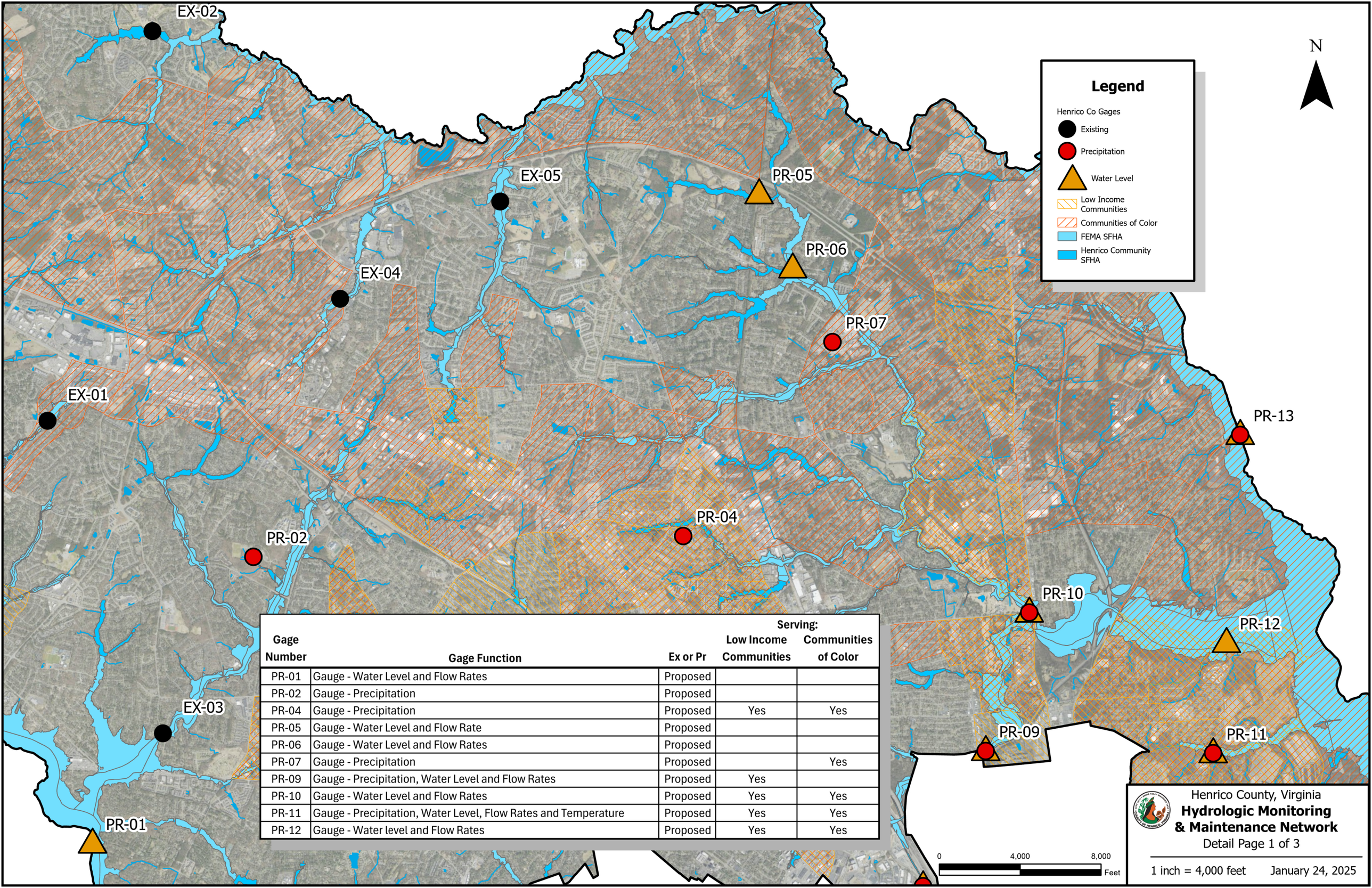
0 12,500 25,000 Feet

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

KEY MAP

1 inch = 12,000 feet January 24, 2025



Gage Number	Gage Function	Ex or Pr	Serving: Low Income Communities	Serving: Communities of Color
PR-01	Gauge - Water Level and Flow Rates	Proposed		
PR-02	Gauge - Precipitation	Proposed		
PR-04	Gauge - Precipitation	Proposed	Yes	Yes
PR-05	Gauge - Water Level and Flow Rate	Proposed		
PR-06	Gauge - Water Level and Flow Rates	Proposed		
PR-07	Gauge - Precipitation	Proposed		Yes
PR-09	Gauge - Precipitation, Water Level and Flow Rates	Proposed	Yes	
PR-10	Gauge - Water Level and Flow Rates	Proposed	Yes	Yes
PR-11	Gauge - Precipitation, Water Level, Flow Rates and Temperature	Proposed	Yes	Yes
PR-12	Gauge - Water level and Flow Rates	Proposed	Yes	Yes

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

Detail Page 1 of 3

1 inch = 4,000 feet

January 24, 2025

PR-08

PR-03

PR-16

PR-15

N

Legend

Henrico Co Gages

- Existing
- Precipitation
- Water Level

- Low Income Communities
- Communities of Color
- FEMA SFHA
- Henrico Community SFHA

Gage Number	Gage Function	Ex or Pr	Serving: Low Income Communities	Serving: Communities of Color
PR-03	Gauge - Precipitation, Water Level and Flow Rates	Proposed		Yes
PR-08	Gauge - Precipitation, Water Level and Flow Rates	Proposed		
PR-15	Gauge - Precipitation	Proposed	Yes	Yes
PR-16	Gauge - Precipitation, Water Level and Flow Rates	Proposed		

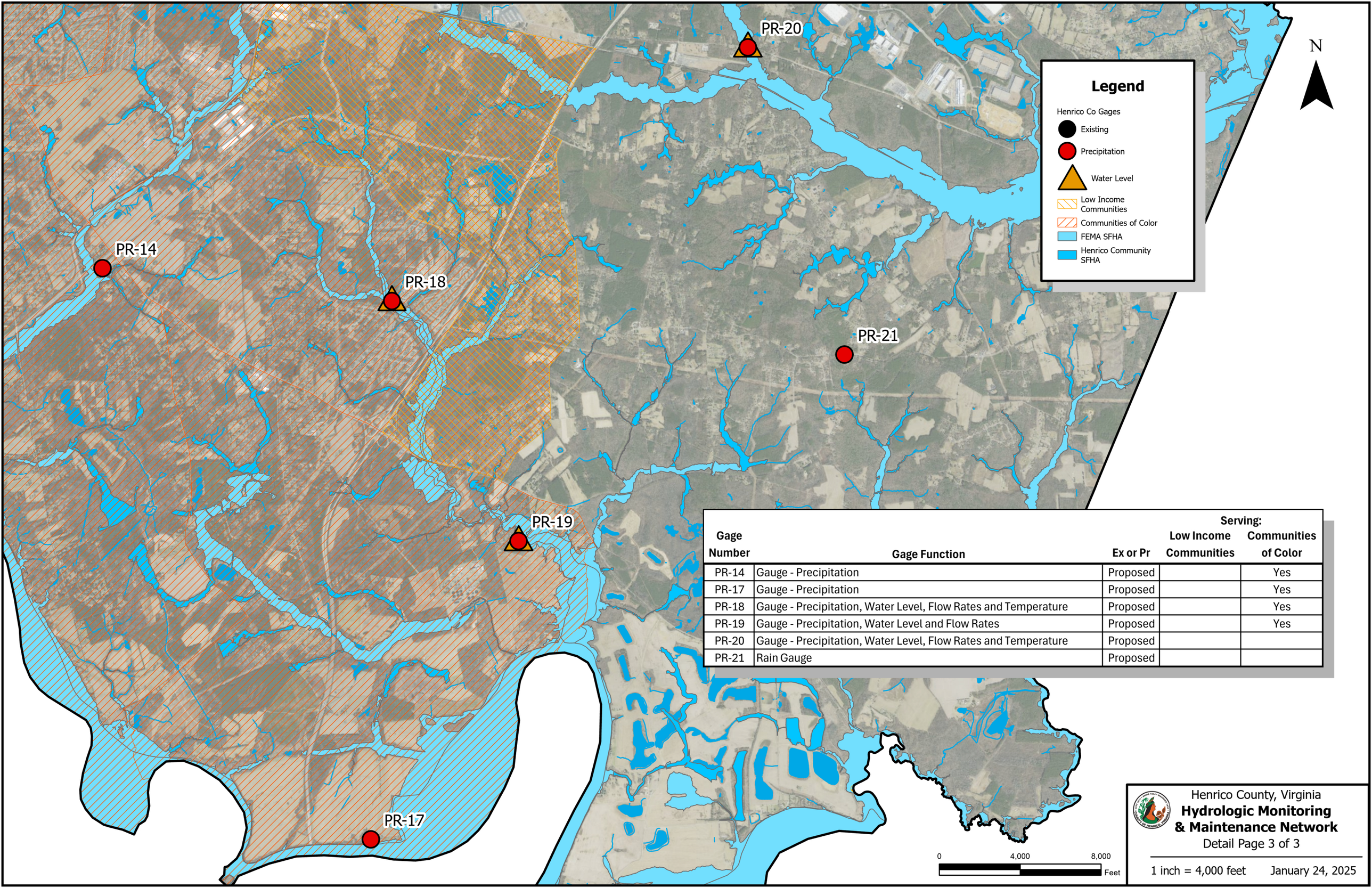
0 4,000 8,000 Feet

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

Detail Page 2 of 3

1 inch = 4,000 feet January 24, 2025



Gage Number	Gage Function	Ex or Pr	Serving: Low Income Communities	Serving: Communities of Color
PR-14	Gauge - Precipitation	Proposed		Yes
PR-17	Gauge - Precipitation	Proposed		Yes
PR-18	Gauge - Precipitation, Water Level, Flow Rates and Temperature	Proposed		Yes
PR-19	Gauge - Precipitation, Water Level and Flow Rates	Proposed		Yes
PR-20	Gauge - Precipitation, Water Level, Flow Rates and Temperature	Proposed		
PR-21	Rain Gauge	Proposed		

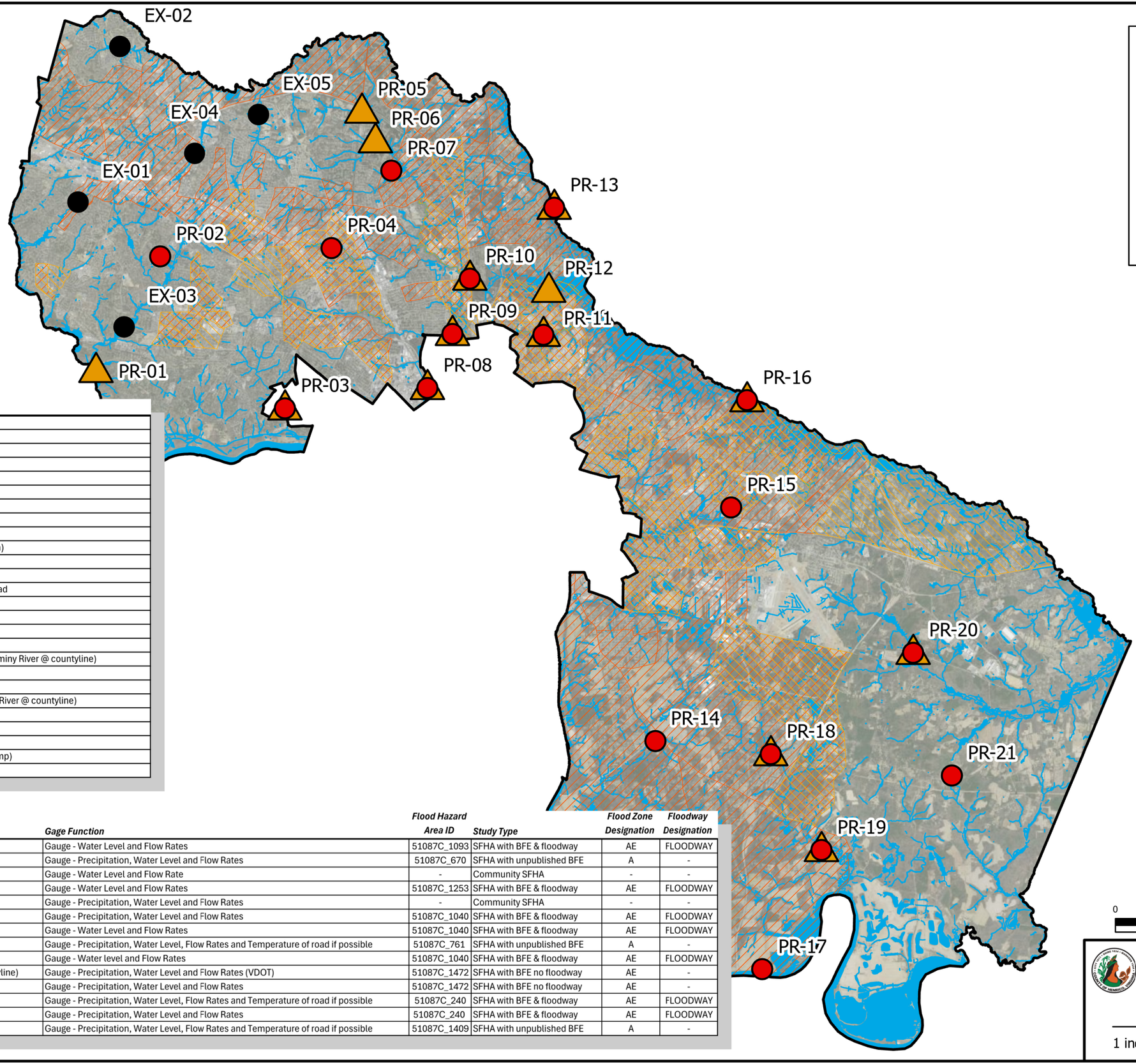
Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

Detail Page 3 of 3

1 inch = 4,000 feet

January 24, 2025



Legend

- Communities of Color
- Low Income Communities

Henrico Co Gages

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- Precipitation
- Water Level

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N

0 12,500 25,000 Feet

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

KEY MAP

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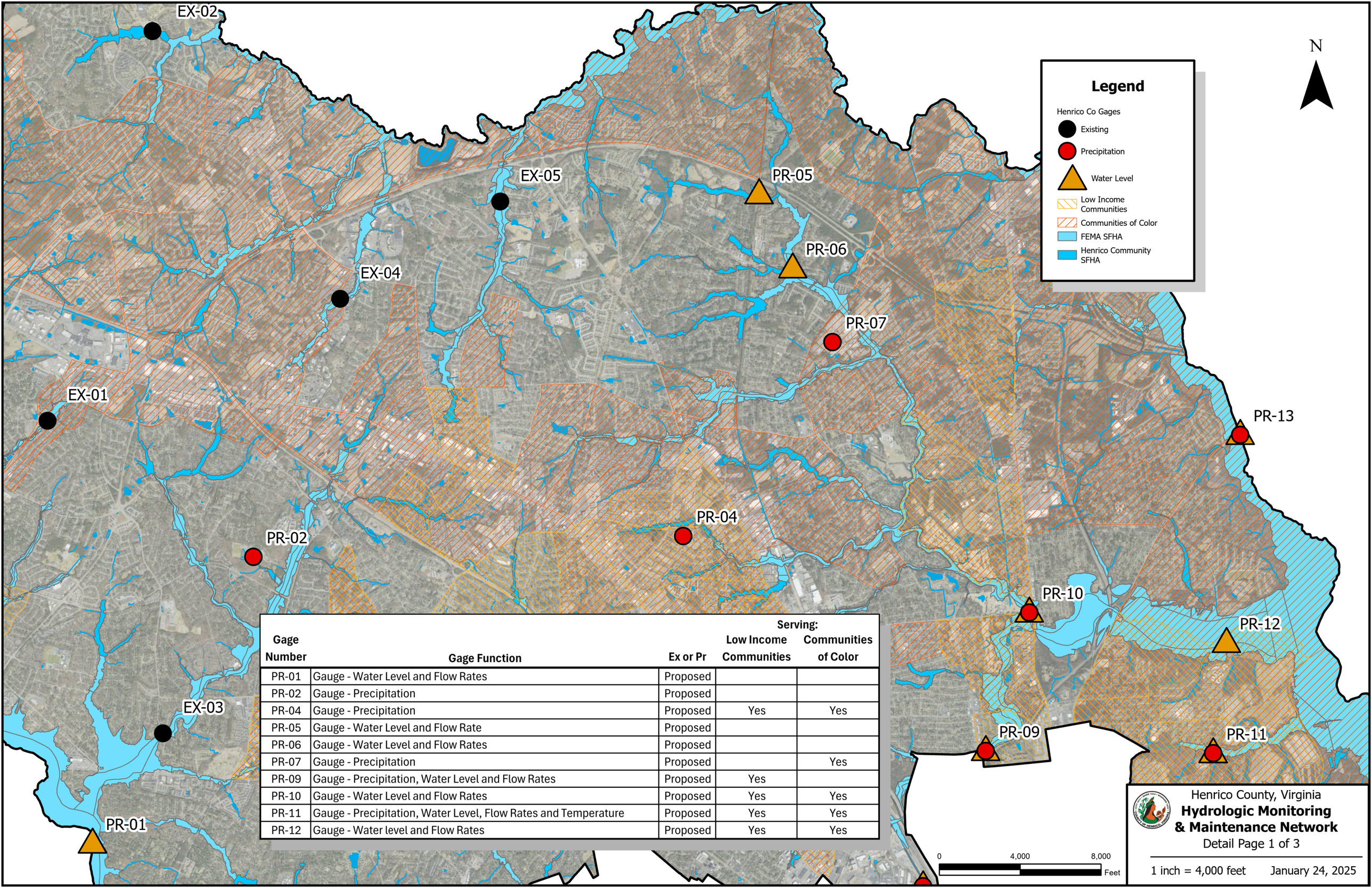

Gage Number	Gage Function	Ex or Pr	Serving: Low Income Communities	Serving: Communities of Color
PR-01	Gauge - Water Level and Flow Rates	Proposed		
PR-02	Gauge - Precipitation	Proposed		
PR-04	Gauge - Precipitation	Proposed	Yes	Yes
PR-05	Gauge - Water Level and Flow Rate	Proposed		
PR-06	Gauge - Water Level and Flow Rates	Proposed		
PR-07	Gauge - Precipitation	Proposed		Yes
PR-09	Gauge - Precipitation, Water Level and Flow Rates	Proposed	Yes	
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PR-11	Gauge - Precipitation, Water Level, Flow Rates and Temperature	Proposed	Yes	Yes
PR-12	Gauge - Water level and Flow Rates	Proposed	Yes	Yes

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

Detail Page 1 of 3

1 inch = 4,000 feet

January 24, 2025

PR-08

PR-03

PR-16

PR-15

N

Legend

Henrico Co Gages

- Existing
- Precipitation
- Water Level

- Low Income Communities
- Communities of Color
- FEMA SFHA
- Henrico Community SFHA

Gage Number	Gage Function	Ex or Pr	Serving: Low Income Communities	Serving: Communities of Color
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PR-08	Gauge - Precipitation, Water Level and Flow Rates	Proposed		
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PR-16	Gauge - Precipitation, Water Level and Flow Rates	Proposed		

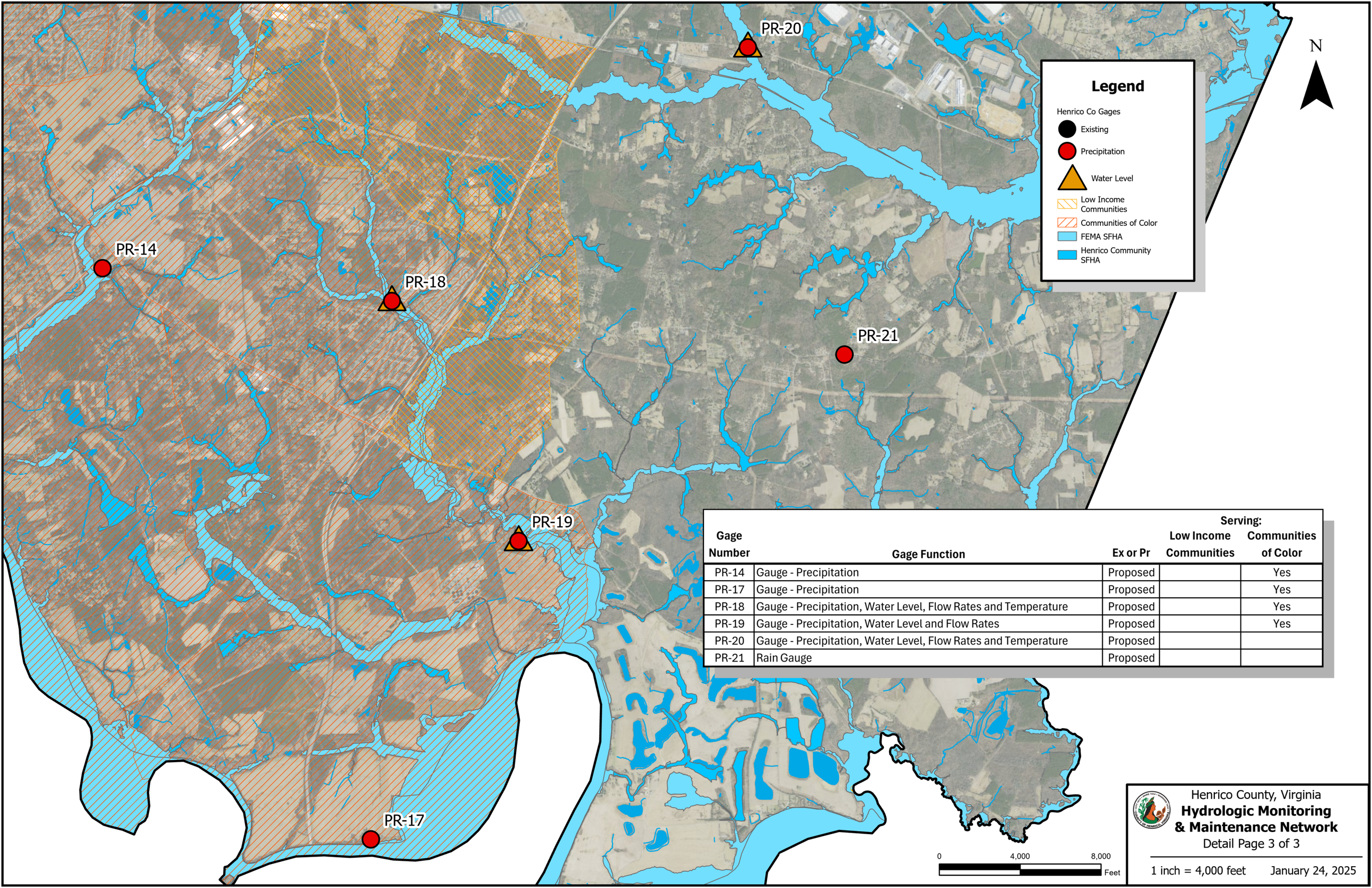
0 4,000 8,000 Feet

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

Detail Page 2 of 3

1 inch = 4,000 feet January 24, 2025



Gage Number	Gage Function	Ex or Pr	Serving: Low Income Communities	Serving: Communities of Color
PR-14	Gauge - Precipitation	Proposed		Yes
PR-17	Gauge - Precipitation	Proposed		Yes
PR-18	Gauge - Precipitation, Water Level, Flow Rates and Temperature	Proposed		Yes
PR-19	Gauge - Precipitation, Water Level and Flow Rates	Proposed		Yes
PR-20	Gauge - Precipitation, Water Level, Flow Rates and Temperature	Proposed		
PR-21	Rain Gauge	Proposed		

Henrico County, Virginia

Hydrologic Monitoring & Maintenance Network

Detail Page 3 of 3

1 inch = 4,000 feet

January 24, 2025

USGS
science for a changing world

U.S. Geological Survey Streamgage Operation and Maintenance Cost Evaluation

...from the National Streamflow Information Program

This Fact-Sheet is one in a series that highlights information or recent research findings from the USGS National Streamflow Information Program (NSIP). The investigations and scientific results reported in this series require a nationally consistent streamgage network with stable long-term monitoring sites and a rigorous program of data collection, quality assurance, management, archiving, and synthesis. NSIP produces multipurpose, unbiased surface-water information that is readily accessible to all.

To help meet the goal of providing earth-science information to the Nation, the U.S. Geological Survey (USGS) operates and maintains the largest streamgage network in the world, with over 7,600 active streamgages in 2010. This network is operated in cooperation with over 850 Federal, tribal, State, and local funding partners. The streamflow information provided by the USGS is used for the protection of life and property; for the assessment, allocation, and management of water resources; for the design of roads, bridges, dams, and water works; for the delineation of flood plains; for the assessment and evaluation of habitat; for understanding the effects of land-use, water-use, and climate changes; for evaluation of water quality; and for recreational safety and enjoyment.

USGS streamgages are managed and operated to rigorous national standards, allowing analyses of data from streamgages in different areas and spanning long time periods, some with more than 100 years of data. About 90 percent of USGS streamgages provide streamflow information real-time on the web. Physical measurements of streamflow are made at streamgages multiple times a year, depending on flow conditions, to ensure the highest level of accuracy possible. In addition, multiple reviews and quality assurance checks are performed before the data is finalized.

In 2006, the USGS reviewed all activities, operations, equipment, support, and costs associated with operating and maintaining a streamgage program (Norris and others, 2008). A summary of the percentages of costs associated with activities required to operate a streamgage on an annual basis are presented in figure 1. This information represents what it costs to fund a "typical" USGS streamgage and how those funds are utilized. It should be noted that some USGS streamgages have higher percentages for some categories than do others depending on location and conditions. Forty-one percent of the funding for the typical USGS streamgage is for labor costs of the USGS staff responsible for the measurement of the streamflow in the field and the time in the office to quality assure and finalize the data (fig. 1). It is reasonable that funding for the entire national streamgage network would closely follow the percentages shown in figure 1 as to how the funds are invested in the network. However, actual costs are specific to a particular streamgage and can vary substantially depending on location and operational issues.

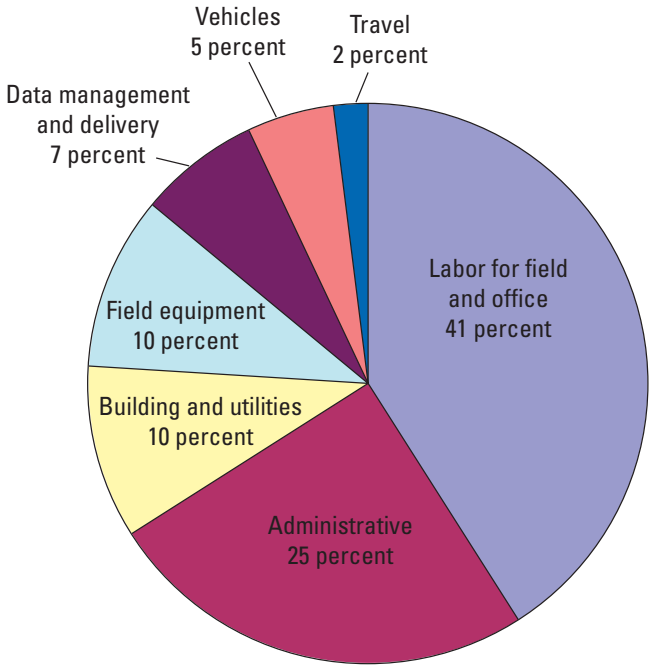


Figure 1. Percentage of operation and maintenance funding invested in various activities for a typical USGS streamgage.

Reference Cited

Norris and others, 2008, Qualitative comparison of streamflow information programs of the U.S. Geological Survey and three non-Federal agencies: U.S. Geological Survey Open-File Report 2007–1426, 12 p.

USGS Streamflow Information can be found at:

- *http://waterdata.usgs.gov/nwis*
- *http://water.usgs.gov/waterwatch*
- *http://water.usgs.gov/nsip*

by J. Michael Norris

Streamgage Operation and Maintenance Tasks

Labor for Field and Office:

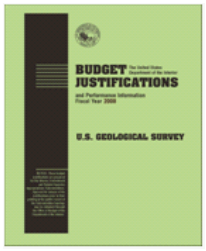
Field

- Routine visits to streamgages
- Emergency repair visits to streamgages
- Visits during flooding
- Maintenance and inspection visits
- Surveying visits
- Streamflow measurements
- Analysis of the discharge computations (field and office)
- Technical training

Office

- Stage data edits
- Development and maintenance of rating curves
- Analysis of rating curve-shifts from changing channel conditions
- Monitoring real-time information for instrumentation problems
- Review of records for rating-curve and discharge computations
- Quality assurance of the data
- Finalization and publication of the streamflow information
- Safety and administrative training

Administrative:



- Safety program management
- National and local management and technical oversight of the program
- Local quality assurance
- Facility costs
- Personnel management
- Purchasing and contracts
- Financial management
- Salary of hydrographers/supervisors
- Salary of administrative support required by the program
- Funding-partner interactions (over 850 nationwide)
- USGS communications (with Congress, the public, and media)
- Development of funding agreements

Building and Utilities:

- Secure storage space for files
- Vehicle parking space, boat storage
- Shop space, laboratory space, warehouse space

- Office space for the streamgage program staff
- Heating, cooling, trash, water, gas, and electric power for office space and streamgages

Field Equipment:

- Gage houses, data loggers, stage or velocity sensors, telemetry equipment, and other equipment for streamgage operation
- Boats and motors, boat maintenance, snowmobiles, all-terrain vehicles, and annual repair and maintenance costs
- Generators, survey equipment, field laptop computers, and hand and power tools
- Equipment for measuring streamflow (meters, Acoustic Doppler Current Profilers, bridge cranes, and automated loggers)
- Safety equipment such as traffic-control equipment and confined-space safety equipment
- Waders, personal floatation devices, and cell phone

Data Management and Delivery:

- Telemetry (satellite up-links, phone lines, etc.)

- Local Information Technology infrastructure, including servers, computers, printers, plotters, and scanners
- Information Technology support, support of the data base, Web access, data archival and retrieval, and network communications

Vehicles:

- Purchasing or leasing field vehicles
- Fuel and vehicle maintenance

Travel:

- Lodging and per diem for staff during visits to streamgages

Richmond-Crater Multi-Region Hazard Mitigation Plan

APPROVAL PENDING ADOPTION JULY 2022

PlanRVA
THE REGIONAL COMMISSION

CRATER PLANNING DISTRICT COMMISSION

REPORT DOCUMENTATION

TITLE	REPORT DATE
Richmond-Crater Multi-Region Hazard Mitigation Plan	JULY 2022

ABSTRACT

The *Richmond-Crater Multi-Region Hazard Mitigation Plan* has been updated for 2022. The region is vulnerable to a wide range of hazards that threaten the safety of residents and have the potential to damage or destroy both public and private property and disrupt the local economy and overall quality of life. While the threat from hazards may never be fully eliminated, the *Richmond-Crater Multi-Region Hazard Mitigation Plan* recommends specific actions designed to protect residents, business owners and the built environment.

GRANT/SPONSORING AGENCY

This report was funded by the Federal Emergency Management Agency through the Virginia Department of Emergency Management, via grant Agreement number FEMA-DR-4411-VA-013 for $262,500.

ACKNOWLEDGEMENTS

The PDCs would like to acknowledge the contributions of Salter's Creek Consulting, Inc., Hampton, Virginia, and Wood throughout the planning process, and contributions of members of Steering Committee.

PlanRVA is where we come together to look ahead. Established in 1969, the Richmond Regional Planning District Commission, known as PlanRVA, has been the home of cooperation among the nine jurisdictions of Central Virginia for more than 50 years. Today, we focus in areas of community development, emergency management, the environment and transportation. We are the seer of the future, convener of our member jurisdictions and regional partners, creator of plans of action and shaper of Central Virginia's future.

The Crater Planning District Commission is a regional planning agency with major emphasis in the areas of transportation, economic and small business development, the environment, and serving as the convener for major military-related discussions among the region's communities. The PDCs mission is to strengthen the quality of life throughout the Crater planning District region by serving as a regional forum of member local governments to address issues of regional significance, providing technical assistance to localities, and promoting and enhancing the collective consensus on the economic, transportation, social, environmental, and demographic interests of the region.

Table of Contents

1.0 Executive Summary 7

1.1 Hazard Identification and Risk Assessment 8
1.2 Capability Assessment 8
1.3 Mitigation Strategy 9
1.4 Plan Maintenance Procedures 10
1.5 Conclusion 10

2.0 Introduction 1

2.1 Updates for 2022 1
2.2 Background 1
2.2 The Need for Local Mitigation Planning 4
2.3 Organization of the Plan 4

3.0 Planning Process 6

3.1 Updates for 2022 6
3.2 Overview of Mitigation Planning 6
3.3 Preparing the Plan 7
3.4 The Planning Committee 9
3.4.1 Richmond-Crater Planning Committee 9
3.5 2021/2022 Community Meetings and Workshops 16
3.6 Involving the Public 22
3.6.1 2021/2022 Public Meetings 23
3.6.2 Public Survey 24
3.6.3 PlanRVA Web Site 25
3.6.4 Better Together Webinar 25
3.6.5 Brochure 25
3.7 Involving Stakeholders 27

4.0 Community Profile 30

4.1 Introduction 30
4.2 Physiography 30
4.3 Hydrology 31
4.4 Climate 34
4.5 Land Use and Development Trends 34
4.5.1 Charles City County 35
4.5.2 Chesterfield County 37
4.5.3 City of Colonial Heights 38
4.5.4 Dinwiddie County 39
4.5.5 City of Emporia 40
4.5.6 Goochland County 42
4.5.7 Greensville County 43
4.5.8 Hanover County and the Town of Ashland 44
4.5.9 Henrico County 46
4.5.10 City of Hopewell 46
4.5.11 New Kent County 47
4.5.12 City of Petersburg 48
4.5.13 Powhatan County 49

4.5.14 Prince George County *50*
4.5.15 City of Richmond *51*
4.5.16 Surry County and the Town of Surry *52*
4.5.17 Sussex County *53*
4.6 Population 54
4.6.1 Race and Sex *55*
4.6.2 Language *55*
4.6.3 Age *55*
4.6.4 Education *55*
4.6.5 Income *56*
4.6.6 Broadband Access *57*
4.7 Housing 58
4.8 Business and Labor 59
4.9 Transportation 64
4.10 Infrastructure 65
4.10.1 Electric *65*
4.10.2 Natural Gas *65*
4.10.3 Telephone *65*
4.10.4 Public Water and Wastewater *66*
4.10.5 Cable Television, Broadband and Internet Providers *66*

5.0 Hazard Identification, Risk Assessment and Vulnerability Analysis 68

5.1 Updates for 2022 68
5.2 Introduction 68
5.2.1 Methodologies Used *69*
5.2.2 National Risk Index *72*
5.2.3 General Asset Inventory *75*
5.3.3 Essential Facilities *75*
5.3 Major Disasters 76
5.4 Flooding 77
Hazard Profile *77*
Location and Spatial Extent *78*
Hazard History *86*
Vulnerability Analysis *88*
FEMA Repetitive Loss and Severe Repetitive Loss Properties *93*
Estimates of Potential Losses *106*
Annualized NCEI Events and Damages *113*
Social Vulnerability *114*
Future Vulnerability, Land Use and Climate Change Impacts *116*
5.5 Flooding Due to Impoundment Failure 119
Hazard Profile *119*
Hazard Profile: Dam Failure *120*
Hazard Profile: Levee/Floodwall Failure *128*
Hazard History *131*
Social Vulnerability *134*
Future Vulnerability, Land Use and Climate Change *134*
5.6 Severe Wind Events (including Tropical Storms, Derechos and Nor'easters) 134
Hazard Profile *134*
Magnitude or Severity *136*
Hazard History *137*
Vulnerability Analysis *142*

Social Vulnerability *147*
Future Vulnerability, Land Use and Climate Change *149*
5.7 Tornadoes 150
Hazard Profile *150*
Magnitude or Severity *150*
Hazard History *152*
Vulnerability Analysis *162*
Social Vulnerability *163*
Future Vulnerability, Land Use and Climate Change *165*
5.8 Wildfires 165
Hazard Profile *165*
Magnitude or Severity *166*
Hazard History *166*
Vulnerability Analysis *171*
Social Vulnerability *175*
Future Vulnerability, Land Use and Climate Change *177*
5.9 Severe Winter Weather 177
Hazard Profile *177*
Magnitude or Severity *179*
Vulnerability Analysis *183*
Social Vulnerability *187*
Future Vulnerability, Land Use and Climate Change *189*
5.10 Thunderstorms (including Hail and Lightning) 189
Hazard Profile *189*
Magnitude or Severity *190*
Hazard History *190*
Vulnerability Analysis *192*
Social Vulnerability *194*
Future Vulnerability, Land Use and Climate Change *195*
5.11 Droughts and Extreme Heat 196
Hazard Profile *196*
Magnitude or Severity *196*
Hazard History *198*
Vulnerability Analysis *202*
Social Vulnerability *206*
Future Vulnerability, Land Use and Climate Change *206*
5.12 Earthquakes 209
Hazard Profile *209*
Magnitude or Severity *209*
Hazard History *211*
Vulnerability Analysis *215*
Social Vulnerability *218*
Future Vulnerability, Land Use and Climate Change *220*
5.13 Landslides 220
Hazard Profile *220*
Magnitude or Severity *221*
Hazard History *222*
Vulnerability Analysis *224*
Social Vulnerability *225*
Future Vulnerability, Land Use and Climate Change *227*
5.14 Shoreline Erosion 227
Hazard Profile *227*

Magnitude or Severity *227*
Hazard History *228*
Vulnerability Analysis *232*
Social Vulnerability *232*
Future Vulnerability, Land Use and Climate Change *232*
5.15 Sinkholes 233
Hazard Profile *233*
Magnitude or Severity *234*
Hazard History *235*
Vulnerability Analysis *235*
Social Vulnerability *239*
Future Vulnerability, Land Use and Climate Change *240*
5.16 Radon Exposure 240
Hazard Profile *240*
Magnitude or Severity *241*
Hazard History *241*
Vulnerability Analysis *245*
Social Vulnerability *250*
Future Vulnerability, Land Use and Climate Change *253*
5.17 Infectious Diseases 254
Hazard Profile *254*
Hazard History *257*
Vulnerability Analysis *262*
Social Vulnerability *263*
Future Vulnerability, Land Use and Climate Change *264*
5.18 Conclusions on Hazard Risk 264

6.0 Capability Assessment 269

6.1 Updates for 2022 269
6.2 Introduction 269
6.3 Staff and Organizational Capability 270
6.4 Technical Capability 272
6.5 Fiscal Capability 275
6.6 Policy and Program Capability 276
6.6.1 Previous Mitigation Efforts *276*
6.6.2 Hazard Mitigation Activity Highlights *276*
6.6.3 Local Government Highlights *278*
6.6.4 Emergency Operations Plans (EOP) *283*
6.6.5 Floodplain Management *284*
6.6.7 Comprehensive Plans *285*
6.7 Legal Authority 288
6.7.1 Regulation *289*
6.7.2 Acquisition *296*
6.7.3 Taxation *296*
6.7.4 Spending *297*
6.8 Summary 299

7.0 Mitigation Strategy 300

7.1 Updates for 2022 300
7.2 Introduction 300
7.3 Mitigation Goals 301

7.4 Identification and Analysis of Mitigation Techniques 304
7.5 Selection of Mitigation Techniques 310
7.6 Mitigation Actions 317
REGIONAL MITIGATION ACTIONS *317*
CHARLES CITY COUNTY *330*
CHESTERFIELD COUNTY *335*
CITY OF COLONIAL HEIGHTS *353*
DINWIDDIE COUNTY *361*
TOWN OF MCKENNEY *374*
CITY OF EMPORIA *380*
GOOCHLAND COUNTY *389*
GREENSVILLE COUNTY *399*
TOWN OF JARRATT *410*
HANOVER COUNTY *412*
TOWN OF ASHLAND *422*
HENRICO COUNTY *433*
CITY OF HOPEWELL *452*
NEW KENT COUNTY *471*
CITY OF PETERSBURG *483*
POWHATAN COUNTY *498*
PRINCE GEORGE COUNTY *506*
CITY OF RICHMOND *518*
TOWN OF SURRY *546*
SUSSEX COUNTY *548*
TOWN OF STONY CREEK *564*
TOWN OF WAKEFIELD *569*
TOWN OF WAVERLY *571*

8.0 Plan Maintenance Procedures 573

8.1 Updates for 2022 573
8.2 Introduction 573
8.3 Implementation 573
8.4 Monitoring, Evaluation and Enhancement 574
8.4.1 Annual Progress Reports *574*
8.4.2 Five-Year Plan Review *575*
8.4.3 Disaster Declaration *576*
8.4.4. Reporting Procedures *576*
8.4.5 Plan Amendment Process *576*
8.5 Continued Public Involvement 577
8.6 Opportunities for Improvement 580

1.0 Executive Summary

The Richmond-Crater Multi-Region Hazard Mitigation Plan is an update to plans approved in 2006 by the jurisdictions of PlanRVA and Crater Planning District Commission (PDC), and the combined Richmond-Crater 2011 and 2017 Multi-Regional Hazard Mitigation Plans.

PlanRVA and Crater PDC convened a joint Hazard Mitigation Steering Committee and Working Group, comprised of representatives from the participating localities. The committee and working group met several times during the planning process and worked closely with Salter's Creek Consulting, Inc., to develop the multi-regional plan update. Public input was sought throughout the process in accordance with Federal requirements. The planning process is documented in Section 3.

The area covered by this plan includes the following communities:

Town of Ashland
Charles City County
Chesterfield County
City of Colonial Heights
Dinwiddie County
City of Emporia
Goochland County
Greensville County
Hanover County
Henrico County
City of Hopewell
Town of Jarratt
Town of McKenney
New Kent County
City of Petersburg
Powhatan County
Prince George County
City of Richmond
Town of Stony Creek
Town of Surry
Sussex County
Town of Wakefield
Town of Waverly

1.1 Hazard Identification and Risk Assessment

The Hazard Identification and Risk Assessment (HIRA) serves as the fact base for the regional hazard mitigation plan. The HIRA consists of three parts, found in Section 5:

1. Identification of which hazards could affect the Richmond-Crater region;

2. Profile of hazard events and determination of what areas and community assets are the most vulnerable to damage from these hazards; and,

3. Estimation of losses and prioritization of the potential risks to the community.

For this plan update, hazards in the previous plan were examined and discussed in detail. Several hazards were combined and new hazards were added as a result. A discussion of the impacts of climate change on each hazard, and the social vulnerability of the study area to hazard impacts were added. **Table 1.1** summarizes which hazards were retained and how they were ranked by the planning participants.

Table 1.1: Conclusions on Hazard Risk for Richmond-Crater Region

CRITICAL HAZARD - HIGH RISK	FLOODING SEVERE WIND EVENTS TORNADOES
CRITICAL HAZARD - MODERATE RISK	SEVERE WINTER WEATHER DROUGHTS AND EXTREME HEAT THUNDERSTORMS
NONCRITICAL HAZARD - LOW RISK	WILDFIRES INFECTIOUS DISEASES EARTHQUAKES SHORELINE EROSION FLOODING DUE TO IMPOUNDMENT FAILURE RADON EXPOSURE
NEGLIGIBLE CONSEQUENCES	SINKHOLES LANDSLIDES

1.2 Capability Assessment

The capability assessment (Section 6) evaluates the current capacity of the communities of the Richmond-Crater region to mitigate the effects of the natural

hazards identified in the HIRA. By providing a summary of each jurisdiction's existing capabilities, the capability assessment serves as the foundation for designing an effective hazard mitigation strategy.

The capability assessment includes an examination of the following local government capabilities:

- *Administrative Capability* – describes the forms of government in the region, including the departments that may be involved in hazard mitigation.
- *Technical Capability* – addresses the technical expertise of local government staff.
- *Fiscal Capability* – examines budgets and current funding mechanisms.
- *Policy and Program Capability* – describes past, present, and future mitigation projects in the region and examines existing plans (e.g., emergency operations plan, comprehensive plan).
- *Legal Authority* – describes how jurisdictions in the region use the four broad government powers (i.e., regulation, acquisition, taxation, and spending) to influence hazard mitigation activities.

1.3 Mitigation Strategy

As part of the plan update, the committee examined and evaluated the goals stated in the 2017 plan word for word. Each of the following updated goal statements represents a broad target to achieve through associated objectives which are fulfilled through implementation of specific Mitigation Action Plans, both for the region as a whole and for each community.

Goal 1: Equitably prepare and protect the whole community against natural hazards

1.1 Increase staff capabilities regarding multi-hazard management and mitigation

1.2 Conduct outreach and educational opportunities for diverse groups of citizens

1.3 Share mitigation successes with citizens and stakeholders

1.4 Reduce disparities in how communities prepare for, respond to, and recover from hazards.

Goal 2: Strengthen and develop partnerships for mitigating and reducing hazard impacts

2.1 Include stakeholders and other regions in planning and training actions.

2.2 Expand outreach and educational opportunities to influence and inform a broad spectrum of stakeholders.

2.3 Collaborate on public safety and support effective system redundancies

Goal 3: Encourage sustainable government practices that support the short- and long-term health, safety and welfare of citizens

3.1 Identify and protect important elements of the economic, social, cultural, historic, and environmental fabric of the community and neighborhoods

3.2 Address restoration of long-term housing and continuity of basic government services for affected populations, especially socially vulnerable communities, during recovery from hazard events

Goal 4: Protect critical infrastructure

4.1 Identify opportunities for information- and intelligence-sharing regarding threats and hazards

4.2 Collaborate on utility management and support effective system redundancies

4.3 Identify and assist owners to maintain and upgrade high hazard potential dams, and protect the people and property downstream

Section 7 contains all of the mitigation action plans for each participating jurisdiction and the region, as well as information on how and when the community expects to implement the actions.

1.4 Plan Maintenance Procedures

The plan outlines a procedure for implementation, maintenance, and plan updates. PlanRVA and Crater PDC will be responsible for monitoring this plan. Annual progress reports from the communities will include corrective action plans if needed.

In accordance with Federal Emergency Management Agency (FEMA) regulations, a written update will be submitted to the Commonwealth and FEMA Region III every five years from the original date of the plan, unless circumstances (e.g., Presidential disaster declaration, changing regulations) require a formal update earlier. The public will be continually informed of changes to the plan as they occur.

1.5 Conclusion

This Richmond-Crater Multi-Regional Hazard Mitigation Plan embodies the continued commitment and dedication of the local governments and community members of the Richmond-Crater region to enhance the safety of residents and businesses by taking actions before a disaster strikes. While little can be done to prevent natural hazard events from occurring, the region is poised to minimize the disruption and devastation that so often accompanies these disasters.

2.0 Introduction

2.1 Updates for 2022

Each section of this plan has been broadly updated as part of the 2022 update process. At the beginning of each section, there is a synopsis of the changes made to that section as part of the update.

Section 2 was updated to modify the scope to include all 23 communities participating in this planning process.

2.2 Background

Mitigation is commonly defined as sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects. A mitigation plan states the aspirations and specific courses of action that a community intends to follow to reduce vulnerability and exposure to future hazard events. These plans are formulated through a systematic process centered on the participation of residents, businesses, public officials, and other community stakeholders.

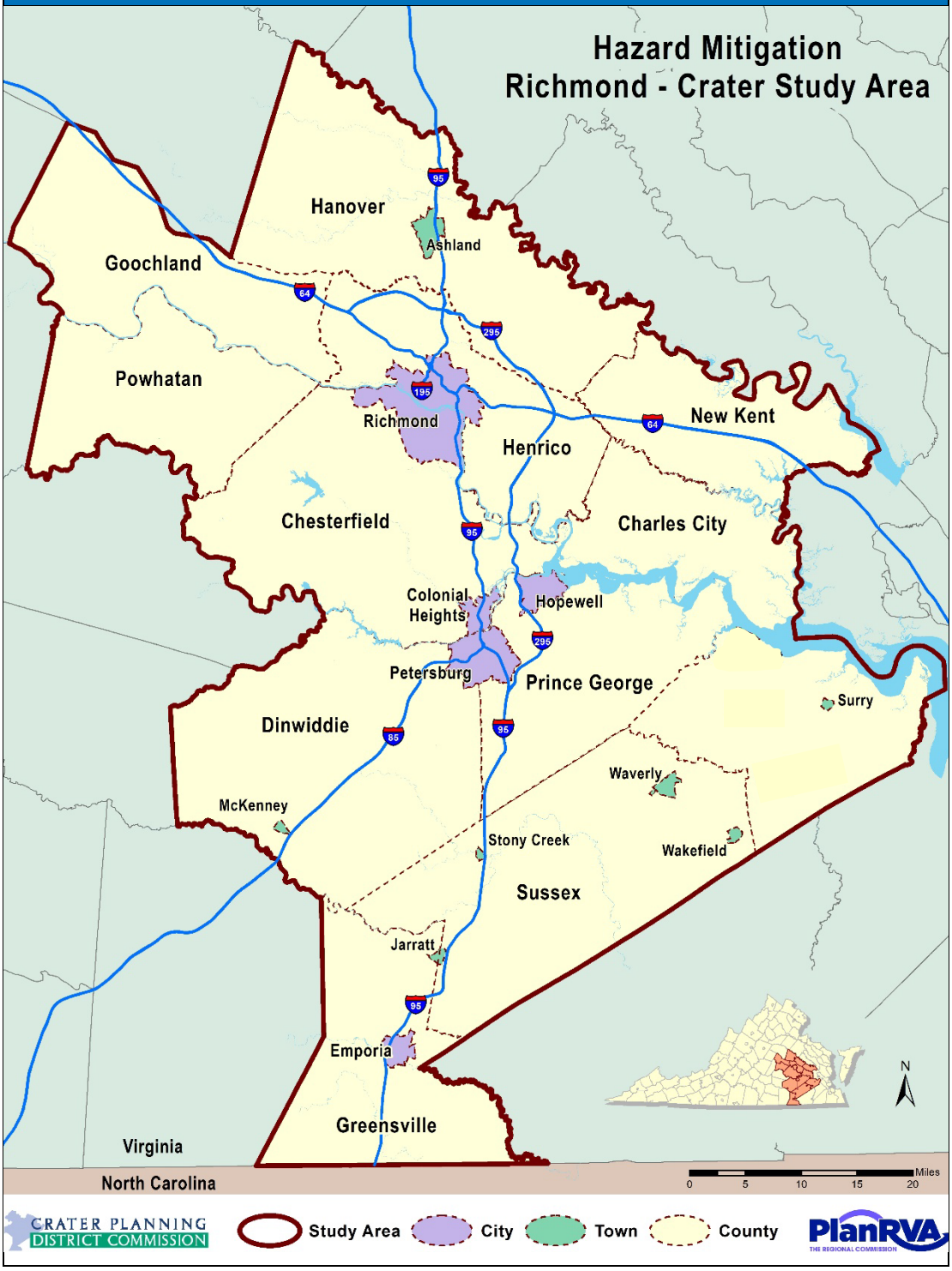
A local mitigation plan is the physical representation of a jurisdiction's commitment to reduce risks from natural hazards. Local officials can refer to the plan in their day-to-day activities and in decisions regarding regulations and ordinances, granting permits, and funding of capital improvements and other community initiatives. Additionally, these local plans will serve as the basis for states to prioritize future grant funding as it becomes available.

The Richmond-Crater Multi-Regional Hazard Mitigation Plan will continue to be a useful tool for all community stakeholders by increasing public awareness about local hazards and risks, and providing information about options and resources available to reduce those risks. Educating the public about potential hazards will help each jurisdiction protect itself against the effects of future hazards, and will enable informed decision-making regarding where to live, purchase property, or locate business.

The area covered by this plan includes the following communities, as shown in **Figure 2.1**:

- Town of Ashland
- Charles City County
- Chesterfield County
- City of Colonial Heights
- Dinwiddie County
- City of Emporia
- Goochland County
- Greensville County
- Hanover County
- Henrico County
- City of Hopewell
- Town of Jarratt
- Town of McKenney
- New Kent County
- City of Petersburg
- Powhatan County
- Prince George County
- City of Richmond
- Town of Stony Creek
- Town of Surry
- Sussex County
- Town of Wakefield
- Town of Waverly

Figure 2.1: Study Area Communities



2021

2.2 The Need for Local Mitigation Planning

On October 30, 2000, President Clinton signed into law the Disaster Mitigation Act of 2000 (DMA 2000), which required state and local mitigation plans that would help to reduce loss of life and property, human suffering, economic disruption, and disaster assistance costs resulting from natural disasters.

DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act and added a new section to the law, Section 322, Mitigation Planning. Section 322 requires local governments to prepare and adopt jurisdiction-wide hazard mitigation plans for disasters declared after November 1, 2004, as a condition of receiving Hazard Mitigation Grant Program (HMGP) project grants and other non-disaster related mitigation grant assistance programs. Local governments must review and, if necessary, update their mitigation plans every five years from the original date of the plans in order to continue Hazard Mitigation Assistance (HMA) program eligibility.

The requirements for local mitigation plans are found in Section 44 Code of Federal Regulations Part 201.6. FEMA's *Local Multi-Hazard Mitigation* Planning Guidance issued on October 1, 2011 provides updated FEMA interpretation and explanation of local plan mitigation regulations and FEMA's expectations for mitigation plan updates. In addition, the Virginia Department of Emergency Management (VDEM) and FEMA now use the 2021 *Local Mitigation Plan Review Tool* to ensure that a plan meets FEMA's regulatory requirements as well as additional requirements identified by the Commonwealth.

2.3 Organization of the Plan

Section 3.0 – Planning Process defines the process followed throughout the update of this plan, including a description of the Richmond-Crater region's stakeholder involvement and the plan for public involvement.

Section 4.0 – Community Profile provides a physical description and demographic profile of the region, and examines characteristics including geography, hydrology, development patterns, demography, and land use.

Section 5.0 – Hazard Identification, Risk Assessment and Vulnerability Analysis identifies, describes and evaluates the natural hazards likely to affect the Richmond-Crater region, and provides a quantification of the impacts those hazards have on the people, infrastructure and resources of the region.

Section 6.0 – Capability Assessment analyzes the region's and each of the local jurisdictions' policies, programs, plans, resources, and capabilities to reduce exposure to the hazards identified in Section 5.0.

Section 7.0 – Mitigation Strategy addresses the Richmond-Crater region's issues and concerns for hazards by establishing a framework for mitigation activities and policies. The strategy includes updated goals and a range of updated mitigation actions to achieve these goals.

Section 8.0 – Plan Maintenance Procedures specifies how the plan will be monitored, evaluated, and updated.

Appendices are included at the end of the plan, and contain supplemental reference materials, including 2022 resolutions of plan adoption and the 2017 mitigation action status updates.

3.0 Planning Process

3.1 Updates for 2022

Summaries of each meeting and the procedures followed during the update process were updated for each subsection. Summaries of previous planning processes were removed for brevity and because they are available in previous plans.

3.2 Overview of Mitigation Planning

Local hazard mitigation planning involves the process of organizing community resources, identifying and assessing hazard risks, and determining how to minimize or manage those risks. This process results in a hazard mitigation plan that identifies specific actions designed to meet the goals established by those that participate in the planning process. To ensure the functionality of each mitigation action, responsibility is assigned to a specific individual, department or agency along with a schedule for its implementation. Plan maintenance procedures are established to help ensure that the plan is implemented, as well as evaluated and enhanced as necessary. Developing clear plan maintenance procedures helps ensure that the Hazard Mitigation Plan remains a current, dynamic, and effective planning document over time.

Participating in a hazard mitigation planning process can help local officials and residents achieve the following results:

- save lives and property;
- save money;
- speed recovery following disasters;
- reduce future vulnerability and increase future resiliency through wise development and post-disaster recovery and reconstruction;
- enhance coordination within and across neighboring jurisdictions;
- expedite the receipt of pre-disaster and post-disaster grant funding; and
- demonstrate a firm commitment to improving community health and safety.

Mitigation planning is an important tool to produce long-term recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices will enable local residents, businesses, and industries to re-establish themselves in the wake of a disaster, getting the community economy back on track sooner and with less interruption.

The benefits of mitigation planning go beyond reducing hazard vulnerability. Measures such as the acquisition or regulation of land in known hazard areas can help achieve multiple community goals, such as preserving open space, improving water quality, maintaining environmental health, and enhancing recreational opportunities. It is the intent of this document to help identify overlapping community objectives and facilitate the sharing of resources to achieve multiple aims, and to include information wherever possible

to demonstrate when the plan is or has been implemented through other planning mechanisms.

44 CFR Requirement

44 CFR Part 201.6(c)(1): The plan shall include documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process and how the public was involved.

3.3 Preparing the Plan

The PDCs used FEMA guidance (FEMA Publication Series 386) to develop and update this Hazard Mitigation Plan. A *Local Mitigation Plan Review Tool*, found in Appendix A, provides a detailed summary of FEMA's current minimum standards of acceptability for compliance with DMA 2000 and notes the location where each requirement is met within the Plan. These standards are based upon FEMA's Interim Final Rule as published in the Federal Register on February 26, 2002, and October 31, 2007, in Part 201 of the Code of Federal Regulations (CFR).

The planning process included eight major steps that were completed during 2021 through 2022; they are shown in green and yellow in Figure 2.1. Each of the planning steps illustrated in **Figure 3.1** resulted in work products and outcomes that collectively make up the Hazard Mitigation Plan.

Table 3.1 provides a summary of the National Flood Insurance Program's Community Rating System (CRS) User's Manual 10-step guidance for plan preparation and how that guidance fits within the 10-step, 4-phase process advocated by FEMA. This plan strives to accomplish the steps in each of these processes.

Figure 3.1: Richmond-Crater Hazard Mitigation Planning Process

Table 3.1: Guidance for Hazard Mitigation Plan Preparation	
FEMA Guidance	**CRS Guidance**
Phase I: Organize Resources Step 1. Get Organized Step 2. Plan for Public Involvement Step 3. Coordinate with Other Departments & Agencies	 Step 1. Organize Step 2. Involve the Public Step 3. Coordinate
Phase II: Assess Risk Step 4. Identify the Hazards Step 5. Assess the Risks	 Step 4. Assess the hazard Step 5. Assess the Problem
Phase III: Develop Mitigation Plan Step 6: Review Mitigation Alternatives Step 7: Draft an Action Plan Step 8: Set Planning Goals	 Step 6. Set Goals Step 7. Review Possible Activities Step 8. Draft an Action Plan
Phase IV: Adopt & Implement Step 9: Adopt the Plan Step 10: Implement the Plan	 Step 9. Adopt the Plan Step 10. Implement, Evaluate, Revise

3.4 The Planning Committee

A community-based planning team made up of local government officials and key stakeholders has continually helped guide the development of this Plan. The committee organized local meetings and planning workshops to discuss and complete tasks associated with preparing the Plan, including reviewing plan drafts and providing timely comments. Additional participation and input from residents and other identified stakeholders were sought through public meetings that described the planning process, the findings of the risk assessment, and the proposed mitigation actions. The committee convened in 2021.

3.4.1 Richmond-Crater Planning Committee

Due to the large geographic area covered and the number of communities participating, the project leaders felt that a Steering Committee was necessary to help more efficiently guide the planning process and facilitate the numerous Working Group members. Thus, the representatives for the communities and stakeholders were divided into a primary Steering Committee and a Working Group. The division was based on discussions with potential committee members from each community and stakeholders and a determination as to which members were most willing to commit themselves to the entire process, to do the majority of the work, to debate goals and objectives and discuss alternatives, and to report back to their constituencies and Working Group members. The participants listed in **Table 3.2a** are the Steering Committee and **Table 3.2b** shows the Working Group members for the 2022 Richmond-Crater Hazard Mitigation Plan Update. Names marked with an asterisk indicate the lead person responsible for that community in the planning, update and maintenance process. Specifically, the tasks assigned to the Steering Committee members included:

- participate in mitigation planning meetings and workshops;
- provide best available data as required for the risk assessment portion of the Plan;
- provide copies of any mitigation or hazard-related documents for review and incorporation into the Plan;
- support the development of the Mitigation Strategy, including the design and adoption of community goals and objectives;
- help design and propose appropriate mitigation actions for incorporation into the Mitigation Action Plan;
- review and provide timely comments on all study findings and draft components of the plan; and
- support the adoption of the Hazard Mitigation Plan by community leaders.

The Working Group includes the Steering Committee members. Working Group members were provided the opportunity and invitation to participate in workshops and public meetings, asked for best available data, asked to review and comment on plan elements, and relied upon to ensure successful adoption of the plan in their community. In many cases, the Working Groups for individual communities also met outside of the more official planning process in additional meetings facilitated by Steering Committee members. Additional participation and input from other identified community staff and stakeholders was sought by the Steering Committee during the planning process primarily through e-mails and phone calls. Stakeholder involvement is discussed in more detail later in this section.

Table 3.2a: Hazard Mitigation Planning Steering Committee Members

Name and Title	Community and Agency	Expertise
Troy Aronhalt, Acting Major	Town of Ashland Police Department	Emergency Management/Public Information
*Nora Green Amos, Director	Town of Ashland, Planning & Community Development	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Christopher A. Workman, FPA/Environmental Engineer	Chesterfield County Environmental Engineering	Structural Flood Control Projects, Property Protection, Planning/Preventive Measures
*Jessica Robison, Emergency Management Coordinator	Chesterfield County, Emergency Management	Emergency Management/Public Information
*Tim Blumenschine, Emergency Manager	City of Colonial Heights, Fire & EMS	Emergency Management/Public Information

Table 3.2a: Hazard Mitigation Planning Steering Committee Members		
Name and Title	**Community and Agency**	**Expertise**
*John Woodburn, Environmental Manager	Goochland County, Dept of Public Utilities	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
*Corey Beazley, Deputy Coordinator	Hanover County, Fire-EMS Department	Emergency Management/Public Information
Gregory Martin, Battalion Chief	Hanover County, Fire-EMS Department	Emergency Management/Public Information
Danielle Curtis, Engineering Technician (Floodplain)	Henrico County, Public Works	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
*Kristin Owen, Floodplain & Dam Safety Manager	Henrico County, Public Works	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
*Kate Hale, Deputy Emergency Management Coordinator	New Kent County, Emergency Management	Emergency Management/Public Information
Joshua Airaghi, Director	New Kent County, Environmental Dept	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
*Darryl Walker, Manager	City of Petersburg, Stormwater Program	Structural Flood Control Projects, Property Protection
*Frank Hopkins, FPA/Planning Director	Powhatan County, Planning	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
*Brianne Fisher, Coordinator	City of Richmond, Office of Sustainability	Planning/Preventive Measures, Property Protection, Resiliency
Surani Olsen, Manager & CRS Coordinator	City of Richmond, Water Resources	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
*Michael Poarch, County Planner	Sussex County, Planning	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Kathryn Tolliver, Government Operations Liaison	American Red Cross, Stakeholder	Emergency Management/Public Information
Michael Tolliver, Government Operations Liaison	American Red Cross, Stakeholder	Emergency Management/Public Information
Dana Adkins, Tribal Environmental Director	Chickahominy Indian Tribe, Stakeholder	Natural Resource Protection
Jay Ruffa, Director of Planning	Crater PDC, Stakeholder	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection

Table 3.2a: Hazard Mitigation Planning Steering Committee Members		
Name and Title	**Community and Agency**	**Expertise**
Heather Barrar, Regional Trails Program Director	FOLAR, Stakeholder	Natural Resource Protection
Warren Taylor, Natural Resource Manager	Pamunkey Indian Tribe, Stakeholder	Natural Resource Protection
Sarah Stewart, Program Manager - Environmental Program	PlanRVA, Stakeholder	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Katie Moody, Emergency Management Program Coordinator	PlanRVA, Stakeholder	Emergency Management/Public Information
Rebekah Cazares, Planner	PlanRVA, Stakeholder	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Leigh Chapman, President	Salter's Creek Consulting, Inc., Stakeholder	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Tony Williams, Mobility Manager	Senior Connections, Stakeholder	Emergency Management/Public Information
Anne Witt, Geohazards Geologist	Va Dept. of Energy, Stakeholder	Natural Resource Protection
Alanna Ostrowski, Forest Technician	Va Dept. of Forestry, Stakeholder	Natural Resource Protection
Jeremey Falkenau, Senior Area Forester	Va Dept. of Forestry, Stakeholder	Natural Resource Protection
Mark Killgore, Lead Dam Safety Engineer	Va Dept. of Conservation & Recreation, Dam Safety, Stakeholder	Structural Flood Control Projects, Property Protection
Angela Davis, NFIP State Coordinator & Floodplain Program Planner	Va Dept. of Conservation & Recreation, Floodplain Management, Stakeholder	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Amanda Weaver, All Hazards Planner	Va Dept. of Emergency Management Region 1, Stakeholder	Emergency Management/Public Information
Nicole Mueller, Planning Specialist	Va. Dept. of Transportation, Stakeholder	Structural Flood Control Projects, Property Protection
Jim Kaste, Professor	College of William & Mary, Stakeholder	Natural Resource Protection
David Stroud, Emergency & Hazard Mitigation Lead	Wood, Stakeholder	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection

* Lead person responsible for that community in the planning, update and maintenance process outlined in Section 8.

Table 3.2b: Hazard Mitigation Planning Working Group Members		
Name and Title	**Community and Agency**	**Expertise**
*Rhonda Russell, Asst County Administrator	Charles City County	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Steven Herring, Public Outreach & CERT Coord	Chesterfield County Fire & EMS	Emergency Management/Public Information
Darshan Parikh, Deputy Emergency Mgmt Coordinator	Chesterfield County Emergency Management	Emergency Management/Public Information
Janet Llewellyn, Planning Manager	Chesterfield County Parks & Recreation	Natural Resources Protection
Kimberly Conley, Asst Director	Chesterfield County Citizen Information and Resources	Public Information
Susan Pollard, Public Information Officer	Chesterfield County, Communications & Media	Public Information
Rachel Chieppa, Senior Planner	Chesterfield County, Planning & Community Development	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
David Kissner, Deputy Fire Chief	Colonial Heights Fire & EMS	Emergency Management/Public Information
Doug Smith, City Manager	Colonial Heights	Emergency Management/Public Information
Brandy Payne, Assistant Director	Colonial Heights, Planning & Community Development	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
*Kevin Kiddy, Emergency Manager	Colonial Heights, Emergency Mgmt	Emergency Management/Public Information
Kevin Massengill, County Administrator	Dinwiddie County	Emergency Management/Public Information
*Dennis Hale, Division Chief	Dinwiddie County, Fire & EMS	Emergency Management/Public Information
Morgan Ingram, Director	Dinwiddie County, Economic Development	Planning/Preventive Measures
Tammie Collins, Deputy County Administrator	Dinwiddie County	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
*Michael Rae, Emergency Services Coordinator	Emporia, Emergency Management	Emergency Management/Public Information
Paul Drumwright, Administrative Services Manager	Goochland County Administration	Public Information
Robin Hillman, Deputy Emergency Services Coordinator	Goochland County	Emergency Management/Public Information
Amanda Huskey, GIS Manager	Greensville County, Geographic Information Systems	Public Information

Table 3.2b: Hazard Mitigation Planning Working Group Members		
Name and Title	**Community and Agency**	**Expertise**
*Lin Pope, Planning Director/Zoning Official	Greensville County, Planning & Community Development	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Mike Flagg, Director	Hanover County, Public Works	Structural Flood Control Projects, Property Protection
Brendan McHugh, Planner	Hanover County, Planning	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Randy Hardman, Deputy Director	Hanover County, Public Works	Structural Flood Control Projects, Property Protection
Michael Dieter, Engineering Manager	Hanover County, Public Works	Structural Flood Control Projects, Property Protection
Alex Mease, Civil Engineer	Hanover County, Public Works	Structural Flood Control Projects, Property Protection
Courtney Cornell, Information Technology System Engineer	Hanover County, Information Technology	Public Information
Bill Rose, Manager	Hanover County, Information Technology	Public Information
Donald Lee, Deputy Director	Hanover County, General Services	Planning/Preventive Measures, Property Protection
Tom Harris, Public Information Officer	Hanover County	Public Information
Ben Felton, Project Engineer	Henrico County, Dept of Public Works	Structural Flood Control Projects, Property Protection
Rob Rowley, Chief	Henrico County, Emergency Mgmt & Workplace Safety	Emergency Management, Public Information
Jen Cobb, Director	Henrico County, Engineering & Environmental Services Director	Natural Resource Protection
Tevya W. Griffin, Director	Hopewell, Dept of Development	Planning/Preventive Measures, Property Protection, Resiliency
Robert Williams, Emergency Services Specialist	Hopewell Bureau of Fire	Emergency Management/Public Information
*Ben Ruppert, Emergency Services Coordinator	Hopewell, Office of Emergency Mgmt	Emergency Management/Public Information
Chris Ward, Senior Planner	Hopewell, Development Department	Planning/Preventive Measures, Property Protection, Resiliency
Reginald Tabor, Director	Petersburg, Planning	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Joanne Williams, Public Information Officer	Petersburg	Public Information
Cynthia Boone, Project Manager	Petersburg, Economic Development	Planning/Preventive Measures, Property Protection

Table 3.2b: Hazard Mitigation Planning Working Group Members		
Name and Title	**Community and Agency**	**Expertise**
Curt Nellis, Asst Emergency Mgmt Coordinator	Powhatan County, Emergency Management	Emergency Management/Public Information
*Donald Hunter, Deputy Emergency Mgmt Coordinator	Prince George County, Emergency Management	Emergency Management/Public Information
Tim Graves, Planner	Prince George County Planning & Zoning	Planning/Preventive Measures, Property Protection, Resiliency
Jeff Stoke, County Administrator	Prince George County	Public Information
Julie Walton, Director	Prince George County, Community Development	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Dave Alley, Acting Building Commissioner	Richmond, Permits & Inspections	Planning/Preventive Measures, Property Protection, Resiliency
Bill Lawson, Deputy Emergency Coordinator	Richmond, Office of Emergency Management	Emergency Management/Public Information
Reid Foster, Public Safety Coordinator	Sussex County, Public Safety Department	Emergency Management/Public Information
Beverly Walkup, Director	Sussex County, Planning	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Richard Douglas, Administrator	Sussex County	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
*Bennie Savedge, Mayor	Town of Surry	Public Information
Molly Rickmond, Town Clerk	Town of Surry	Public Information
*Melanie Willson, Mayor	Town of Jarrett	Public Information
*Meagan S. Haire Abby, Mayor	Town of McKenney	Public Information
Martha Stone, Clerk of Council	Town of McKenney	Public Information
*Brian Laine, Mayor	Town of Wakefield	Public Information
Anne Monahan, Town Clerk	Town of Wakefield	Public Information
*Angela McPhaul, Mayor	Town of Waverly	Public Information
*Franklin Jackson, Mayor	Town of Stony Creek	Public Information
Marsha Bishop, Town Clerk	Town of Stony Creek	Public Information

Table 3.2b: Hazard Mitigation Planning Working Group Members		
Name and Title	**Community and Agency**	**Expertise**
John Fitzgerald, Fire Chief	Capital Region Airport Commission	Planning/Preventive Measures, Property Protection
Ron Svejkovsky, MPO Director	Crater PDC - TCAMPO	Planning/Preventive Measures, Property Protection
Rashaunda Lanier-Jackson, Community Engagement Manager	PlanRVA	Public Information
Michelle Hamor, Chief of Planning and Policy Branch	USACE, Norfolk	Planning/Preventive Measures, Property Protection, Resiliency, Structural Flood Control Projects
John Highsman, Forester	VA Dept of Forestry	Natural Resource Protection
Heather Dowling, Senior Area Forester	VA Dept of Forestry	Natural Resource Protection
Brandy Buford, Floodplain Program Planner	VaDCR, Floodplain Management	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Michael Barber, Floodplain Program Planner	VaDCR, Floodplain Management	Planning/Preventive Measures, Property Protection, Resiliency, Natural Resource Protection
Tiffany Dubinsky, Statewide Transit Planning Manager	Va Dept of Rail & Public Transportation	Emergency Management/Public Information

* Lead person responsible for that community in the planning, update and maintenance process outlined in Section 8.

3.5 2021/2022 Community Meetings and Workshops

Below is a summary of the key meetings and community workshops during the 2021/2022 update process. Routine discussions and additional meetings were held by local officials to accomplish planning tasks specific to their department or agency. A consultant (Salter's Creek Consulting, Inc., of Hampton, Virginia) was hired with grant funds to update the hazard identification and vulnerability analysis, to guide the committee through the planning process based on the revised information and to assist each community with adoption of the final plan. All meeting summary information is included in Appendix C, which includes committee and public meeting minutes, attendance sheets, and correspondence with committee members and stakeholders.

NOVEMBER 20, 2021: PROJECT KICKOFF MEETING

Participants in the Kickoff Meeting discussed the overall approach to updating the Hazard Mitigation Plan, including strategies for outreach and public participation, as well as the

steps necessary to meet the requirements of the DMA 2000, and the CRS of the National Flood Insurance Program (NFIP). The consultant initiated data collection efforts at the meeting and reviewed the existing list of hazards with the representatives present.

The group discussed project schedule and potential stakeholders and how they would be asked to participate, including tasks such as: reviewing drafts, participating on the committee, and/or attending public meetings. Due to the ongoing COVID 19 safety protocols in place at the time , the group and the consultant decided that each of the main three meetings would be held virtually through online meeting software. Committee meetings would be held virtually, as well.

JUNE 21, 2021: FIRST PLANNING COMMITTEE MEETING

The consultant provided an overview of the proposed update approach to committee members. The Committee reviewed the Hazard Identification and Vulnerability Assessment information presented. Committee members discussed the hazards of most critical concern to the region, and concurred to adjust the names of several hazards, removed several hazards and added hazards.

The committee members present voted on their mitigation priorities and ranked hazards using the methodology described in Section 5. The committee considered a list of hazards that included flooding, coastal and tropical storms, severe thunderstorm/hail/lightning, winter weather/storms, drought, high hazard dam failure, tornado, extreme heat, earthquake, wildfire, coastal erosion/landslides/sinkholes, radon exposure and pandemic flu.

The first part of the meeting focused on the flood analysis, including the hybrid modeling analysis conducted. Participants discussed their frustration with obtaining NFIP repetitive flood loss data and the inability to know flood insurance coverage happening in private flood insurance market. The group discussed nomenclature for Infectious Disease or Pandemic Flu.

OCTOBER 15, 2021: SECOND PLANNING COMMITTEE MEETING

The second Planning Committee meeting was the beginning of the "Mitigation Strategy Workshops." The meeting began with a presentation on how a complete capability assessment contributes to identification of effective mitigation strategies. The discussion focused on local capabilities and the capability matrix each community was asked to complete.

The consultant helped Committee members review several documents in preparation for the goal setting exercise which was the focus of the workshop. This background helped Committee members maintain continuity and to develop linkages between various local, regional, and state planning efforts.

Data, documents, plans and procedures reviewed as part of the goal setting portion of the planning process included, but were not limited to, the following:

- 2018 *Commonwealth of Virginia Hazard Mitigation Plan* goals and objectives;
    - These items were reviewed by committee members prior to the work on updating the goals and objectives to help ensure that the regional plan supports and does not contradict the State's goals and objectives.
- Goals and objectives from Virginia Beach Resiliency planning effort;
- Goals and objectives from the *Virginia Coastal Resilience Master Planning Framework*, 2020;
- Draft goals and objectives from the 2022 *Hampton Roads Hazard Mitigation Plan* update going on concurrently;
- Goals and objectives from the 2016 *Middle Peninsula Hazard Mitigation Plan;*
- Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards, FEMA January 2013;
- Each of the existing plan's three primary goals and related objectives; and
- Dam safety reports for state-regulated dams, state dam safety regulations and interviews with dam safety officials at the Virginia Department of Conservation and Recreation (DCR).

The group was provided a list of potential, broad community goal key phrases extracted from the existing plans in order to encourage brainstorming about revising the goal statements. The members also reviewed existing goal statements from the current plan and other plans pertinent to the region. The group then went to work carefully reviewing the existing mitigation plan goal statements. Participants were encouraged to critique each word in light of the goal key words identified earlier and any changes that had taken place in their communities in the previous five years. The facilitator provided early recommendations, reworked, grouped together, and then presented the revised goals and objectives in real time during the meeting so that the group could arrive at a consensus on the broader mitigation goals and objectives associated with the updated mitigation plan. Detailed notes on the reasoning behind why the mitigation goals and objectives were modified is included in Section 7, which shows the changes and the revised goals and objectives.

The group discussed the current status of COVID 19 protocols and the ability to meet in person for the third workshop. Those present preferred a hybrid approach for Workshop #3 and the development of new and revised mitigation actions for 2022. The consultant proposed a virtual group workshop that would discuss the types of mitigation actions and provide examples and some suggested reading materials, followed by a series of in-person working group meetings, termed "office hours" at three locations in the study area to facilitate review, revision and development of each community's existing mitigation actions.

NOVEMBER 23, 2021: THIRD MITIGATION PLANNING COMMITTEE MEETING

The group reviewed a general list of potential mitigation actions categorized by type and the consultant provided examples, both local and national, of various successful mitigation actions. A brief discussion of the various categories followed. The consultant discussed a variety of mitigation categories for considering and evaluating possible mitigation action alternatives appropriate to each community. Suggested reading materials for the group included:

Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards, FEMA 2013;

Mitigation Best Practices – FEMA web site;

Mitigation Success Stories, Association of State Floodplain Managers, 2002;

Mitigation Matters: Policy Solutions to Reduce Local Flood Risk, Pew Charitable Trusts web site;

Zoning for Coastal Flood Resiliency, New York City Planning;

Mitigation Action Portfolio, FEMA web site;

Buoyant City: Historic District Resiliency & Adaptation Guidelines, Miami Beach, 2020; and

Coastal Flood Resilience Design Guidelines, Boston Planning & Development Agency, 2019.

The consultant then facilitated a discussion on regional mitigation actions from the 2017 plan and made real-time edits to those actions. The group also discussed the addition of several proposed, new regional mitigation actions regarding: NFIP repetitive flood loss data analysis at the state or regional level and preparation of repetitive flood loss area analyses; use of radon test kits to test structures; verifying status of significant hazard dams region-wide; and, strengthening/creating transportation networks for evacuation; and partnering with private companies on critical lifeline continuity.

COMMUNITY-SPECIFIC WORKING GROUP MEETINGS

All communities were invited by email to schedule a one-on-one meeting with the consultant toward the end of the planning process. Most of the communities involved in the plan took advantage of consultant-facilitated brief, in-person meetings at the community level to discuss their final Mitigation Action Plan. Participants worked carefully through a review of the list of existing mitigation actions from their existing plan, deciding which actions to modify or delete based on their progress toward completion. The group then selected and discussed priorities for several new proposed actions provided by the consultant.

The consultant shared additional review notes on several items that varied by community, and that typically included:

- comprehensive plan, resilience plan and strategic plan review notes;

- floodplain management regulation review notes;
- capabilities or capability gaps noted over the course of the planning process;
- repetitive loss area maps (hard copies provided during the meeting);
- community-specific critical facility vulnerabilities as shown in the HIRA, and as discussed in the First Planning Committee Meeting; and
- other pertinent materials such as news clippings.

While previous plans have benefitted from the synergies of having all communities attend a large workshop to address the MAP revisions and share mitigation ideas, COVID 19 protocols in 2021 required a revised methodology to allow some one-on-one discussion of mitigation actions, but to limit the number of people convened at any one time. The meetings were held over the course of several days in December 2021. On Monday December 6, Hanover County, Ashland and Henrico County representatives met at the Hanover ECC Training Room. On Tuesday, December 7, representatives of Powhatan County, Richmond, Sussex County and Goochland County met in the PlanRVA Conference Room. On December 10, representatives of Dinwiddie County, Colonial Heights, Prince George County, Hopewell, Charles City County and New Kent County met in the Crater PDC conference room, and a representative from Friends of the Lower Appomattox River (FOLAR) also met with the contractor separately. The contractor also met virtually with Chesterfield County on December 9. Attendance for each community was as follows:

Hanover County	Courtney Cornell
	Bill Rose
	Donald Lee
	Tom Harris
	Gregory Martin
Ashland	Troy Arnholt
	Nora Amos
	Corey Beazley
Henrico County	Ben Felton
	Kristin Owen
	Rob Rowley
Powhatan County	Curt Nellis
Richmond	Surani Olsen
	Brianne Fisher
	Bill Lawson
Sussex County	Beverly Walkup
	Michael Poarch
Goochland County	John Woodburn
Dinwiddie County	Dennis Hale
	Morgan Ingram

	Tammie Collins
Colonial Heights	Tim Blumenschine
	Brandi Payne
	Kevin Kiddy
	David Kissner
FOLAR	Heather Barrar
Prince George County	Donald Hunter
	Tim Graves
Hopewell	Chris Ward
	Benjamin Ruppert
	Robert Williams
Charles City County	Rhonda Russell
New Kent County	Kate Hale
Chesterfield County	Jess Robison
	Chris Workman
	Rachel Chieppa

In addition, the consultant met virtually with the Mayor of Stony Creek, Frank Jackson, on February 9, 2022, to discuss the town's risk and vulnerability and to brainstorm mitigation actions to address that risk. Several new mitigation actions were developed for the town as a result of this extended conversation.

Initial participation by the communities of Greensville County, Jarratt, McKenney, Surry, Wakefield and Waverly was less than preferred; thus, the planning team checked several times throughout the process to confirm that the communities were all on the email list notifying them of all meetings and planning opportunities. Finally, in June 2022, planners reached out by phone to each community and requested their review of pertinent information in the plan and approval to move forward with the mitigation actions as described. The following communication log documents these phone calls and emails by Jay Ruffa from the Crater PDC:

Town of McKenney: June 7 and 8 email communications with Mayor Meagan Haire Abby confirmed that McKenny is working with Dennis Hale from Dinwiddie County and that they have depended on him to relay and approve information on their behalf.

Town of Surry: On June 9, 2022, Mr. Ruffa spoke with Town Clerk and confirmed that the town worked with Ray Phelps from Surry County on reviewing their actions. Clerk indicated that Mitigation Action 2 is OK, but stated that in regard to mitigation action 1, they really have no flood prone property or structures because they are not in the floodplain. However, the rest of the mitigation strategy sounded adequate. Consultant suggested keeping mitigation action 1 because flood damage can and does occur outside the 100-year mapped floodplain, and retaining the action helps provide financial resources should that type of flooding occur.

Town of Jarrett – June 9, 2022, Town Clerk returned his call and indicated they will have Mayor contact Mr. Ruffa this week. No additional contact to date.

Town of Wakefield - June 8, 2022 – Mr. Ruffa spoke with the Town Clerk and indicated they will get us a response by Monday June 13 at the latest.

Town of Waverly - June 8, 2022 – Mr. Ruffa spoke with Town Clerk. Mr. Ruffa resent actions to Town Clerk and the Mayor. On June 10, 2022, he spoke with the Mayor and she indicated approval of the mitigation actions and invited Mr. Ruffa to come to the August 9th meeting for expected adoption of the plan.

Greensville County – February 10, 2022 and July 18, 2022 – Written correspondence from Linwood E. Pope, Jr., Director of Planning, via email, and E. Lynn Parker, Greensville County Emergency Services Coordinator, via letter, indicated that County personnel had reviewed and approved the plan components and had no further comments or issues with the mitigation action plan in the February 2022 draft. Those written correspondence are provided in Appendix C.

44 CFR Requirement

Part 201.6(b)(1): The planning process shall include an opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.

3.6 Involving the Public

Individual resident involvement provides the planning committee with a greater understanding of local concerns and increases mitigation success by developing community "buy-in" from those directly affected by public policy and planning decisions. As residents become more involved in decisions that affect their life and safety, they are more likely to gain appreciation of the natural hazards present in their community and take personal steps to reduce hazard impacts. Public awareness is a key component of an overall mitigation strategy aimed at making a home, neighborhood, school, business or city safer from the effects of natural hazards.

Public input was initially sought using three primary methods: (1) open public meetings advertised locally; (2) broadly-distributed public survey; and, (3) the posting of the draft Hazard Mitigation Plan on each PDC's web site. Public meetings were held at three stages of the planning process; early in the process to introduce the plan update process, again in the middle stage to share results of the Hazard Identification and Risk Assessment; and again, after the planning committee workshops, but well prior to adoption by governing bodies.

3.6.1 2021/2022 Public Meetings

Three open public meetings were held virtually via Zoom to present the planning process and to review mitigation actions to be included in the Hazard Mitigation Plan.

The first public meeting was held March 9, 2021. The goal was to introduce the public to the planning process and invite their involvement. The group discussed the hazards in the 2017 plan and provided comments on hazards proposed to be included in the update. The facilitator polled the group about their concerns regarding various hazards and provided a question and answer session at the end.

Upon completion of the Hazard Identification and Risk Assessment, the Committee held another open, virtual public meeting on June 28, 2021. This meeting included review of the results of the hazard study for the region, including detailed information regarding exposure, risk assessment and social vulnerability.

Upon completion of a draft Plan, the Committee held another public meeting on the draft Hazard Mitigation Plan on March 16, 2022. The meeting provided further opportunity for the public and identified stakeholders to review and comment on the draft plan. The plan was posted on the PDC web sites earlier that week, and PDC contact information and a comment form were provided to assist the public with submitting comments. The 2-week review period concurrent with the March 16, 2022 meeting provided residents with an opportunity to review the content of the Plan's sections.

All public meetings were advertised broadly by the communities on social media, on physical bulletin boards, and via email to help ensure that local officials, residents, businesses, and other public and private interests in the region, including neighboring communities, were notified on how to be involved in the local mitigation planning process. Additionally, the PDCs and the communities advertised the meetings on their web sites. The public meeting advertisements are included in Appendix C, which also includes all committee and public meeting minutes, attendance sheets, and invitation correspondence.

The public meeting on March 16, 2022 was termed the "Feedback Forum" in an effort to solicit public comment and feedback on the draft plan. Once again, the committee relied on the efforts of multiple community Public Information Officers, web masters, and other communication specialists to use a variety of sources to spread the word about the planning effort. Records of advertisements and solicitations for involvement are included in Appendix C (meeting minutes), Appendix D (public survey response summaries), and Appendix E (responses to public comments).

Additionally, the plan was reviewed and presented to each community's elected officials at a public hearing prior to adoption. Though the plan was in its final format for these meetings, this did provide additional opportunity to answer questions and present findings to the public and elected officials. The resolution of adoption by each community is included in Appendix B. Adoption dates are shown in **Table 3.3**.

Table 3.3: Date of Plan Adoption by Each Jurisdiction	
Community	**Date Of Plan Adoption**
Charles City County	
Chesterfield County	
City of Colonial Heights	
Dinwiddie County	
Town of McKenney	
City of Emporia	
Goochland County	
Greensville County	
Town of Jarratt	
Hanover County	
Town of Ashland	
Henrico County	
City of Hopewell	
New Kent County	
City of Petersburg	
Powhatan County	
Prince George County	
City of Richmond	
Town of Surry	
Sussex County	
Town of Stony Creek	
Town of Wakefield	
Town of Waverly	

3.6.2 Public Survey

A public survey was distributed early in the planning process to solicit additional feedback from attendees. As indicated above, the public survey was also distributed online in spring

2021 as part of the committee's effort to improve and use public feedback. The results of a total 192 responses collected are summarized in Appendix D.

3.6.3 PlanRVA Web Site

Throughout the planning process, PlanRVA maintained a web site at https://planrva.org/emergency-management-home/the-alliance/hazard-mitigation/ that provided a description of the planning process and posted meeting information. The page included a copy of the draft plan prior to the final Public Meeting to provide the public an opportunity to comment. Those comments are addressed through the standard comment/response format documented in Appendix E. Crater PDC linked to the PlanRVA web site from their web site during the planning process.

3.6.4 Better Together Webinar

On October 21, 2021, PlanRVA used one of their regular "Better Together" webinar series to focus on the 2022 update to the regional hazard mitigation plan. Each month, PlanRVA hosts one of these public forums with a different theme, hosted by experts in that particular topic or field of investigation. The organization invites the public, as well as a variety of public officials, agency representatives and stakeholders to listen in and ask questions to foster discussion, and then posts the forums on their YouTube channel for posterity. The October 2021 webinar is posted online at: https://www.youtube.com/watch?v=XS-H2ph9Hnc.

3.6.5 Brochure

In addition to the public meetings, web site and survey, the Committee issued a brochure template that was distributed by many of the jurisdictions, primarily via social media and web postings on their respective web sites. The brochure template is shown in Figure 3.2 below and provides background information on the planning process, the Community Rating System, and how citizens can become involved. The blank lines are intended for individual jurisdictions to input contact information for their staff point of contact.

Figure 3.2: Richmond-Crater Hazard Mitigation Planning Brochure

2022 Richmond-Crater Regional Hazard Mitigation Plan Update Process

Hazard Mitigation Planning

A Hazard Mitigation Plan is the result of a planning process to identify hazards and develop strategies to reduce loss of life and property. This planning process is structured around the four phases of the Disaster Mitigation Act of 2000, which the region's planning consultant has aligned with the ten steps of the Community Rating System (CRS). Having an adopted Hazard Mitigation Plan that is updated every five years helps ensure each community in the region is eligible for federal disaster funding following a disaster event.

The Community Rating System (CRS)

The CRS is a national program developed by the Federal Emergency Management Agency (FEMA) to encourage communities to reduce their risk to flood-related hazards. The CRS rewards the efforts communities take that go above and beyond the minimum requirements of the National Flood Insurance Program (NFIP) by providing discounts on flood insurance premiums.

Citizen Involvement

Citizen participation is an important component of mitigation planning for any community. The planning team needs your input on the types of hazards that are your priority concern, and your opinion on ways to lessen their impact.

Phase 1
1. Organize Planning Team
2. Plan for Public Involvement
3. Coordinate with Other Agencies

Phase 2
4. Identify the Hazards
5. Estimate Losses

Phase 3
6. Identify Goals & Objectives
7. Develop Potential Mitigation Actions
8. Draft the Mitigation Plan

Phase 4
9. Adopt the Plan
10. Implement and Maintain the Plan

Hazards Addressed by the Richmond-Crater Hazard Mitigation Plan

The planning committee has identified the following hazards for inclusion in the Richmond-Crater Hazard Mitigation Plan:

- Tropical Storms
- Severe Wind
- Tornados
- Severe Thunderstorms
- Flooding
- Winter Weather
- Drought
- Wildfire
- Earthquake
- Geological Events
- Pandemic

- Visit the web site. Get more information and follow the planning process at https://planrva.org/emergency-management-home/the-alliance/hazard-mitigation/. The website contains announcements for upcoming meetings, minutes and presentations from past planning meetings, information on the identified hazards, draft planning documents for review, a public survey, and more.

- Take the survey. A public outreach survey is available online here. Please complete the survey as soon as possible to ensure that your opinion is captured! If you would like a hard copy, please use the email below.

- Send us information or comments. If you have information to share for inclusion in the plan, please contact our planning consultants, Salter's Creek Consulting, by email: leigh.morgan2@verizon.net. The draft plan will be made available for public review on the web site prior to being submitted to FEMA.

3.7 Involving Stakeholders

44 CFR Requirement

Part 201.6(b)(2): The planning process shall include an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process.

A range of stakeholders, including neighboring communities, agencies, businesses, academia, nonprofits, hospitals, and other interested parties were invited and encouraged to participate in the development of the Hazard Mitigation Plan. Stakeholder involvement was encouraged through notifications and invitations to agencies or individuals to participate in Planning Committee meetings, the Mitigation Strategy Workshops and document review.

In addition to the Planning Committee meetings, the committee encouraged open and widespread participation in the mitigation planning process through the design and publication of advertisements that promoted the open public meetings. These media and social media advertisements and the PDC web page postings provided opportunities for local officials, residents, and businesses to offer input.

During the 2021/2022 update process, additional stakeholders were contacted and invited to participate in one of three ways: 1) attend and participate in Committee meetings; 2) attend and participate in the Public Meetings; and/or 3) review draft documents and provide comments and critique. The stakeholders identified as such in **Table 3.2** responded to a more formal request to serve as stakeholders and to participate in the planning process through one of the methods identified above. The additional stakeholders invited that did not choose to participate included:

- State agency representatives;
    - Virginia State Police
    - Virginia Coastal Zone Management Program
    - ChamberRVA
    - Soil & Water Conservation Districts
        - James River
        - Colonial
        - Hanover Caroline
        - Monacan
        - Henricopolis

- Representatives of local tribes;
    - Chickahominy Eastern Division Tribe
    - Rappahannock Tribe
    - Upper Mattaponi Tribe
- Neighboring jurisdictions;
    - Hampton Roads Planning District Commission (HRPDC)
- Representatives from colleges and universities in the region;
    - Virginia Institute of Marine Science
    - Virginia Commonwealth University (several students attended public meetings)
    - Richard Bland College
    - University of Richmond
    - Randolph Macon College
    - Virginia State University
    - Virginia Community College System
- National Weather Service, Wakefield;
- Non-profit organizations;
    - The Nature Conservancy
    - Capital Region Land Conservancy
- Representatives from utilities servicing the region;
    - Dominion Energy
- Social service providers in the region;
    - Central Virginia Healthcare Coalition
    - United Way
- Representatives from military bases in the region; and,
    - Fort Lee
    - Defense Supply Center

- Representatives from the medical community
    - HCA Healthcare
    - Central Virginia Health Services
- Other groups
    - Port of Virginia;
    - Virginia Hispanic Chamber of Commerce;
    - Virginia Asian Chamber of Commerce;
    - National Association for the Advancement of Colored People;
    - Greater Richmond Transit Company
    - Richmond City Schools
    - DuPont

4.0 Community Profile

4.1 Updates for 2022

Section 4 has been updated to reflect more current conditions. Tables and figures have been updated, as necessary, to reflect recent data and to modify discussion for Surry County, and the Towns of Claremont and Dendron, which are all now participating in the HRPDC hazard mitigation planning process. Census data from 2020 were incorporated, where possible.

4.1 Introduction

This Richmond-Crater study area encompasses approximately 3,728 square miles and is bordered generally by Fluvanna, Cumberland, Amelia, Nottoway, and Brunswick Counties to the west; Louisa, Spotsylvania, Caroline, King and Queen, and King William Counties, as well as the Pamunkey River to the north; James City, Newport News, Isle of Wight, Surry and Southampton Counties as well as the James and York Rivers to the east; and the State of North Carolina to the south.

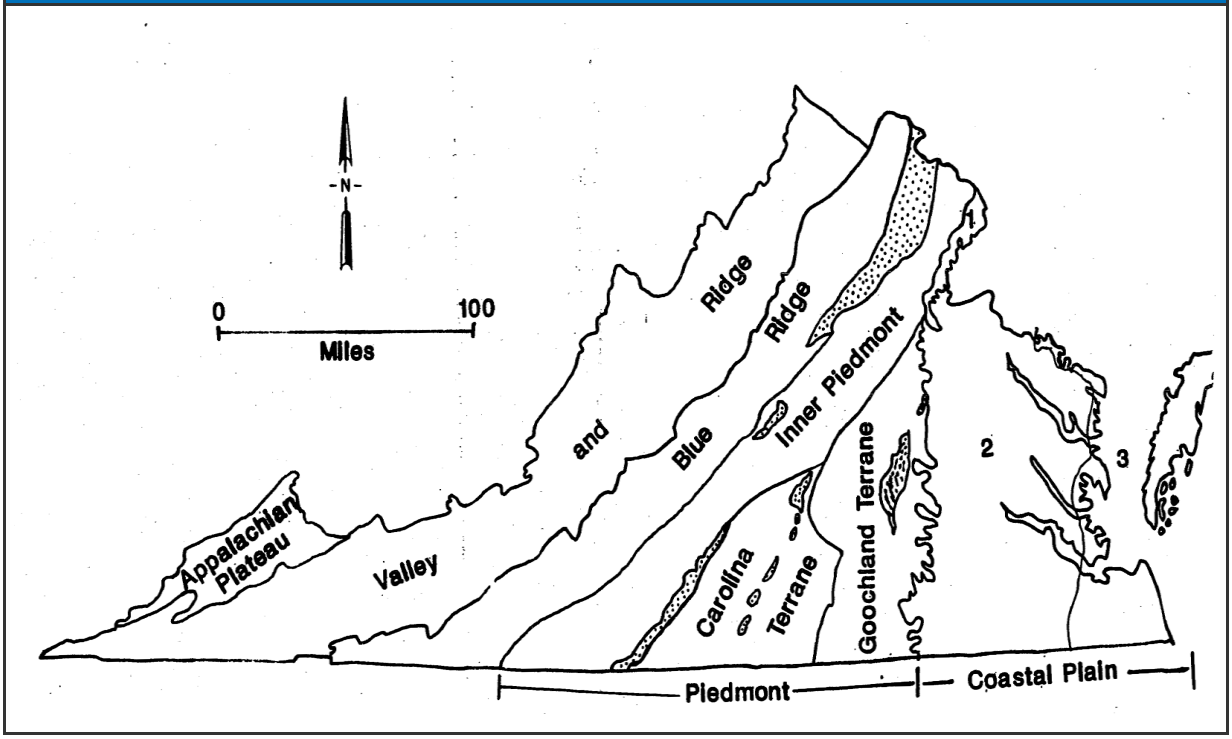
Based on total land mass, Dinwiddie County is the largest jurisdiction at 504 square miles. The Cities of Emporia and Colonial Heights are the smallest jurisdictions in the area at around seven square miles each (excluding the towns), while Charles City County is the smallest county at 182 square miles.

4.2 Physiography

The Richmond-Crater region is characterized by two distinct physiographic regions, the Southern Piedmont and the Atlantic Coastal Plain, as shown in **Figure 4.1**. The Fall Line serves as the dividing line between these two regions. The Southern Piedmont is characterized by deeply weathered, exposed bedrock and a rolling topography. The Fall Line is the easternmost extent of rock-filled river rapids, the point at which east-flowing rivers cross from the hard, igneous, and metamorphic rocks of the Piedmont to the relatively soft, unconsolidated strata of the flat Coastal Plain. The areas of the region in the Coastal Plain are gently dissected by streams but can be locally quite rugged where short, high-gradient streams have incised steep ravine systems.[1] The Cities of Richmond, Petersburg, and Emporia lie approximately at the Fall Line, which is where the James, Appomattox, and Meherrin Rivers, respectively, become unnavigable west of the Fall Line.[2]

[1] "The Natural Communities of Virginia: Classification of Ecological Community Groups (Version 2.4)," DCR, accessed July 18, 2011, http://www.dcr.virginia.gov/natural_heritage/ncintro.shtml.
[2] "Physiographic Regions of Virginia," Virginia Places, accessed July 18, 2011, http://www.virginiaplaces.org/regions/physio.html.

Figure 4.1: Physiographic/Geologic Provinces of Virginia



Source: U.S. EPA, undated

Land elevations in the Richmond-Crater region vary from mean sea level in the eastern, coastal counties to approximately 500 feet above sea level west of Richmond. Generally, the western portions of the region are at higher elevations.

4.3 Hydrology

As shown in **Figure 4.2**, rivers in Virginia drain to one of three main watersheds: the Chesapeake Bay, the North Carolina Sounds, and the Mississippi River. The Richmond-Crater study area lies within three major watersheds. The James and York, which flow into the Chesapeake Bay, and the Chowan, which flows south to the North Carolina Sounds.

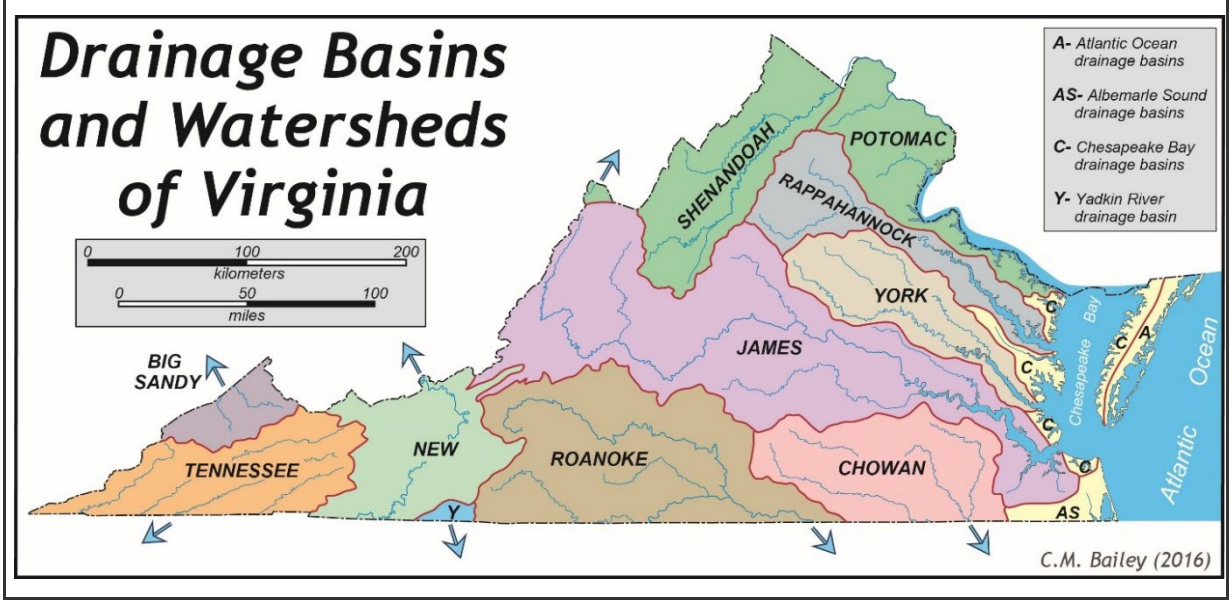
The James River watershed is the largest watershed in Virginia, spanning 10,236 square miles, including 39 counties and 19 cities and towns. The watershed covers approximately one-fourth of Virginia's area and is home to one-third of its people, who live largely along the I-64 corridor from Richmond to Hampton Roads. The watershed itself is fed by more than 25,000 miles of tributaries, but primarily the James, Appomattox, Maury, Jackson, and Rivanna Rivers. It is Virginia's largest tributary to the Chesapeake Bay.

The York River watershed covers a much smaller area, comprised of all or portions of 11 counties to the north and east of Richmond. It has a drainage basin of 2,669 square miles and is the only watershed located entirely within the Coastal Plain. Its main tributaries

are the York River, Pamunkey River, and Mattaponi River. It is one of the most studied watersheds in the country and is in relatively good health ecologically. The upper areas of the basin are buffered by freshwater marshes and lowland, hardwood swamps that help protect the surrounding area from the effects of severe weather and human activity. Downstream, saltwater marshes provide a similar service. However, rapid population growth and related construction over the past 20 years has increased the need for more intense land use planning.

The Chowan River basin spans 3,675 square miles and is comprised of the Nottaway River, Meherrin River, and the Blackwater River. These rivers flow southeast toward the North Carolina border and empty into Albemarle Sound, located mostly within North Carolina. The Albemarle-Pamlico Estuarine System is the second-largest estuarine system in the United States. The Virginia portion of the basin is the second largest in area of the three major Virginia watersheds, but the least populated.

Figure 4.2: Physiographic/Geologic Provinces of Virginia



Source: Accessed online at: http://geology.blogs.wm.edu/hydrology/, 2016

The James River flows through the City of Richmond. Numerous small streams flow through the city before discharging into the James. Many of these urban watersheds are contained entirely within city limits. Others originate in suburban areas surrounding the city. The floodplains of these smaller streams contain varied residential, commercial and industrial development. The floodplains of Broad Rock and Grindall Creeks above the Seaboard Coastline, and Powhite Creek above the Powhite Freeway are undeveloped.

Below Powhite Freeway, Powhite Creek parallels the road in an improved channel and the road takes up nearly all the remaining floodplain.

The Meherrin River flows in a southeastern direction through the center of the City of Emporia. The channel is relatively well defined, with overbank areas generally covered with varying amounts of vegetation and tree cover. Fall Run borders the corporate limits of the City of Emporia on the south.

The Appomattox River bisects the City of Petersburg and the City of Colonial Heights, about 20 miles south of Richmond, and approximately 6 miles above its confluence with the James River. The natural development of Petersburg began at the Appomattox River and progressed southward. This progression resulted in heavy industrial and commercial development along the flood plains of the Appomattox River and the lower reaches of the smaller streams penetrating the city. Beyond the highly developed core and along the small streams to the south, there is a mixture of industrial, commercial, and residential development. The Appomattox River forms the southern and eastern boundary of Colonial Heights. Swift Creek, a tributary to the Appomattox River, forms the northern boundary of the city. Swift Creek's watershed is generally rectangular in shape and measures approximately 30 miles long and 9 miles wide at its broadest points. It has a drainage area of approximately 184 square miles. Old Town Creek flows east to the Appomattox River. The creek's narrow watershed is approximately 7.5 miles long and has a drainage area of approximately 13.5 square miles.

The City of Hopewell is located just south of the confluence of the Appomattox and James Rivers. The City's location in the Coastal Plain is typified by its low relief. The land is generally level, but some streams are short in length with steep gradients. Sandy soil and clay subsoil are predominant, where much of the soil has been formed from rock fragments washed down from the Piedmont region. Cabin Creek drains a large portion of the western end of the City, flowing south to north into the Appomattox River. One of the main tributaries of cabin Creek is Bullhill Run. Bailey Creek drains the southern portion of Hopewell and flows west to east along the southern corporate limits before emptying into the James River. Cattail Creek drains the central portions of Hopewell.

Additional rivers in the region include the Blackwater River, Chickahominy River, and the North Anna River. The Blackwater originates in Prince George County as a coastal plain swamp, then meanders east into Surry County. The Chickahominy begins about 15 miles east of Richmond, then continues east for 87 miles. It marks the eastern border of Charles City County. The North Anna River originates in Lake Anna and flows southeast through central Virginia for 62 miles. It is a major tributary to the Pamunkey River.

There are also several large creeks that run through the region. Stony Creek, formed by the merging of White Oak Creek and Butterwood Creek in Dinwiddie County, passes through the center of the Town of Stony Creek. Twenty-one miles in length, it is a tributary of the Nottaway River.

According to the DCR natural heritage inventory, there are at least seven important ecological community groups in the Richmond-Crater study area that are interrelated with the water resources of the region:

- Pine/Scrub Oak Sandhills
- Fluvial Terrace Woodlands
- Bald Cypress – Tupelo Swamps
- Coastal Plain/Piedmont Swamp Forests;
- Coastal Plain/Piedmont Floodplain Forests;
- Tidal Bald Cypress Forests and Woodlands; and,
- Tidal Freshwater and Oligohaline Aquatic Beds

The Virginia Scenic Rivers program, administered by DCR, identifies, recognizes and provides limited protection to rivers whose scenic beauty, historic importance, recreation value, and natural characteristics make them resources of particular importance. Reaches of the Blackwater, lower James, and Nottoway Rivers are all designated scenic rivers through the program, although the part of the Blackwater River that is designated scenic is outside the study area. Similarly, the Nationwide Rivers Inventory is a register of river segments that possess unique, rare or exemplary features that are significant at a comparative regional or national scale. Segments of the Blackwater, Chickahominy, James, Northwest, Nottoway, Ware, Yarmouth, and York Rivers are designated on the Nationwide Rivers Inventory for various reasons.

4.4 Climate

The present-day climate of Virginia is generally classified as humid subtropical, but within-state variation of temperature, precipitation, and length of growing season is dramatic. Average temperatures in the region are about 76 degrees Fahrenheit in the summer and 39 degrees in the winter. Average annual rainfall is around 43 inches, spread fairly evenly throughout the year. Average snowfall ranges from 12 to 17 inches annually, with highest amounts recorded in January and February. Additional discussion of weather extremes, including winter storms, are included in Section 5.

4.5 Land Use and Development Trends

The jurisdictions in the Richmond-Crater region vary dramatically from primarily rural to urban, sometimes within the same jurisdiction. While the Cities of Colonial Heights, Emporia, Hopewell, Petersburg, and Richmond have typical urban/suburban development patterns, most of the counties are rural in character. Charles City, Dinwiddie, Goochland, Greensville, Hanover, New Kent, Powhatan, Prince George, Surry and Sussex Counties are mainly rural with some pocketed areas of suburban development. Approximately 22% of Hanover County is Suburban Service Area and the planned region for about 70% of the county's expected residential growth; the remaining 78% of the county is rural.

Chesterfield and Henrico Counties and the City of Richmond are more suburban and urban in character.

In Virginia, the authority for land use planning and land use regulations resides at the local level. As required by the Code of Virginia, all jurisdictions in the Richmond-Crater region maintain local Comprehensive Plans that include a land use element and manage land development through zoning and subdivision regulatory ordinances.

In addition to local authority, state and regional programs and processes encourage regional coordination when planning for land use, transportation, economic and environmental matters. For example, the urbanized area of the Richmond-Crater region constitutes two regional transportation planning organizations for federal programs: the Richmond Regional Transportation Planning Organization and the Tri-Cities Metropolitan Planning Organization. As required by federal code, these organizations regularly update a long range regional transportation plan that includes population, housing, and employment projections in the urbanized area and considers land use trends. Most of the population in the Richmond-Crater region lives within the urbanized area, which is expected to continue. The Richmond and Crater regions also have Comprehensive Economic Development Strategies (CEDS). Analysis of population and employment data are foundational to the development of the CEDS, as well as their annual updates over successive years.

4.5.1 Charles City County

Charles City County is a rural community located between the more urban areas of Richmond and Williamsburg-Newport News metropolitan areas. The county has a wealth of historic homes and other sites reflecting its pre-European settlement history and more than 400 years of post-European settlement. The county is heavily forested with small residential communities scattered throughout. As of 2014, about 80% of the county was used for agricultural or forestry purposes or was otherwise in a natural state.[3] Development tends to be clustered at road intersections or along the James and Chickahominy Rivers. Much of the undeveloped land is in large tracts under single ownership.

The county is divided into three magisterial districts. Almost half of the population is concentrated in the Harrison District that covers the western portion of the county. Most of the commercial and industrial development is also located in the western part of the county. About one-third of the population lives in the central portion of the county, in the Tyler District. The remaining population is in the Chickahominy District.

Most of the housing stock in Charles City County is single-family homes. Given trends in surrounding areas and the rapid increase in the cost of stick-built homes, it is likely the number of manufactured homes in Charles City County will continue to increase.

[3] "Forest Inventory Data Retrieval (2002-2007)," Virginia Department of Forestry, August 26, 2009, http://www.dof.virginia.gov/resinfo/FIA_2007_StandardTables.htm.

Forests cover approximately 73% of the County's land area. The majority of the forests, about 75%, is owned by private landowners. In 2007, accessible forest area accounted for 67% of the total available land.[6] Land used for rural residential and public/semi-public uses accounted for the difference.

A Dominion Energy substation provides electricity to the county, located on Chambers Road off Roxbury Road (Route 106). Two power substations provide electricity to the county. Efforts are underway to ensure that the courthouse and municipal complex are on both grids.

Charles City County seeks to preserve its rural character by establishing development controls which direct growth to neighborhood residential areas within centralized development centers. This marks a break from the historical growth pattern, which encouraged sprawl and consumed agriculture and farm lands. New controls are expected to relieve the pressure on agriculture and forest lands, leading to more orderly and attractive development patterns and allowing for efficient use of tax dollars. Transportation growth is anticipated to become focused due to this new policy of directing growth within development centers.

Commercial development is very low in Charles City County when compared to neighboring localities. Commercial land within Charles City County typically consists of country stores with gas pumps, antique shops, garages, greenhouses, banks, marinas, and retail and professional services. Charles City County encourages commercial growth, primarily in the development centers.

Light and heavy industrial growth is expected to continue, given the continued expansion of Ft. Lee in Prince George County. The fort's mission is focused on military supply, subsistence, transportation, maintenance, and munitions. In 2015, Ft. Lee became the US Army's third-largest training site after completing a ten-year expansion period. More recently, it was made the temporary home of approximately 2,500 Afghan refugees, primarily interpreters and their families. It can be reasonably assumed that a portion of these families will choose to make the area their permanent home, meaning that residential growth will continue to expand, as well.

Contrary to earlier projections, the population in Charles City County shrank 6.66% between 2010 and 2020, contracting from 7259 people to 6773 according to the US Census. It had previously been expected to increase by approximately seven percent. According to the Weldon Cooper Center for Public Service, the County's population is expected to increase slightly to 6941 in 2030 before declining to 6816 in 2040, thus remaining almost completely flat for the next 20 years. For comparison, Virginia's population grew 7.9% over the past decade, increasing from 8 million to 8.63 million people. Projections for Virginia's growth rates over the next two decades will be released by the Weldon Cooper Center in 2022.

The Charles City County Planning Commission expects a population increase of 819 people, or 11.9%, by 2040, based on four different projection scenarios. This will require the

construction of approximately 350 additional housing units at a rate of 17-18 per year but will otherwise have only minimal impact on the area. Commercial and industrial growth is expected to increase but only moderately.[4]

4.5.2 Chesterfield County

Chesterfield County, which arcs below the south side of Richmond, has been split into numerous small areas for planning purposes and the development pattern varies immensely between these areas. Portions of the county are built out at suburban densities while other portions of the county remain undeveloped and rural. For instance, the western part of the Southern and Western Planning Area is designated as "rural conservation," meaning that uses should be restricted to large-lot residential, forestry, or agriculture. Closer to the City of Richmond, however, the development intensity increases. In this area, the Midlothian Turnpike corridor continues to be one of the county's prime locations for planned light industrial, commercial, and office uses.

Leapfrog development has characterized the Central Area, creating a disjointed development pattern. The types of development in the Central Area have included single-family subdivisions, scattered multi-family complexes, and small- to medium-sized shopping areas often along highway corridors, large employment centers, industrial parks, and an airport. This area is experiencing rapid growth, particularly west of U.S. Route 10.

Significant commercial and industrial development has occurred in the Eastern Area in recent years, and this trend is expected to continue. The Eastern Area also has a great deal of residential development, often adjacent to older commercial-strip zoning and uses. This pattern is particularly seen along U.S. Route 10.

A dominant theme of the county's comprehensive plan is a commitment to maintain a strong and growing economic base in Chesterfield County. New and existing business and industrial development provides diverse employment opportunities and revenue, and is vitally important in providing the types of services that promote a high quality of life in the county.

Since the 19th century, development patterns have been greatly influenced by the changing transportation and public utilities networks. Traditionally, the economic development base consisted primarily of large manufacturing and chemical industries. Today, the economic base has been enhanced by development of a variety of commercial and corporate office uses providing a range of services and employment opportunities for the county and region. In 2017, there were 136,000 jobs within the county, an increase of 20% over the number of jobs in 2010. PlanRVA projects that Chesterfield County will have approximately 166,000 jobs by 2035, an increase of 47 percent over 2010.

Chesterfield County is a community committed to promoting and maintaining a high quality of life for all residents and employers. As such, it is important that the county's

[4] Charles City County web site, accessed online at: http://charlescitycountyva.info/AgendaCenter/ViewFile/Agenda/_02272020-325

neighborhoods and business corridors be maintained in the highest quality possible and stabilized to ensure continued vitality. The public sector's role for ensuring long term stability and supporting a high quality of life is to provide equitable distribution and efficient allocation of public resources. Provision of equitable public services will promote private investment and reinvestment in aging and maturing areas.

Between 2010 and 2020, the County's population increased just over 15% to 364,548 people. This is a slower rate of growth than the County experienced between 2000 and 2010 when the population increased by 22%. Still, the total recorded in the census was nearly 10,000 more than the County had been projecting. Residents under the age of 14 constituted the largest segment of the population while residents over the age of 65 made up the fastest growing segment and those 55 and older the second largest. In coming years, a slowing birthrate is expected to keep the youth population stable while the population of older residents will continue to grow. The County is becoming more racially and ethnically diverse and approximately 12% of households speak a language other than English at home. Of those who speak English "less than 'very well'," the vast majority are Spanish-speakers.

Chesterfield County boasts a population that is better-educated and better paid than others in the region and the average population of Virginia. Lastly, the size of the average household has increased slightly over the past decade to 2.74 members.[5]

4.5.3 City of Colonial Heights

Colonial Heights is located at the Fall Line, or where the Coastal Plain meets the Piedmont. The city shows a linear development pattern along U.S. Route 1. The City is almost completely developed, with very few options for new building other than scattered infill possibilities. More land is devoted to residential purposes than any other use, with single-family detached homes representing the norm. There is some multi-family housing, including duplexes, townhomes, and apartment buildings. The 500 new housing units built since 2000 are primarily two, new multi-family units. The city recognizes that there is a need for increased housing suitable for its growing population of senior residents and for younger, single people if it wants to attract new residents, and is considering the feasibility of mixed-use property, particularly near the Southpark Mall Regional Shopping Center.

The city's comprehensive plan indicates that most commercial property is located along major transportation corridors, specifically The Boulevard (US Route 1/301), Temple and Ellerslie Avenues, and at the Southpark Mall. Industrial properties are primarily located in specific segments of West Roslyn Road, on Ellerslie Avenue, and on Charles Dimmock Parkway, although most of these properties are really for more intense commercial use than traditional industrial properties like factories.

Institutional properties, mostly churches and buildings owned by civic organizations, are scattered throughout Colonial Heights, as are parks and public schools. About 29% (1,625

[5] Chesterfield County Demographic Report, accessed online at: https://www.chesterfield.gov/DocumentCenter/View/20197/Chesterfield-County-Demographic-Report-2020,

acres) of the city is not developed, but the majority of the undeveloped land (983 acres) is unbuildable because of site constraints such as the presence of wetlands, floodplains, or steep slopes.

Land use patterns are generally well-established in Colonial Heights, and there is minimal need for significant land use change. The city has existing plans for development and revitalization of particular areas of Colonial Heights, while taking care to protect the elements that make living in the city desirable. These plans currently extend to 2044.

There is minimal need for additional public facilities; however, there may be need for additional public parks and open spaces in specific sections of the city that are currently underserved. Where possible, Colonial Heights will incorporate transitional land uses between higher activity uses, such as commercial, to lower activity uses such as single-family neighborhoods with less intense commercial or higher density residential uses, and create a mixture of recreational, commercial and residential uses along the river as recommended in the Appomattox River Corridor Plan.

The most significant growth period for the city was between 1950 and 1960. This was due, in part, to the 1954 and 1957 annexations. The city continued to grow at a relatively fast pace until the 1980s when the population stabilized. Between 2010 and 2020, the population of Colonial Heights increased from 17,411 to 18,170 and is expected to continue to increase slightly through 2040.

The city is also expected to become more racially diverse over this time period. According to Data USA, in 2019 there were nearly five times more whites than people of any other ethnicity in Colonial Heights. Blacks made up 14.6% of the population, Asians 4.15%, and Hispanics 5.87%. Approximately 7.32% of the city's population is foreign-born. According to the Weldon Cooper Center, the number of Black people in Colonial Heights is expected to decrease over the next two decades while the percentage of Asians is expected to increase. The number of Hispanics is expected to remain essentially flat. The white population is expected to decrease.

According to the Virginia Employment Commission, there were 8,363 people employed in the City of Colonial Heights as of June 2020. Retail is the largest industry with 27% of workers, followed by health care-related and food service/hospitality, both with 17% of workers. Local, State, and Federal Government employment combined equals approximately 15% of the workforce[6].

4.5.4 Dinwiddie County

Dinwiddie County, like many of the jurisdictions in the Crater Planning District, is divided by the Fall Zone into two physiographic provinces, the Piedmont to the west and the Coastal Plain to the east. Approximately three-fourths of the county is located in the Piedmont Plain. The major rivers that flow through this area, the Appomattox and Nottoway, occupy narrow floodplains with only minor meandering. These rivers divide the

[6] Virginia Employment Commission, Economic Information & Analytics, Quarterly Census of Employment and Wages, 2nd Quarter [April, May June], 2020

County into two unequal portions, with the Appomattox River Basin defining the northern 16% of the county and the Nottaway River Basin the southern 83%. The Appomattox River drains into the James River Basin and the Nottoway into the Chowan River Basin. The eastern portion of the county in the Coastal Plain tends to be flat and swampy, which deters development.

The county has grown in three distinct areas. The first area is along major highways such as River Road, U.S. Route 1, and U.S. Route 460. Such development occurs individually or in small strips. Clusters of development are also located in the fringe parts of the Town of McKenney and existing villages and crossroads such as Dinwiddie Courthouse and Sutherland areas. Finally, as the City of Petersburg has expanded, development has begun to cluster in its outskirts in the northeastern part of the county. Approximately 40% of county residents live in this portion of the county. It is also one of the areas where public utilities are available. Residential development patterns include single-family and duplex units, apartment complexes, and manufactured housing parks.

In Dinwiddie County, commercial development tends to occur near residential development. Most of the commercial establishments are located in the northeastern section of the county, a few businesses are located in the Courthouse area, and travel service facilities such as gasoline stations, motels, and restaurants are located mainly along U.S. Routes 1 and 460. The county has an industrial park at the municipal airport. There is also some industrial presence in the Town of McKenney.

Most of the open space land in Dinwiddie County is under the ownership of timber companies. It is estimated that 244,049 acres of land, or 73% of the county's land area, are in some sort of timber production. The timber stands are mainly located in the western half of the county.

Future growth will be centered in the urban Northeastern Area of the county and scattered throughout the rest of the county. There is concern that farmers will find it difficult to continue using their land for agricultural purposes as development increases.

According to the Bureau of the Census, the increase for Dinwiddie County during the decade of 2000 to 2010 was about 14.2% or 3,468 persons. From 2010 to 2020, the population dropped slightly, from 28,001 to 27,947, which contravened the Virginia Employment Commission projection of 5.5% growth. Approximately 62% of County residents were white alone (not Hispanic or Latino), just over 32% were Black, almost 4% were Hispanic or Latino, and the remainder were multi-racial or Asian. The Virginia Employment Commission projects population growth between 2020 and 2030 of 3.3% and an additional 2.49% by 2040.

4.5.5 City of Emporia

The City of Emporia is located approximately 65 miles south of Richmond, 10 miles north of the North Carolina border, in the center of Greensville County. The Meherrin River runs from west to east through the center of town. Like several other cities in Virginia, Emporia is located at the Fall Line, with the western side of the city in the Piedmont and the eastern

part in the Coastal Plain. The Meherrin River flows to the southeast and eventually drains into the Chowan River Basin.

Thanks to its location, Emporia has always been a trade center. Originally, there were two towns – Hicksford, founded in 1796 on the south bank, and Belfield, founded in 1798 on the north bank. Following the establishment of the Atlantic and Danville Railroad in the 1870s, the railroad's president (and local General Assembly representative) Sam Tillar convinced the Assembly to approve a merger of the two towns in 1887 and renamed it Emporia. Today, Emporia is a crossroads for cars and trucks traveling on I-95 and Route 58, with much of the city's commercial activity located near the intersection of the two highways and most recent development located to the immediate northwest of it.

In addition to providing travel services for drivers, Emporia is the county seat. The primary use of land within the city limits is residential, with mostly single-family detached homes, some multi-family developments and a few trailer parks. Most of the higher-density units are found in the northeastern part of the city while most of the newer residential developments are single-family homes on larger lots scattered around the periphery of the town. There has also been some construction of single-family homes on infill properties in the older parts of town.

Industrial use is the second most common land use in Emporia. These developments tend to be concentrated near major transportation routes, such as adjacent to railroad tracks and near the Meherrin River Dam. There are three main retail areas. One is north of the river and is made up of a part of the central business district and the Emporia Shopping Center. The second is south of the river and is comprised of the other part of the central business district and the area near the courthouse. The third area is at the intersection of I-95 and U.S. Route 58, which is the site of a large shopping center.

The Emporia comprehensive plan states that demand for development will continue along its traditional pattern. Single-family homes will continue to be in demand as will auto-oriented commercial uses. The plan notes a focus on downtown revitalization and a desire to discourage rampant strip development.

As of 2014, 44.2% of the land (1897 acres) within the city limits was vacant or underdeveloped, a drop from 52.6% in 2007 About a quarter of this land has site constraints such as floodplains or steep slopes that prevent it from being developed. Of the remaining area, vacant land was mostly concentrated in two places: around Route 58 and East Atlantic Avenue on the eastern edge of the city and the area extending north from Route 58 to the northern boundary of the city. New construction will have to be built in those locations or on limited infill property.

According to the latest census, the population of Emporia dropped from 5,927 in 2010 to 5,766 in 2020, contravening the Weldon Cooper Center's 2017 projection of an increase to 6,214. The Center projected a population of 6,447 in 2030 and 6,586 in 2040 but will likely revise these figures downward in the future to reflect the reality of the 2020 census results. The existing population of Emporia is aging, which will likely increase the demand for one-

level houses, independent living communities, assisted living centers, and full-service retirement homes with nursing and medical facilities. A growing elderly population will also create demand for specialized types of health care, social, and human services. In addition, both families and seniors benefit from access to parks and recreational opportunities.

Heavily-traveled corridor growth has fueled strip development along Route 58 and Market Drive. These developments have negatively affected Emporia's traditional commercial centers in the downtown areas. However, the growth of regional retail and travel services also benefit the city. Many people traveling along I-95 view Emporia as a destination city and one which is able to provide goods and services required by travelers.

Over the next twenty years, industrial growth will continue to play an important role in shaping Emporia's future. This will be particularly true of the city's surrounding environs, where larger, more favorable sites for industry are generally located. Although Emporia enjoys a diverse economy, growth prospects for the surrounding area will hinge on the community's ability to retain and attract industry.

4.5.6 Goochland County

Goochland is located approximately 30 miles west of downtown Richmond, 45 miles east of Charlottesville, and 105 miles south of Washington, D.C. It is squarely in the Piedmont Province of Virginia with the James River serving as the county's southern boundary for more than 40 miles. Goochland County is still mostly rural with land that is well-suited to its agriculture and forestry operations.

Development has been deliberately concentrated in the eastern part of the county closest to the Richmond metropolitan area. Development pressure from the western Richmond suburbs has led to the County's creation of a development plan showing a strong commitment to preserving the open space, rural nature, and agricultural and forest lands of the county while allowing the growth of residential and commercial areas in the eastern portion.

Since the 1970s, Goochland County has been using zoning and the comprehensive plan to implement the village concept. These land use tools have been shaping development that supports the county's goals of preserving open space and retaining rural character while directing new development toward established villages. Goochland's Land Use Plan divides population centers into Major Villages and Rural Crossroads. Population growth is directed toward the Major Villages where County services (water, sewer, electricity, etc.) are already established and can be expanded when needed with the least amount of difficulty and expense. Rural Crossroads are meant to provide necessary goods and services to the surrounding area but where population growth is not encouraged to protect the rural nature of the area.

While the population was expected to grow 4.77% between 2010 and 2020, it actually grew 13.86% and is projected to grow another 5.87% by 2030 and another 11.43% by 2040, according to the Weldon Cooper Center projections of 2017. The county attributes its

attractiveness to its strong school system, rural atmosphere, and proximity to the amenities and businesses located in western Henrico County. In addition, pandemic-related shifts in where people live and work may make Goochland County a more attractive option to those who no longer need to be physically close to their jobs.

The county's comprehensive plan defines its goal of balanced development as:

- High quality commercial, industrial, and employment hubs
- Vibrant, healthy villages that respect the character of each community
- High quality residential development that is compatible with adjacent land uses
- Preserved natural, cultural, and historic resources
- Viable agricultural and forestry resources that are important components of the local economy

The county also has recently completed a Major Thoroughfare Plan Update that lays out plans for the development of the road network to support and complement the expected land development through 2040. The plan examines the assets and needs of multiple forms of transportation (car, bicycle, etc.) and serves as a living document that can be modified over the years to keep pace with both the county's plans and any modifications that may be necessary.

Goochland's location in the central Piedmont region with the James River on the southern border, away from most developed areas, makes it less subject to hazards related to weather and water. The James River has three watershed regions – the upper, middle, and lower. Goochland County lies in the Middle James River region. Most of Goochland County is drained by the James River and its tributaries, but eastern portions of the county are drained by Tuckahoe, Dover, and Genito Creeks. This area is mostly agricultural, with a few low-density subdivisions. Central Goochland County is drained by the Beaverdam Creek/Courthouse Creek watershed and the James River/Mohawk Creek watershed. This area also mostly agricultural with low-density residential housing, but with higher density in the Goochland Courthouse area. Finally, the western portion of the County is drained by Byrd, Little Lickinghole, and Big Lickinghole Creeks. The land use there is almost entirely agricultural or forest lands with very few residential units. The watersheds are of particular interest in this County, as approximately 87% of households rely on wells for drinking water and the quality of the groundwater is a major consideration where development is being considered.

4.5.7 Greensville County

Rolling hills give way to flat land midway through Greensville County, which is bisected by the Fall Line and I-95. Like many other counties in the Richmond-Crater area, Greensville's highest elevations lie in the west and slope downward to the southeast. This topography has a strong influence on development patterns in the county, as the location, size, and prevalence of slopes, drainage patterns, wetlands, floodplains, soil types, and land cover dictate where and how development can occur.

The land cover of Greensville is 54.5% forest, 14.1% wetlands, and 12.6% active croplands. An additional 8.6% of the land is harvested forest/disturbed land. The County is further defined by its network of rivers, creeks, ponds, small lakes, and swamps, with the Meherrin and Nottoway Rivers comprising the main surface waters. The Nottoway serves as the county's northern border, while the Meherrin River flows through the middle of the county from west to east. Both rivers drain into the Chowan River system.

The county's 2020 population of 11,399 represents a drop of 7.5% from 2010. The highest concentration of people in the region is found in the City of Emporia, located in the center of the County. The next-largest town is Jarratt, which has 554 residents. There is some residential development scattered along the primary roads and highways in the county. Approximately 59.4% of the population is Black, 37.7 % is white, and 2.5% is of Hispanic or Latino heritage. The population of the county is projected to remain flat through 2040, though steadily increasing in median age. The demographic profile of the county is skewed by the inclusion of Greensville Correctional Center, which houses 3,123 institutionalized adult men. That number accounts for 27.1% of the county population.

Single-family detached homes dominate the housing stock, with very few multi-family units. Mobile homes account for more than 20% of single-family housing. The supply of affordable housing is a major concern of residents.

Other concerns include the lack of job opportunities, the quality of local education and school buildings, the lack of population growth, and the lack of internet and broadband. These issues present challenges to the improvement of the school system and the growth of business and commercial opportunities.

Residents treasure their rural character and open space, the sense of community in Greensville, and the natural environment. The area's strength as a transportation crossroads is recognized as a valuable asset, along with its manufacturing economy and an industrial mega site in the county. Greensville's proximity to Richmond, Hampton Roads, and Raleigh – all within 80 miles of the county – is also an asset. Because of the importance of transportation infrastructure, the need to invest in road maintenance and public transportation is widely supported.

Future growth will be shaped by the county's priorities, physical topography, financial resources, as well as the county's commitment to remaining primarily rural. Growth areas are expected in the Emporia fringe area and along the I-95/U.S. Route 301 corridor. In recent years, Greensville County has made significant investments in housing, economic development, and infrastructure. The county's next priority is to refocus their efforts on some of the issues of greatest concern to its residents, as described above.

4.5.8 Hanover County and the Town of Ashland

Hanover County is the northernmost county in the Richmond-Crater region, located immediately north of Henrico County and includes the northern edge of the Richmond Metropolitan Area. Although most of the county's population lives in the southern portion that lies closest to Richmond, much of the county is rural. County policies have been shaped

around the goal of retaining the rural and agricultural nature of Hanover County while accommodating the needs of the ever-growing population.

Population growth is one of the biggest issues – possibly the biggest issue – faced by Hanover County in recent decades. Since the 1990s, the county has seen steady population growth of 1% or more each year. In 2010, the county's population was 99,863, in 2020 it was 109,979. For planning purposes, the county assumes a growth rate of 1.5% annually. To preserve the rural nature of the county, planners have deliberately directed approximately 70% of development into the Suburban Service area around I-95 that serves as the major commuter route between Hanover and Richmond. The remainder of county land is categorized according to its primary use(s), and each type of land use has guidelines for development and restrictions on density to ensure that growth proceeds in an orderly and efficient fashion that will not overtax county resources or significantly change the primarily rural and agricultural feel of the county.

These categories are: Rural Areas (open land, wetlands, wildlife habitats, and forests), with the subcategories of Agricultural Land Use (farms and farmed forests, low-density residential), Rural Villages (small towns) and Rural Commercial Node Land Use (mostly road intersections with commercial services for the local community); the Suburban Service Area near Richmond, which includes several subcategories for residential, commercial, industrial, and recreational uses; Commercial Land Use that can be located anywhere in the county; Destination Commerce Land (businesses that serve an entire region and are unique in character); Planned Business Land Use (office and industrial parks); and several subcategories that are industrial in nature. Each category has its own strategies and goals for usage that, combined, meet the county's overall strategic goals for shaping where and how growth takes place.

Like other counties in the Richmond-Crater district, the Fall Line divides the land between the Piedmont and the Coastal Plains. The highest elevation in the county lies in the west at approximately 370 feet and drops gradually to the east until it reaches sea level. Most of the county is located within the York River watershed but the southernmost part falls within the James River watershed. Hanover County is located within three primary sub-watersheds: the Pamunkey, the Middle James, and the Lower James. Most of the steep slopes of the county are found along rivers and streams. Around the Fall Line, the banks of several rivers, particularly the South Anna River, have fairly steep bluffs characterized by exposed rock. Further to the east, there are some steep slopes along the tributaries that flow into the Pamunkey River.

The Town of Ashland is located in the heart of Hanover County. Established in 1858, the early growth of the town was fueled by the railroad. In more recent times, Randolph-Macon College and I-95 have influenced the town's development. The town is approximately 7 square miles. Ashland is largely developed, so emphasis is placed on community stabilization and preservation. Although the area to the north and west of Ashland has been under consideration for further development, no plans have yet been made.

4.5.9 Henrico County

Henrico County forms a rough semicircle around the northern portion of Richmond, and much of the land closest to the city is urban or suburban. The county is a major transportation hub, hosting Richmond International Airport, an Amtrak station, and portions of I-95, I-295, I-64, and Route 895. The county has seen steady increases in both population and new businesses, gradually increasing the amount of land used for residential and commercial purposes. Over the last three decades, much of the county has gone from rural to suburban or commercial, which has brought both challenges and benefits. Henrico County has responded by creating a detailed comprehensive plan outlining guidelines and strategies for the county's growth through 2026.

While the largest category of land use is described as "vacant," this is misleading as a lot of this land is actually used for agricultural purposes. Additionally, some of this land cannot be developed because it lies in a floodplain, contains wetlands, or is otherwise undevelopable. The second-largest category is single-family residential, occupying a quarter of the county's land area. Other categories occupy considerably less area, including public and semi-public land, commercial property, and industrial purposes. Approximately 3% of the County is occupied by water, including the James and Chickahominy Rivers and Tuckahoe Creek.

The population of Henrico increased nearly 9% between 2010 and 2020, growing from 306,935 to 334,389. This is significantly lower than the Weldon Cooper Center's projection of 352,577 for 2020. Projections for 2030 and 2040 are 400,396 and 450,630, respectively. Although previous trends were consistent with an annual 2% growth rate, the county has now adopted a scenario that uses a declining growth rate over the subsequent planning period.

The planning department expects that demand for retail, residential, and office space will be concentrated in the western portion of the county while industrial demand will be primarily in the eastern portion, but significant residential development continues in the eastern portion of the county. During this plan update, Henrico County began the process of updating its Comprehensive Plan. The new Comprehensive Plan will provide the framework for how the county will grow and develop through 2045 and will be incorporated into future iterations of this plan.

4.5.10 City of Hopewell

The City of Hopewell is located 18 miles southeast of Richmond at the confluence of the James and Appomattox Rivers. Hopewell was founded more than 400 years ago and is the second oldest continually inhabited English settlement after Hampton. It is known for its historic buildings and architecture, although much of the city was destroyed by fire in 1915. Unfortunate urban renewal projects in the 1960s did further damage to the city's character, although recent projects have begun a turnaround. Most significantly, an attractive Riverwalk was completed in 2019.

The city occupies approximately 11.3 square miles and is comprised of an industrial sector, regional commercial properties, and several compact urban neighborhoods. Approximately

80% of Hopewell's working population commutes outside of the city for work, mostly to Richmond. The proximity of the capital is a major influence on Hopewell, providing employment, shopping and services not found locally.

Hopewell's population began steadily declining in 1980, then increased slightly in 2010 and again in 2020 when the population reached 23,033. The Weldon Cooper Center projects the population to increase at a rate of about 1,000 people (4.8%) every ten years through 2040

The Appomattox River serves as the city's northern border and the James River serves as most of the eastern border. Neighboring counties are Chesterfield to the north, Charles City to the northeast, and Prince George to the east, south, and west.

The City of Hopewell falls entirely within the Coastal Plain (close to the western edge of the province) and the area governed by the Chesapeake Bay Preservation Act. The steepest slopes in the county can be found along the James and Appomattox Rivers.

Residential properties dominate the land use pattern of the city. Single-family homes are the main housing type, though there are some multi-family units such as apartments, townhomes, and condominiums. Much of the housing was built in the 1900s for workers. Five large subdivisions have been built since 2000.

Industrial uses are found in the northeastern part of the city along the James River and Bailey Creek. The vacant industrial land is owned by existing businesses and is reserved for their future growth. According to the comprehensive plan, a large part of the industrial development is in the floodplain.

The amount of vacant land in the city is not enough to meet future demands for growth. Infill development and redevelopment of existing parcels will have to be pursued. As of 2010, there was limited vacant land available at the new I-295 interchange for commercial development. One goal of the city is to promote industrial development through a commercial business park, but available land is limited. Significant residential structures are being converted to business uses in core village areas. Most residential "development" is infill.

In comparison to peer communities, Hopewell's economic and demographic metrics show room for improvement. The income for city residents is substantially below Virginia's average and the rate of new employment is static. A disproportionate number of city residents (8,300+) are out-commuters for employment. The in-commuter city workforce (6,700+) spends little non-work time and money in the city. Unemployment rates are high. The marketplace for goods and services is severely underperforming.

4.5.11 New Kent County

Rural land uses have long dominated New Kent County's landscape but the last decade has seen significant change and growth. After the 2020 Census was completed, New Kent was seen as the fastest growing county in Virginia after Loudoun County in northern Virginia, jumping from 18,429 people in 2010 to 22,945 in 2020 – an increase of 24.5%. The arrival of more than 4,400 new residents in one decade is attributed primarily to New Kent's appeal

as an attractive location with a high quality of life and home prices that compare favorably to other counties in the greater Richmond area. Like Loudoun, New Kent County is a desirable exurb.

New Kent County is located in the northeast corner of the Richmond-Crater district. Hanover and Henrico counties lie to the west and Charles City County to the south. The county is located well east of the Fall Line in the Coastal Plain.

Although the county is still predominantly rural, with population clusters scattered along rural roads, New Kent County also has clusters of subdivisions of various kinds, with most of them concentrated in the western third of the county closest to Richmond. This is the area currently experiencing the highest levels of growth. However, there are also population clusters located in the eastern third, particularly around Lanexa and the Diascund Creek Reservoir, where commuting to jobs in Williamsburg is feasible.

Commercial centers are located at Bottoms Bridge, Providence Forge, and Eltham, all of which are complemented by nearby residences. There are smaller clusters of residential and commercial development at Lanexa, Barhamsville, and Quinton. New Kent Courthouse has few commercial uses but is a center for government and institutional uses with residences interspersed and nearby. Perhaps the most significant area of commercial growth in recent years is at the old Colonial Downs racetrack where Rosie's Gaming Emporium opened in 2021. Lastly, several golf course residential communities and vineyards have proven attractive to residential development and have brought festival events to the county. The 2012 comprehensive plan called for concentrating future development in mixed-use village centers. The exception was industrial uses, which should take advantage of the large amount of vacant property along I-64 and U.S. Route 33. While an updated comprehensive plan has not yet been published, the process of creating Envision New Kent Strategic Plan was kicked off in January, 2020, with a draft writing process begun in April, 2021. This document will define the county's vision for growth and change through 2040.

4.5.12 City of Petersburg

The City of Petersburg is in the heart of the Richmond-Crater district, located 23 miles southeast of Richmond and 9 miles southwest of Hopewell. It is bordered by Chesterfield County to the northwest, Dinwiddie County to the southwest, and Prince George County to the east. The City of Colonial Heights is just north of Petersburg, separated from it only by the Appomattox River. Petersburg is 23.1 square miles (14,784 acres) and in 2020 had a population of 33,458, an increase of 3.2% from 2010. The percentage of Black residents is 76.7% of the population compared to about 20% in Virginia as a whole. Petersburg is a nexus of major roadways, with 1-85 and Routes 1/301 and 460 all merge with or cross 1-95 in the heart of the city.

In 2016, after years of mismanagement, Petersburg was in financial crisis with $19 million dollars in unpaid bills and a $12 million budget gap. A team of outside consultants imposed drastic budget cuts that staved off complete financial collapse. Since then, Petersburg has

reached a new level of financial soundness that has increased its ratings by various agencies and improved its reputation with surrounding localities and with the Commonwealth. While the City is still years away from being debt-free and still struggles with high poverty and crime rates, local developers, entrepreneurs, and artists have been working hard to turn Petersburg around.

Given that annexation of county land is not an option, the City of Petersburg has a finite amount of land available for growth. Furthermore, developable land is limited by Chesapeake Bay Preservation Act requirements and other physical site constraints. Therefore, development and revitalization efforts are focused on existing neighborhoods with infill properties and/or properties in need of extensive renovation. Land use fragmentation is a major issue in Petersburg with incompatible uses often located side by side.

The city has two distinct residential patterns. The first is found in the "Old City," north of I-85. A mix of residential types (e.g., single family, multi-family, and duplexes) is found here. Newer developments, mainly suburban subdivisions, have sprung up south of I-85, in large part due to the Southside Regional Medical Center now located there. Some infill of single-family homes and duplexes has also taken place.

Recent progress has energized efforts to revitalize Petersburg. Some financial grants and funding have been secured and work is underway. The research and recommendation phase is complete and decisions are currently being finalized. Priorities include: building or redesigning the city's gateway areas, redevelopment of the riverfront Harbor Project, neighborhood revitalization in several specific areas, and working with Virginia State University regarding their expansion plans, among others.

4.5.13 Powhatan County

Powhatan County was one of the fastest-growing counties in the country earlier this century, experiencing a population jump of 46% between 1990 and 2000 and another 25% by 2010. The county's growth rate over the last 10 years slowed to 8% (30,333 people in 2020), but is projected to rise by another 13% by 2030 before slowing again. Powhatan's growth is largely due to its proximity to Richmond. Like Goochland and New Kent Counties, Powhatan offers an attractive rural location with a lower cost of living, higher quality of life, and lower housing costs than the Richmond Metropolitan Area. Like many exurban/rural areas, Powhatan is significantly wealthier and has more married-couple families than Virginia's population as a whole.

The eastern edge of Powhatan County is located about 15 miles west of downtown Richmond, with Chesterfield County lying between them. The county is bordered on the north by Goochland County and the James River, and on the south by Amelia County and the Appomattox River. Cumberland County lies to the west. The county is located entirely within the Lower Piedmont region and encompasses 272 square miles.

Originally inhabited by the Monacan Indians, Powhatan was first explored by Europeans in 1608 when Christopher Newport led an expedition up the James River. The first European

settlers came in 1699 when hundreds of Huguenot refugees arrived after fleeing persecution in France. They gradually spread throughout the area and some of their original buildings still stand.

The county has always been primarily agricultural, and experienced steady population declines from the mid-nineteenth through the mid-twentieth century. In the 1970s, the county's population began to increase again as suburban development spread beyond Chesterfield County to the eastern edge of Powhatan County. Since 2000, most new development in the county has been in subdivisions that feature 5-acre lots, especially around the Route 711 corridor and near Courthouse Village. Commercial growth has been concentrated mostly alongside the Route 60 corridor and east of the interchange at Route 711 and Route 288. Agriculture is now made up mostly of smaller family farms and niche agricultural industries such as greenhouses, vineyards, or equestrian facilities. Some forestry is also still found in the county; however, government, construction, and retail trade are now the dominant employment industries.

Maintaining Powhatan County's rural character is paramount to the county's vision and plans for growth. Any development proposals will be considered with an eye to whether the plans would interfere with the preservation of "signature" parts of the county, wooded and rural landscapes, or cultural and environmentally-sensitive resources. The county supports reasonable levels of development, but only that which will allow the county to maintain its rural character, provide adequate services, and maintain fiscal sustainability.

4.5.14 Prince George County

Prince George County is situated about 25 miles southeast of Richmond and 75 miles northwest of Norfolk. The City of Hopewell and the James River form its northern border, Charles City County lies to the northeast, Surry County to the east, Sussex County to the southeast, and, continuing clockwise, Dinwiddie County, the City of Petersburg, and the Appomattox River to the west. The county is east of the Fall Line and within the Coastal Plain. In the northern half of the county, water drains into the Appomattox and James Rivers and eventually into the Chesapeake Bay. In the southern part, water flows into the Nottoway River and Blackwater River watershed and then into the Chowan River before reaching the Albemarle-Pamlico Sound.

Prince George County's character is shaped less by its location and more by Fort Lee, a large and growing military base located in the northwestern part of the county that lies between the Cities of Petersburg, Colonial Heights, and Hopewell. In 2005, under directives from the U.S. Congress's Base Realignment and Closure (BRAC) Commission, specific Army and Air Force training operations were combined at Fort Lee, transforming the base into a major military facility. Prince George County and the surrounding area reaped tremendous economic benefits from the BRAC expansion and used Federal monies to build a public library, and elementary school, and make a number of other investments in local infrastructure to accommodate the needs of the growing base and the families who came with it.

The daily population on Fort Lee rose from about 32,000 to 48,000 between 2005 and 2011. Military personnel came from all across the South to Fort Lee as well as from Alexandria and Fort Eustis, Virginia. In January 2009, the combined Sustainment Center of Excellence Headquarters was opened and transformed Fort Lee into the third largest Army training installation in the country. In July 2009, the Army Logistics University opened and began offering more than 200 courses and training 2,300 military and civilian students in logistics and military management techniques.

Since the expansion was completed in 2011, the county has been able to turn its attention to capital facility needs, including the improvement of parks and recreation facilities, school repairs and other maintenance and upkeep projects.

Largely because of Fort Lee, the population of Prince George County has continued to grow. Between 2010 and 2020, the population grew from 35,725 to 43,010, slightly more than 20%. The current population exceeds the numbers projected by the Weldon Cooper Center even through 2040. Given that no further base expansions are expected in the near future, growth population will likely be modest; however, 2,500 Afghan refugees were relocated to Fort Lee on a temporary basis in 2021, and it is likely that at least some will elect to stay in the area.

Aside from Fort Lee, Prince George County has a flourishing industrial base located in several industrial parks, along with product distributors like Ace Hardware, Goya Foods, and Service Center Metals. This has helped balance the tax base in the county. Rolls-Royce is a major investor in the county, beginning the manufacture of aircraft engines there in 2010 and investing in the Commonwealth Center for Advanced Manufacturing educational training facility that opened in the county back in 2011.

Approximately 89% of the county is forested or in crop production. The Virginia Department of Forestry (VDOF) estimates that roughly 74% of the total land area is forested, some of which is commercially owned, and 15% is cropland. The remaining 11% of land is used for residential, commercial, industrial, or public uses.. Single-family homes comprised about 74% of the housing stock, followed by manufactured homes that accounted for about 12%. Most of the single-family homes are found in subdivisions near the two cities. The remainder of the residential development is scattered throughout the county. Commercial development occurs primarily as strip development along major routes.

When considering future development, the county must assess a number of environmental factors as well as land use plans, etc., before approving rezoning requests or specific proposals. Not all land is suitable for development and the residents of Prince George County have expressed the desire to protect agricultural uses and environmentally important areas of the County.

4.5.15 City of Richmond

Richmond is located at the Fall Line of the James River, a feature central to the city since it was founded in 1737. The James River runs from west to east through the center of the city, although slightly more of Richmond is located on the north bank than the south. The city is

62.5 square miles and is not allowed to annex any further land, therefore nearly all new growth will come from redevelopment. Richmond has recently released a new comprehensive plan, "Richmond 300," outlining its vision and goals through 2037. The plan acknowledges that while the City's population has grown remarkably in recent years, its growth has not benefitted everyone and the city must change its approach to make sure that future growth is equitable, sustainable, and beautiful.

Six "Big Moves" were identified in the plan that will guide the City as it moves forward. Richmond will:

- Re-Write the Zoning Ordinance: Direct growth to appropriate areas while maintaining existing neighborhoods as well as creating new authentic neighborhoods adjacent to enhanced transit.
- Re-Imagine Priority Growth Nodes: Target growth in jobs and population to Downtown, Greater Scott's Addition, Route 1 Corridor, Southside Plaza, and Stony Point Fashion Park.
- Expand Housing Opportunities: Encourage the development of housing options throughout the city to expand the geography of opportunity by de-concentrating poverty.
- Provide Greenways & Parks for All: Develop parks and greenways so that by 2037 100% of Richmonders live within a 10-minute walk of a park.
- Reconnect the City: Cap highways to reknit neighborhoods destroyed by interstates, build/improve bridges, introduce street grids, and make the city easier to access by foot, bike, and transit.
- Realign City Facilities: Improve City buildings (schools, libraries, fire stations, police stations, etc.) to provide better services in efficient, shared-use, accessible facilities to better match and serve the growing city.

4.5.16 Surry County and the Town of Surry

Surry County is a rural county characterized by a rolling topography that gradually becomes more level in the eastern portions of the county. Seventy-five percent of the county is forested. Traditionally, forestry and agricultural land uses have supported the majority of employment but have experienced recent decline. Surry County is the location of the Surry Power Station, a nuclear power plant built in 1972 which is the County's main employer.

The Town of Surry is the only community in Surry County participating in this planning effort. The town was originally established in 1652 and was incorporated in 1928. It is the county seat and a hub for businesses serving the surrounding county. The town has a total land area of 0.8 square miles, and is located at the intersection of Virginia Routes 10 and 31, about 4 miles from the Jamestown-Scotland Ferry dock on the south side of the James River. The town's total population as reported in the 2020 Census was 357, a 7% decline since the 2010 Census population of 383.

The county's comprehensive plan calls for improved county and town cooperation, in order to build momentum in ensuring that future development is concentrated in and around the historic towns and crossroads that already exist in the county. The plan calls for "residential investment areas" and commercial areas around the Town of Surry, in particular, to counteract the population decline forecast by the Weldon Cooper Center for the county, and to preserve the rural character of the rest of the county. Zoned commercial areas would provide strategic growth to sustain commercial uses that are expected to diversify and bolster the county's tax base. In 2016, the Hampton Roads Sanitation District (HRSD) added Surry County to their service territory and in 2017, the county and town reached agreements for HRSD to assume ownership and operate their wastewater systems. HRSD is planning a series of system improvements in the long-term.

4.5.17 Sussex County

Sussex County encompasses 496 square miles in southeastern Virginia, about 45 miles southeast of Richmond and 70 miles west of Hampton Roads. The county is bordered by Dinwiddie and Prince George Counties to the north, Surry County and the Blackwater River to the northeast, Southampton County to the southeast, and Greensville County to the southwest. The county lies in the Coastal Plain, so the topography ranges from slightly rolling to relatively level with some marsh areas. Water in the county drains into Stony Creek and the Nottoway and Blackwater Rivers.

Sussex County is primarily rural with agriculture and agricultural-related manufacturing forming the basis of the local economy. Approximately 80% of the land is commercial forestry, the remaining agricultural land is devoted to peanuts, cotton, corn, flue-cured tobacco, small grains, and soybeans.

The towns of Jarratt, Stony Creek, Wakefield, and Waverly are located in Sussex County. Jarratt is split between Sussex and Greensville County, with the western half in Greensville County and the eastern half in Sussex County. The population in 2020 was 10,829, marking a drop of more than 10% from the 12,087 recorded in 2010. The majority of housing is comprised of single-family detached homes. The number of manufactured homes has risen dramatically since 1990, accounting for 58% of building permits issued between 1990 and 1996. In 1990, manufactured homes accounted for only 24% of the housing stock; by 1996, that percentage had risen to 40%. Most residential development is in subdivisions or as strips along the highway. This pattern preserves land for agricultural and forestry uses.

The Future Land Use Map shows a large portion of the county, including the floodplains, classified for conservation uses. Large-lot, residential development is allowed in this area as is agricultural, forestry, and passive recreation. In addition, the plan calls for development to be concentrated in existing community hubs instead of scattered throughout the county.

4.6 Population

The total population of the jurisdictions included in the Richmond-Crater region was 1,302,101 as of the 2020 U.S. Census. Between 2010 and 2020, New Kent County saw the greatest increase in population with a growth rate of 24.5%. Conversely, Sussex County saw a 10.4% population drop, according to the 2020 Census. **Table 4.1** shows population by jurisdiction, the associated change rate, and population projections for each jurisdiction to the year 2040. The region's growth rate is not projected to be evenly distributed across all jurisdictions. New Kent County is expected to continue its rapid growth by an astonishing 36% by 2040. Dinwiddie County's population is projected to grow by 22%. On the other hand, the City of Petersburg is expected to lose almost 14.5% of population and the City of Colonial Heights may lose 6.7%. Rural Sussex, Prince George, and Greensville Counties are also expected to lose population over the next two decades. New Kent and Dinwiddie Counties are growing because the regions of those counties that lie closest to Richmond are developing into exurbs.

Table 4.1: Population by Jurisdiction

Jurisdiction	2020 Population	Percentage Change in Population, 2010 – 2020	2040 Projected Population	Percentage Change in Population, 2020 – 2040
Charles City County	6,773	-6.65%	7,710	13.83%
Chesterfield County	364,548	15.27%	435,294	19.40%
City of Colonial Heights	18,170	4.35%	16,955	-6.68%
Dinwiddie County (inc. Town of McKenney)	27,947	0.19%	34,080	21.94%
City of Emporia	5,766	-2.71%	6,586	14.22%
Goochland County	24,727	0.12%	29,174	18.03%
Greensville County (inc. Town of Jarratt*)	11,391	-6.95%	11,404	-0.11%
Hanover County (inc. Town of Ashland)	109,979	10.12%	127,780	16.18%
Henrico County	334,389	8.94%	399,966	19.61%
City of Hopewell	23,033	1.95%	23,482	1.94%
New Kent County	22,945	24.50%	30,964	35.94%
City of Petersburg	33,458	3.20%	28,613	-14.48%
Powhatan County	30,333	8.15%	35,854	18.20%
Prince George County	43,010	20.39%	42,640	-0.86%
City of Richmond	226,610	10.96%	250,600	10.58%
Surry County (inc. Town of Surry)	6,561	-7.04%	5,992	-8.67%
Sussex County (inc. Towns of Stony Creek, Wakefield, Waverly)	10,829	-10.40%	10,563	-2.45%

* Although Jarratt is located in both Greensville and Sussex Counties, for the purposes of this plan, the Town is included under Greensville County in tables.
Sources: U.S. Census Bureau Decennial Census, 2010 and 2020, and University of Virginia Weldon Cooper Center, Demographics Research Group. (2020). Virginia Population Estimates. Retrieved from https://demographics.coopercenter.org/virginia-population-estimates

4.6.1 Race and Sex

Virginia has become more racially diverse in recent years. According to 2015 U.S. Census Bureau data, the majority of the population in the Richmond-Crater region was reported to be of a single race (98.1%). In American Community Survey (ACS) 2019 data, that percentage had dropped to 97.2. Of the total population reporting one race, 57.9% were white, 35.9% were Black, and 5.0% were Hispanic. In Virginia as a whole, 69.4% were white, 19.9% were Black, and 9.8% were Hispanic/Latino. In both Virginia and the United States as a whole, 50.8% of the population is female. In the Richmond-Crater study area, the percentage is 49.9.

4.6.2 Language

About 4.4% of the Richmond-Crater region's residents are foreign-born, which is a drop from 7.6% reported in 2015. An estimated 6.8% of the population speaks a language other than English at home. The recent influx of refugees from Afghanistan is currently centered in or near Fort Lee in Prince George County. As these refugees resettle, some will likely choose to stay in the area, particularly in the counties close to Richmond.

4.6.3 Age

Another segment of the population that may require accommodations related to hazard events is characterized by age. The 2019 ACS from the U.S. Census Bureau shows that 5.3% of the Richmond-Crater region's population is under the age of 5 and a total of 20.5% is under age 18. At the other end of the scale, 17.7% of the population is 65 or older, a jump of more than 5% in the last five years. Compared to the rest of Virginia, the Richmond-Crater area has slightly fewer small children and young people, but 1.8% more senior residents.

4.6.4 Education

In Virginia, 38.8% of adults have college degrees. This is 6.7% higher than the United States, reflecting the high number of jobs connected to the federal and state governments as well as defense, tech, and business. Within the Richmond-Crater region, Henrico County has the highest percent of college graduates (43.7%), followed by Goochland (41.8%), Chesterfield (41%), Hanover (39.8%), and the City of Richmond (39.6%).

The areas with the fewest college graduates are: Greensville County (9.2%), Sussex County (12.7%), the City of Emporia (13.8%), Charles City County (14.7%), and the City of Hopewell (14.8%). These areas also have the lowest percentages of high school graduates. These numbers, coupled with the age-related demographics described in the previous paragraph and the percentage of non-English speakers, are important to keep in mind when developing public outreach programs. The content and delivery of public outreach

programs should be consistent with the audiences' needs and ability to understand complex information.

4.6.5 Income

Within the study area, the American Community Survey data for 2015-2019 indicate Goochland County had the highest household median income of $93,994, followed by Hanover County at $89,390, Powhatan at $89,090, and New Kent County at $87,904 (see **Table 4.2**). The average household income in the region in 2020 was $63,069, slightly above the American average of $62,843, but significantly below the Virginia average of $74,222.

Household median income was lowest in the City of Petersburg at $38,679, followed closely by the City of Hopewell at $39,030. The next closest was Sussex County at $47,250 in median household income.

The percentage of people in the region who lived in poverty in 2019 was 13.5%. Poverty in the region is concentrated in cities, with the most impoverished localities being the City of Emporia with 27.0% of the total population living in poverty, the City of Petersburg (24.1%), the City of Hopewell (23.6%), and the City of Richmond (23.2%). In rural areas, Greensville County (21.5%), and Sussex County (18.9%) had the highest levels of poverty. In the Commonwealth, 9.2% of the population lived in poverty, compared to 11.4% in the nation. The area's relatively high levels of poverty indicate that the Richmond-Crater region has some significant hurdles to overcome in terms of households being able to afford hazard mitigation projects reliant on self-funding.

Income levels between the jurisdictions included in the Richmond-Crater region vary greatly. Table 4.2 shows the breakdown by jurisdiction.

Table 4.2: Income Characteristics by Jurisdiction

Jurisdiction	Median Household Income, 2015-2019	Persons Living in Poverty (percent),
Charles City County	$57,198	9.9%
Chesterfield County	$82,599	6.6%
City of Colonial Heights	$54,550	12.1%
Dinwiddie County (inc. Town of McKenney)	$60,346	11.1%
City of Emporia	$27,063	27.0%
Goochland County	$93,994	5.8%
Greensville County (inc. Town of Jarratt)	$50,300	21.5%
Hanover County (inc. Town of Ashland)	$89,390	5.0%
Henrico County	$70,307	8.3%
City of Hopewell	$39,030	23.6%
New Kent County	$87,904	4.6%

Table 4.2: Income Characteristics by Jurisdiction		
Jurisdiction	**Median Household Income, 2015-2019**	**Persons Living in Poverty (percent),**
City of Petersburg	$38,679	24.1%
Powhatan County	$89,090	5.3%
Prince George County	$71,912	8.2%
City of Richmond	$47,250	23.2%
Surry County (inc. Town of Surry)	$57,.962	11.6%
Sussex County (inc. Towns of Stony Creek, Wakefield, Waverly)	$49,487	18.9%

Source: U.S. Census Bureau, American Community Survey 2015-2019

4.6.6 Broadband Access

In recent years, access to broadband internet service has become vital to the population's ability to receive information and services. The percentage of people in the Richmond-Crater region who have access to broadband reflects both income and availability. While broadband is widely available in heavily-populated areas, it is less widely available in rural ones and is also relatively more expensive. Regardless, broadband access is quickly becoming as vital a utility as electricity or phone service, as witnessed beginning in 2020 during the COVID-19 pandemic, when so many people had to work and attend school from home for long periods.

Table 4.3 shows the percentage of households with a broadband internet subscription between 2015 and 2019 in each locality. An average of 76.7% of residents in the region had access, trailing the Virginia average of 83.9% and the nationwide average of 82.7%.

Table 4.3: Broadband Availability	
Locality	**Households With Broadband Internet Access**
Charles City County	61.5%
Chesterfield County	90.1%
City of Colonial Heights	78.1%
Dinwiddie County	74.5%
City of Emporia	65.2%
Goochland County	83.2%
Greensville County	63.2%
Hanover County	86.0%
Henrico County	86.2%
City of Hopewell	75.7%

Table 4.3: Broadband Availability	
Locality	**Households With Broadband Internet Access**
New Kent County	79.1%
City of Petersburg	69.0%
Powhatan County	89.5%
Prince George County	83.3%
City of Richmond	75.4%
Surry County	64.8%
Sussex County	66.4%

Source: U.S. Census Bureau, American Community Survey, 2015-2019

4.7 Housing

As of 2019, there were 373,595 housing units in the study area according to the U.S. Census. The highest number of housing units were located in Henrico and Chesterfield Counties. About 67.8% of residents in the study area own their own homes, a drop from 70.1% in 2015. However, the district's percentage is higher than the national average of 64.0% or the state average of 66.3%. The average, however, is skewed by the significantly lower rate of homeownership in the cities of Emporia, Hopewell, Petersburg and Richmond. **Table 4.4** illustrates the housing characteristics of each jurisdiction in the Richmond-Crater region. When considering mitigation options, special attention should be given to the difference in capabilities between owners and renters.

Table 4.4: Housing Characteristics by Jurisdiction				
Jurisdiction	**Housing Units 2019**	**Owner-Occupied Housing Units 2015-2019**	**Median Value of Owner-Occupied Housing Units 2015-2019**	**Median Gross Rent 2015-2019**
Charles City County	3,391	83.9%	$167,900	$813
Chesterfield County	134,267	75.8%	$241,200	$1,251
City of Colonial Heights	N/A	62.9%	$171,700	$1,038
Dinwiddie County (inc. Town of McKenney)	11,856	77.2%	$168,300	$1,005
City of Emporia	N/A	40.1%	$116,800	$694
Goochland County	9,613	84.9%	$375,200	$1,208
Greensville County (inc. Town of Jarratt)	4,205	73.3%	$117.700	$854
Hanover County (inc. Town of Ashland)	42,264	82.5%	$282,900	$1,159
Henrico County	139,274	62.7%	$242,600	$$1,170
City of Hopewell	N/A	46.7%	$122,900	$886
New Kent County	8,956	86.5%	$281,100	$1,010
City of Petersburg	N/A	38.8%	$108,100	$947
Powhatan County	11,274	90.1%	$279,200	$980
Prince George County	12,605	67.6%	$213,300	$1338
City of Richmond	N/A	42.6%	$230,500	$1,025
Surry County (inc. Town of Surry)	3,611	74.3%	$197,800	$903
Sussex County (inc. Towns of Stony Creek, Wakefield, Waverly)	4,837	69.2%	$125,800	$807

Source U.S. Census Bureau, ACS 2015 – 2019

4.8 Business and Labor

The diversity of the region is strongly reflected within the business sector. While the Richmond-Crater region is home to seven Fortune 500 companies in 2020, the outlying area is primarily rural with limited commercial development. The Fortune 500 companies located in the region are shown in **Table 4.5.**

Table 4.5: Richmond-Crater Region Fortune 500 Companies		
Fortune 500 Company	**2020 Rank**	**Locality**
Altria Group	167	Henrico County
Performance Food Group	168	Henrico County
CarMax	173	Goochland County
Dominion Energy	197	Richmond
Owens & Minor	332	Hanover County
Markel	335	Henrico County
Genworth Financial	360	Richmond

Source: Fortune Magazine, accessed online March 2021

The sectors with the most employees in the Richmond-Crater region are:

- Health care and social assistance
- Retail trade
- Finance and insurance
- Accommodation and food services
- Manufacturing
- Construction
- Professional, scientific, and technical services
- Other services (except public administration)
- Administrative and Support and Waste Management
- Remediation Services
- Wholesale trade

Sectors with the largest annual payrolls are:

- Finance and insurance
- Health care and social assistance
- Professional, scientific, and technical services Manufacturing
- Retail trade
- Wholesale trade
- Construction
- Administrative and Support and Waste Management and Remediation Services
- Other services (except public administration)
- Accommodation and food services

Listed below are the largest 15 employers of the Richmond and Crater regions. Following is a list of the top 5 employers in each locality. Unless otherwise identified, all data comes from the Virginia Labor Market Information of the Virginia Department of Education posted in February, 2014, or the Virginia Economic Development Partnership, the most recent data available during the planning process.

Top Employers in the Richmond Region	**Top Employers in the Crater Region**
Capital One Bank	U. S. Department of Defense
Virginia Commonwealth University	Walmart
Henrico County School Board	Southside Regional Medical Center
Chesterfield County School Board	County of Prince George
MCV Hospital	Dominion Energy
Bon Secours Richmond Health System	Food Lion
HCA Virginia Health System	Greensville Correctional Center
Richmond City Public Schools	Central State Hospital
County of Henrico	City of Petersburg School Board
City of Richmond	Boars Head Provisions Company
Walmart	Honeywell International, Inc.
County of Chesterfield	Hopewell City School Board
Kroger	City of Petersburg
Hanover County School Board	Amazon
U.S. Department of Defense	Dinwiddie County School Board

Charles City County:

Charles City County School Board

U.S. Remodelers Inc.

County of Charles City

Atlantic Bulk Carrier Corporation

Charles City Timber & Mat

Chesterfield County:

Chesterfield County School Board

County of Chesterfield

U.S. Department of Defense

Amazon Fulfillment Services

HCA Virginia Health System

Dinwiddie County:

Walmart Distribution Center

Central State Hospital

Amazon Fulfillment Center

Dinwiddie County School Board

Southside Virginia Training Center

Goochland County:

Capital One Bank

CarMax Auto Superstores

Goochland County School Board

Luck Stone Corporation

Performance Food Group, Inc.

Greensville County and City of Emporia:

Greensville Correctional Center

Boars Head Provisions Company

Greensville County Schools

Western Express, Inc.

Beach Mold & Tool, Inc.

Hanover County:

Hanover County School Board

Bon Secours Health Systems Inc.

Kings Dominion

County of Hanover

Tyson Farms

Henrico County:

Henrico County School Board

County of Henrico

Bon Secours Richmond Health System

Capital One Bank

HCA Virginia Health System

City of Hopewell:

Honeywell International

Hopewell City School Board

HCA Virginia Health System

City of Hopewell

E.I. DuPont De Nemours & Co.

New Kent County:

New Kent County School Board

County of New Kent

AHS Cumberland Hospital

Curtis Contracting Company

Food Lion

City of Petersburg:

Southside Regional Medical Center

City of Petersburg School Board

City of Petersburg

Amsted Rail Company, Inc.

Powhatan County:

Anthem

Powhatan County School Board

Virginia Department of Juvenile Justice

Powhatan Correctional Center

Deep Meadow Correctional Center

Prince George County:

U.S. Department of Defense

County of Prince George

Food Lion

U.S. Department of Justice

U.S. Army Non-Appropriated Funds Division

City of Richmond:

Virginia Commonwealth University

MCV Hospital

Richmond City Public Schools

City of Richmond

U.S. Department of Veterans Affairs

Surry County:

Dominion Energy (Surry)

S. Wallace Edwards and Sons (Surry)

Seward Lumber Company (Claremont)

Windsor Mill Company (Dendron)

(Source: www.surrycountyva.gov)

Sussex County:

Sussex I Correctional Center

Sussex II Correctional Center

Sussex County School Board

Personal Touch Home Care

County of Sussex

4.9 Transportation

The Richmond-Crater region is located at a crossroads of transportation within the Commonwealth of Virginia. Rail lines radiate outward from Richmond in all directions, with both passenger (Amtrak) and freight (CSX, Norfolk Southern) services available. It should be noted that due to the Transforming Rail in Virginia program, rail service – both passenger and freight – will be expanding in the Commonwealth. The $3.7 billion program was established to build a 21st-century rail network across Virginia. As part of the program, former Governor Northam finalized an agreement with Norfolk Southern to expand passenger service to the New River Valley, for example.

In addition to rail, the region is served by the Richmond International Airport and numerous general aviation facilities, including the Emporia/Greensville Regional Airport, Chesterfield County Airport, Dinwiddie County Airport, Hanover County Municipal Airport, New Kent Airport, Petersburg Municipal Airport, and the Wakefield Municipal Airport. The Richmond International Airport normally attracts over 3 million travelers each year, although volume has been substantially reduced since spring 2020 as a result of COVID 19. The airport has 3 asphalt-grooved runways and handles about 150,000 operations annually (landings/takeoffs), including both passenger and freight operations. As of March 2021, the airport had 7 airlines operating passenger service, including: United, American Airlines, Delta, JetBlue Airways, Southwest Airlines, Spirit, and Allegiant.

The James River is navigable by large ships up to the eastern portion of the City of Richmond at the Fall Line. The region is served by the Richmond Marine Terminal, Central Virginia's domestic and international multi-modal freight and distribution hub. The port serves waterborne, rail and truck shippers throughout the mid-Atlantic states, and is owned by the City of Richmond and leased to the Virginia Port Authority. The port handles containers, temperature-controlled containers, breakbulk, bulk, and neo-bulk cargo. James River Barge Service, a thrice-weekly Container-on-Barge service from Hampton Roads to Richmond, provides a maritime alternative to I-95 by transporting goods on the James River via barges, removing container traffic off local roads and highways. Major export/import cargoes include chemicals, pharmaceuticals, forest products, paper, machinery, consumer goods, frozen seafood, produce, campers, steel, steel products, stone, tobacco leaf, aluminum, project cargo, vehicles, boats, wire coils, wire rods, pipe, and aplite. The port is the westernmost commercial maritime port on the North Atlantic coast.

Several interstates intersect the Richmond-Crater region. Interstate 64 is an east-west route extending from Norfolk to Staunton, Virginia. Interstates 95 and 85 are north-south routes, with I-95 being the primary route along the East Coast, extending from Maine to Florida, and I-85 serving as the main route between Richmond and Atlanta, Georgia. In addition, Richmond is encircled by I-195, I-895 (a toll road), and I-295 which begins north of Richmond in Henrico County, passing through Charles City County, extending through the

City of Hopewell to the City of Petersburg, providing an alternative to I-95 through the heart of Richmond. Interstate I-95 continues to be upgraded, including bridge improvements and other minor paving and shoulder improvements/repairs. A number of large U.S. highways also service the region, including: U.S.460, U.S.58, U.S.250, U.S. 522, U.S. 33, U.S. 1, U.S. 301/SR 2, U.S. 360, and U.S. 60. The state road network is extensive throughout the region. Some of the major routes include SR-6, SR-10, SR-54, SR-156, SR-288, SR-249, SR-155, and SR-5. U.S. 460 connects the City of Petersburg area with Norfolk and the ports of Hampton Roads, and U.S. 58 passes through the City of Emporia along Virginia's southern border. Henrico County is the only county in the region that maintains its own roads. The City of Richmond maintains its own road network.

4.10 Infrastructure

4.10.1 Electric

The Richmond-Crater region has five electricity suppliers: investor-owned Dominion Energy and three electric cooperatives – Prince George, Southside, and Mecklenburg

The western portions of New Kent County are on a "looped" scheme for electricity. If one portion of this area were to lose power, it could regain power rather easily because it is tied into the system. Dominion Energy has not found it to be cost-effective to institute a similar system in the eastern portion of the county and therefore this area is prone to electrical outages.

Two power substations provide electricity to Charles City County. Efforts are underway to ensure that the courthouse and municipal complex are on both grids. In addition, Ingenco, located at the landfill, provides electricity to the power grid.

Powhatan County is served by Dominion Energy (61% of the county) and Southside Electric Cooperative (39% of the county). Power outages primarily occur here because of ice or wind storms. Most of the Southside Electric grid is powered by one substation in the county, and the majority of the Dominion Energy feeds that serve the county enter on two distribution lines from substation(s) in Chesterfield.

4.10.2 Natural Gas

Natural gas is provided to the region by: the City of Richmond (City of Richmond and Henrico County); Virginia Natural Gas (Hanover, New Kent, and Charles City Counties); and Columbia Gas of Virginia (all remaining localities).

4.10.3 Telephone

Local telephone service is provided throughout Greater Richmond by Verizon Communications Inc. AT&T and Cavalier Telephone are the largest competitive providers. An extensive fiber optic network with digital switching capability and Synchronous Optical Network self-healing fiber optic rings insures uninterrupted service. Special Access

Services (DS1, DS3, OC-12 and OC-48) are available throughout the area. Verizon can provide dual capacity. Major long-distance carriers include AT&T, Verizon, and Sprint.

Telephone service providers are declining in importance as the percentage of homes in Virginia with land line service is now below 40% and dropping. Cell service providers are numerous and varied, but the providers with the most pervasive coverage in Virginia are the four major cell phone networks: AT&T, Verizon, Sprint, and T-Mobile. Verizon's 3G and 4G LTE cover the greatest percentage of the state at 93%, but AT&T is close behind at 90%. T-Mobile and Sprint also provide service coverage.

4.10.4 Public Water and Wastewater

In the region, public water and wastewater treatment is available in the City of Richmond and Hanover (including the Town of Ashland), Henrico, New Kent, and Powhatan Counties. Public water is also provided by the Appomattox River Water Authority, Chesterfield County, Dinwiddie County Water Authority, City of Emporia, Greensville County Water and Sewer Authority, Town of Jarratt, Town of McKenney, Petersburg and Dinwiddie Water Authority, City of Petersburg, Prince George County, City of Richmond, Town of Stony Creek, Surry County, Sussex Service Authority, and Virginia American Water Company. Private well and septic systems serve Charles City and Goochland Counties. Portions of Hanover, Henrico, and New Kent Counties are also served by private systems.

In Powhatan County, a public waterline runs from the Chesterfield County line to the eastern end of Route 60. Other providers are Aqua-Virginia, which serves the Courthouse area and portions of the Route 60 corridor, and Founder's Bridge Utility Company, which provides water to a few specific areas.

4.10.5 Cable Television, Broadband and Internet Providers

Cable television and internet service are almost always provided by the same companies. In the Richmond-Crater region, the primary providers are: Xfinity, Verizon FIOS, Verizon, Viasat, HughesNet, Comcast, and Cox Communication. Other providers are DISH, DIRECTV, Frontier FiberOptic, Spectrum, and Sparklight (CableONE).

The most common wired broadband internet connections in the greater Richmond area are provided via cable (97.38% coverage) and fiber (81.71% coverage), according to BroadbandNOW. Regular cable TV providers (using pre-existing TV wires) are the primary source for cable-based home internet service. Fiber technology, which uses fiber-optic lines, can be faster but because not all fiber connections can reach all subscriber addresses, some switch to copper cables nearby and thus do not necessarily offer true gigabit speeds.

The most commonly available internet option for Richmond-area residents is Viasat Internet. HughesNet is close behind, offering mostly satellite-based service. There are 18 internet service providers in Richmond, 8 of which offer residential service.

Outside of the Richmond area, there are usually 2 to 3 providers of internet service in any given area, but the more rural the area, the less likely it is to have access to broadband service. The Virginia Telecommunications Initiative, a $29.6 million initiative to extend broadband to lesser-served communities in Virginia, will begin accepting applications in June 2022, with announcement of the awards in December 2022. Counties in the Richmond-Crater region that are currently listed as applying for assistance are: Charles City County, Chesterfield County, Dinwiddie County, Greensville County, Hanover County, Henrico County, New Kent County, Sussex County, Goochland County, and Powhatan County,

5.0 Hazard Identification, Risk Assessment (HIRA) and Vulnerability Analysis

5.1 Updates for 2022

The 2022 update to the HIRA includes information on the most recent hazard occurrences, and updates regarding the frequency analysis and annualized damages to reflect recent history. Exposure data from Hazus and updated vulnerability data for flood, earthquake and wind from Hazus were included.

Each hazard was assessed for three new components of risk: 1) social vulnerability; 2) impacts of climate change; and 3) mass evacuation impacts. Following committee discussion, "Thunderstorms and Lightning" were removed from the plan due to the low risk and vulnerability associated with that hazard. The PDCs and Committee considered Radon Exposure and Infectious Diseases worthy of inclusion in the updated plan. A revised system of ranking the hazards was added as well. The tables at the end of the section regarding Conclusions on Hazard Risk were all updated. All figures were updated to reflect current conditions.

5.2 Introduction

The purpose of the HIRA is to identify the hazards that could affect the planning regions. The hazards are individually profiled to describe historical hazard events and determine what areas and community assets are the most vulnerable to damage from these hazards. The vulnerability analysis includes estimated losses for each hazard and a summary prioritization of hazards in terms of potential risks to the community.

The hazards discussed in this section are as follows:

Flooding

Flooding due to Impoundment Failure

Severe Wind Events

Tornadoes

Wildfires

Severe Winter Weather

Thunderstorms (including Hail & Lightning)

Droughts and Extreme Heat

Earthquakes

Landslides

Shoreline Erosion

Sinkholes

Radon Exposure

Infectious Diseases

5.2.1 Methodologies Used

Data from the National Centers for Environmental Information (NCEI) Storm Events Database were used to inform the weather-related hazard identification. The NCEI receives storm data from the National Weather Service (NWS), which in turn receives it from a variety of sources, which include but are not limited to: county, state, and federal emergency management officials, local law enforcement officials, Skywarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry, and the general public. Information on hazard events not recorded in this database is provided in narrative format for each hazard subsection to supplement the NCEI data and to provide a more accurate depiction of historical hazard events in the region.

Two distinct risk assessment methodologies were used in the formation of the vulnerability assessment. The first consists of a quantitative analysis that relies upon best available data and technology, while the second approach consists of a somewhat qualitative analysis that relies on the local knowledge and rational decision making skills of local officials. Upon completion, the methods are combined to create a "hybrid" approach for assessing hazard vulnerability for the region that allows for some degree of quality control and assurance. The methodologies are briefly described and introduced here and are further illustrated throughout this section.

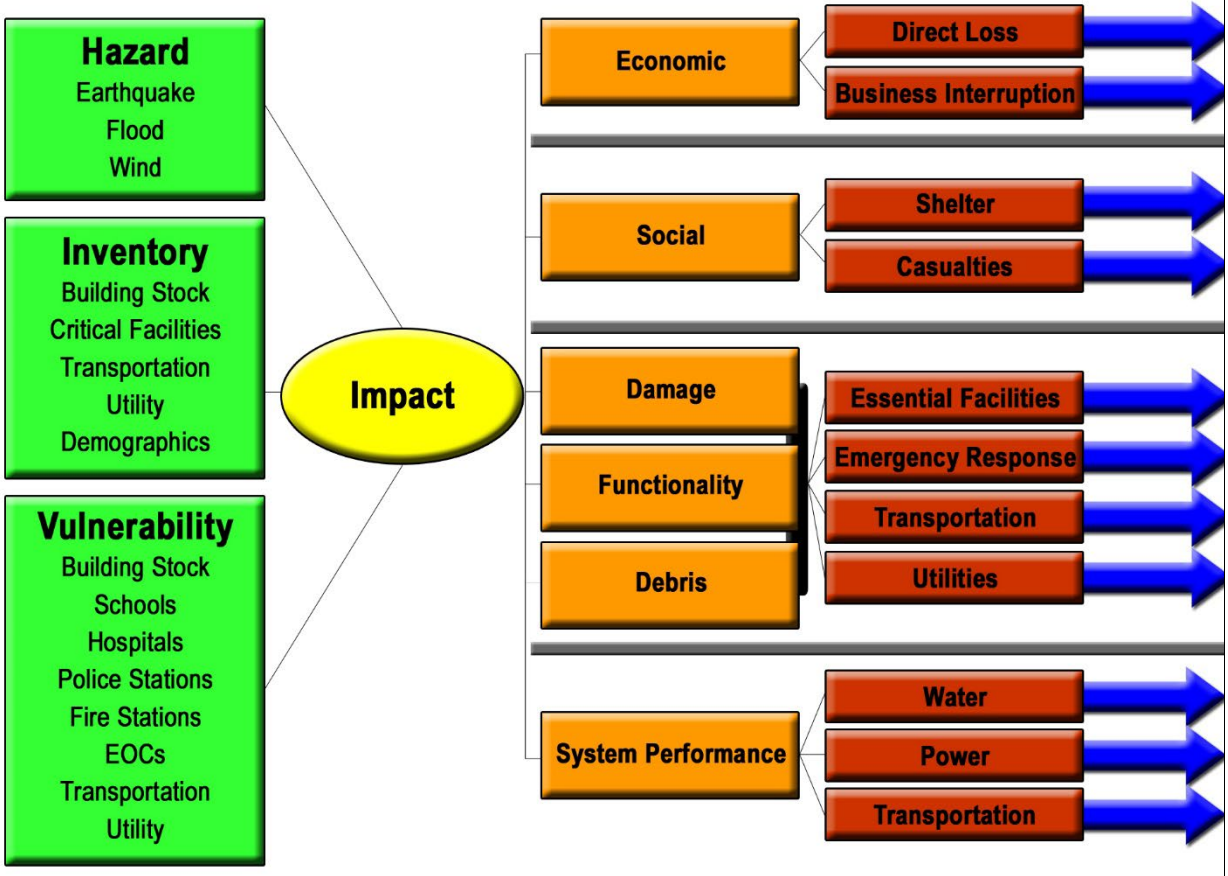
The quantitative assessment involved the use of the most recent version of Hazards U.S. Multi-Hazard software (Hazus), a geographic information system (GIS)-based loss estimation tool available from FEMA, along with a statistical risk assessment methodology for hazards outside the scope of Hazus. For the flood hazard, the quantitative assessment incorporates a detailed GIS-based approach. When combined, the results of these vulnerability studies are used to form an assessment of potential hazard losses (in dollars) along with the identification of specific community assets that are deemed at-risk.

Hazus is FEMA's standardized loss estimation software package, built on an integrated GIS platform using a national inventory of baseline geographic data (including information on the region's general building stock and dollar exposure). Originally designed for the analysis of earthquake risks, FEMA expanded the program in 2003 to allow for the analysis of multiple hazards: namely the flood and wind (hurricane wind) hazards. By providing estimates on potential losses, Hazus facilitates quantitative comparisons between hazards and assists in the prioritization of hazard mitigation activities.

Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information (see **Figure 5.1**). The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment.

Figure 5.1 shows a conceptual model of Hazus methodology. More information on Hazus loss estimation methodology is available through FEMA at www.fema.gov/hazus.

Figure 5.1: Conceptual Model of Hazus Methodology



Source: FEMA

This risk assessment used Hazus to produce regional profiles and estimated losses for three of the hazards addressed in this section: flooding, tropical storm winds, and earthquake. For each of these hazards, Hazus was used to generate probabilistic "worst case scenario" events to show the extent of potential damages. Both earthquake and wind were modeled using Hazus Level 1 and flood was modeled using Hazus Level 2.

For hazards outside the scope of Hazus, a statistical risk assessment methodology was designed and in previous plans, this method was applied to generate potential loss estimates. The approach was based on the same principles as Hazus, but did not rely on readily available automated software. In recent years, the historical data from which hazard assessment conclusions were made have become less reliable. For example, damages for wildfire were not reported for the two most recent reporting periods, and the communities reviewing the historical damage data from the NCEI expressed concern that

the damages were severely underestimated. Until more reliable historical damage data can be provided, planners determined that a qualitative methodology for examining historical losses and making conclusions about future risk was needed as shown below to supplement the quantitative analysis.

Despite the shortcomings of certain historical data, this analysis included collection of and updates to relevant GIS data from local, state and national sources. These sources include each community's GIS department, FEMA, VDOF, and NOAA. Once all data were acquired, GIS was used to demonstrate and spatially analyze risks to people, public buildings and infrastructure. Primary data layers included geo-referenced point locations for public buildings, critical facilities, and infrastructure elements. Using these data layers, risk was assessed and described by determining the parcels and/or point locations that intersected with the delineated hazard areas.

The qualitative assessment relies less on technology and more on historical and anecdotal data, community input, and professional judgment regarding expected hazard impacts. The qualitative assessment completed for the Richmond-Crater region is based on committee member dot voting to indicate their priorities for mitigation spending. The members present at the first planning workshop on June 21, 2021, were awarded hypothetical "mitigation grants" in the following amounts: 1 - $1,000,000 grant; 2 - $250,000 grants; and 4 - $25,000 grants.

Each participant was then tasked with determining how they would spend their mitigation dollars. The groups were reminded that projects must be cost-beneficial and that FEMA urges communities to "prioritize mitigation actions based on level of risk a hazard poses to lives and property." Each participant voted in the online forum for the hazards they considered a priority for spending. Results are shown in a series of tables at the end of this section. Communities were reminded of a full range of hazards, including the hazards in the previous hazard mitigation plan as well as Infectious Disease and Radon Exposure. Although the list was not a comprehensive list of all hazards that may ever impact the region, the resultant hazards summarized in this section were determined by committee members to be the necessary hazards for the purposes of determining mitigation actions.

While the quantitative assessment focuses on using best available data, computer models and GIS technology, this qualitative ranking system relies more on historical data, local knowledge, and the general consensus of the planning committee. The results allow identified hazards to be ranked against one another.

Using both the qualitative and quantitative analyses to evaluate the hazards that impact the region provided planning committee members with a dual-faceted review of the hazards. This allowed officials to recognize those hazards that may potentially be costly, but also to plan and prepare for hazards that may not cause much monetary damage but could put a strain on the local resources needed to recover.

All conclusions of the vulnerability assessment completed for the region are presented in "Conclusions on Hazard Risk" at the end of this section. Qualitative findings for each hazard are detailed in the hazard-by-hazard vulnerability assessment that follows,

beginning with an overview of general asset inventory and exposure data for each jurisdiction.

5.2.2 National Risk Index

The National Risk Index (NRI) is a relatively new dataset and online application from FEMA that identifies communities most at risk to various natural hazards. For each of the 18 natural hazards explored, risk is calculated by multiplying each hazard's expected annual losses by social vulnerability (a consequence enhancing component of risk that measures the susceptibility of social groups to the adverse impacts of natural hazards) and dividing by community resilience (a consequence reduction component of risk that measures the ability of a community to plan for, absorb, recover from and adapt to the impacts of hazards). In other words:

$$Risk = Expected\ Annual\ Loss \times Social\ Vulnerability \times (1/Community\ Resilience)$$

In the risk equation, each component is represented by a unitless index score that depicts a community's score relative to all other communities at the same level. The Risk Index score is a unitless index and represents a community's relative risk in comparison to all other communities at the same level. All calculations are performed separately at two levels—County and Census tract—so scores are relative only within their level. It must be stressed that scores are relative, representing a community's relative position among all other communities for a given component and level. Scores are not absolute measurements and should be expected to change over time either by their own changing measurements or changes in other communities.

For every score, there is also a qualitative rating that describes the nature of a community's score in comparison to all other communities at the same level, ranging from "Very Low" to "Very High." Because all ratings are relative, there are no specific numeric values that determine the rating. For example, a community's Risk Index score for a single hazard could be 8.9 with a rating of "Relatively Low," but its Social Vulnerability score may be 11.3 with a rating of "Very Low." The rating is intended to classify a community for a specific component in relation to all other communities at the same level.

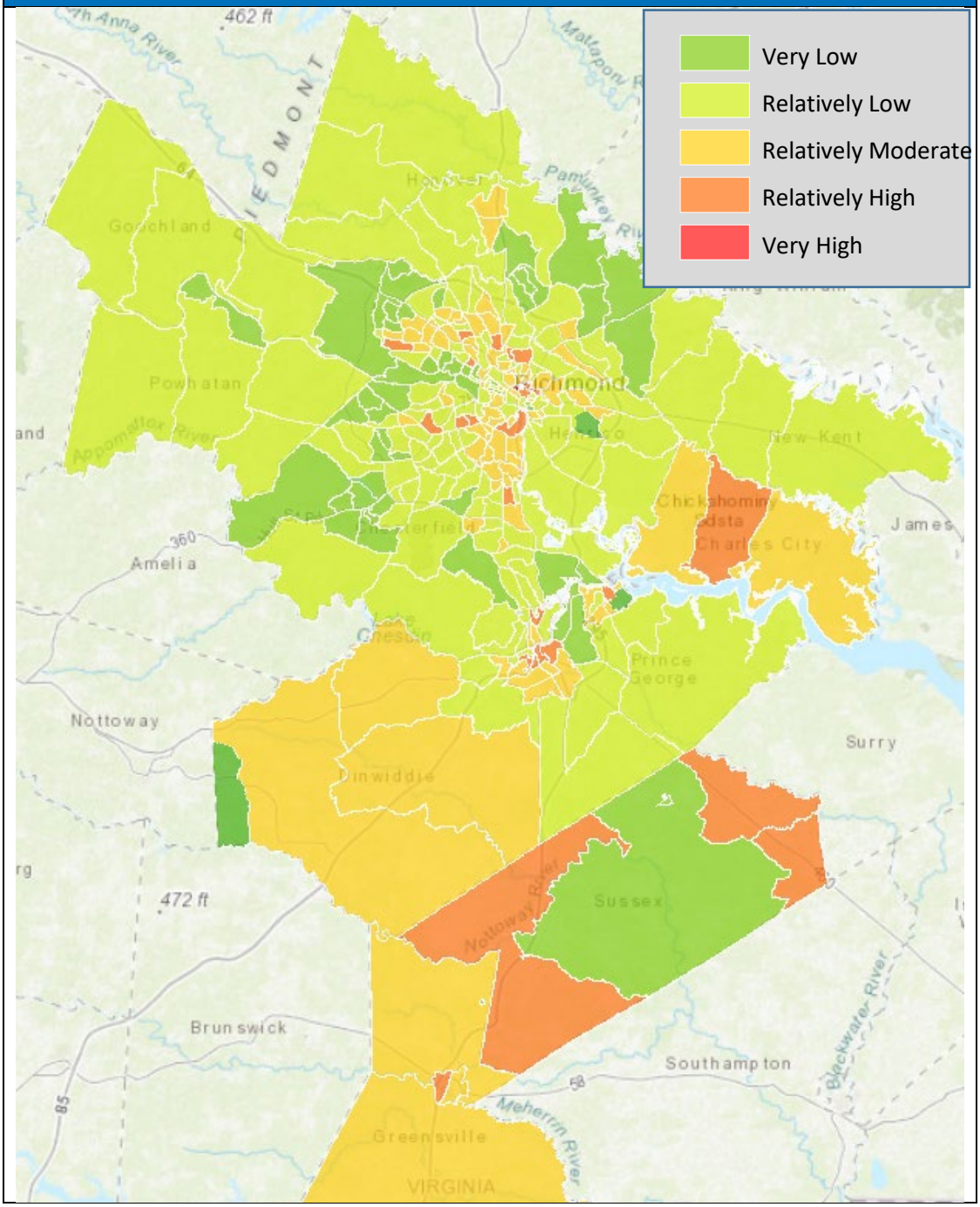
Source data for the social vulnerability component is derived from University of South Carolina's Hazards and Vulnerability Research Institute (HVRI) Social Vulnerability Index (SoVI). SoVI is a location-specific assessment of social vulnerability that utilizes 29 socioeconomic variables that contribute to a community's reduced ability to prepare for, respond to, and recover from hazards:

Median gross rent for renter-occupied housing units
Median age
Median dollar value of owner-occupied housing units
Per capita income
Average number of people per household
% population under 5 years or age 65 and over
% civilian labor force unemployed
% population over 25 with <12 years of education
% children living in married couple families
% female
% female participation in the labor force
% households receiving Social Security benefits

% unoccupied housing units
% families with female-headed households with no spouse present
% population speaking English as second language (with limited English proficiency)
% Asian population
% African American (Black) population
% Hispanic population
% population living in mobile homes
% Native American population
% housing units with no car available
% population living in nursing facilities
% persons living in poverty
% renter-occupied housing units
% families earning more than $200,000 income per year
% employment in service occupations
% employment in extractive industries (e.g., farming)
% population without health insurance (County SoVI only)
Community hospitals per capita (County SoVI only)

Figure 5.2 shows the foundational social vulnerability for the study area using the factors above, without analysis of resilience or loss data for a particular hazard. This map is used to interpret social vulnerability for hazards not specifically addressed in the NRI such as sinkholes. The map data are also used to rate mitigation actions for those hazards. This plan uses the full NRI dataset to produce maps of relative social vulnerability to several of the prominent natural hazards, including: flooding, severe wind events, and tornadoes.

Figure 5.2: NRI Social Vulnerability of the Study Area



Source: National Risk Index for Natural Hazards, FEMA 2021

Note: The Town of Surry is mapped in the *2022 Hampton Roads Hazard Mitigation Plan Update*; social vulnerability rating for the town is relatively moderate north of Route 10, and relatively low south of Route 10.

5.2.3 General Asset Inventory

The total dollar exposure of buildings within the study area is estimated to be $166 billion. This figure is based on the total number of buildings located throughout the region based on the Hazus default inventory (**Table 5.1**). The data provide an estimate of the aggregated replacement value for the region's assets and indicate that at least 61-percent of the structures are of wood construction.

Table 5.1: Exposure of the Built Environment

Community	Building Inventory by Type of Construction			
	Wood	Manufactured Homes	Masonry, Concrete, Steel	Total
Goochland County	$2,351,402,000	$26,620,000	$1,194,603,000	$3,572,625,000
Hanover County, inc. Ashland	$10,323,535,000	$41,239,000	$6,111,963,000	$16,476,737,000
Henrico County	$27,935,064,000	$24,559,000	$17,284,140,000	$45,243,763,000
New Kent County	$1,828,641,000	$23,172,000	$831,277,000	$2,683,090,000
Powhatan County	$2,518,231,000	$23,597,000	$1,200,380,000	$3,742,208,000
Richmond	$15,310,205,000	$38,719,000	$13,797,923,000	$29,146,847,000
Charles City	$523,409,000	$27,482,000	$271,230,000	$822,121,000
Chesterfield County	$29,732,123,000	$126,389,000	$15,045,912,000	$44,904,424,000
Colonial Heights	$1,484,948,000	$510,000	$1,079,487,000	$2,564,945,000
Dinwiddie County	$1,832,966,000	$89,731,000	$974,490,000	$2,897,187,000
Emporia	$356,446,000	$5,176,000	$389,636,000	$751,258,000
Greensville County, inc. Jarratt	$491,746,000	$51,033,000	$366,232,000	$909,011,000
Hopewell	$1,532,553,000	$6,872,000	$1,016,928,000	$2,556,353,000
Petersburg	$2,242,405,000	$21,342,000	$2,209,937,000	$4,473,684,000
Prince George County	$2,359,394,000	$53,205,000	$1,283,049,000	$3,695,648,000
Surry County	$509,304,000	$26,917,000	$259,858,000	$796,079,000
Sussex County, inc. Stony Creek, Wakefield, Waverly	$541,312,000	$58,292,000	$423,059,000	$1,022,663,000
Totals	**$101,873,684,000**	**$644,855,000**	**$63,740,104,000**	**$166,258,643,000**

Source: Hazus

5.3.3 Essential Facilities

There is no universally accepted definition of what constitutes essential or critical facilities and infrastructure, nor is one associated with FEMA and DMA 2000 planning requirements. However, for purposes of this Plan, essential facilities and infrastructure are identified as "*those facilities or systems whose incapacity or destruction would present an immediate threat to life, public health, and safety or have a debilitating effect on the economic security of the region.*" This typically includes facilities and systems based on

their high relative importance for the delivery of vital services, the protection of special populations, and other important functions in the region; however, for this risk analysis, the default Hazus list of essential facilities was used and includes: Emergency Operations Centers (EOC); hospitals; police stations; fire stations; schools; hazardous materials facilities; water and wastewater facilities; energy facilities (electric, oil and natural gas); and communication facilities.

Table 5.2 shows the results of a simple overlay analysis of the number of essential facilities that are located in the 100-year floodplain, 500-year floodplain, and a Storm Surge Zone for a Category 1,2,3 or 4 hurricane.

Table 5.2: Critical Facility Vulnerability Analysis

Community	100-Year Floodplain	500-Year Floodplain	Storm Surge Zone
Goochland Co	1	0	0
Hanover Co	2	1	0
Henrico Co	32 in FEMA SFHA; 8 in County floodplain*	0	0
New Kent Co	0	0	1
Powhatan Co	1	0	0
Richmond	8, inc. 2 in floodway	4	4
Charles City	0	0	3
Chesterfield Co	2, inc. 1 in floodway	1	9
Colonial Heights	2	0	1
Dinwiddie Co	2	0	0
Emporia	1, inc. 1 in floodway	2	0
Greensville Co	1	0	0
Hopewell	0	0	2
Petersburg	3	1	2
Prince George Co	0	0	0
Sussex Co	2, inc. 1 in floodway	0	0
Totals	26, inc. 5 in floodway	9	22

** Henrico County used an internally-produced list of facilities for this analysis.*

5.3 Major Disasters

Twenty-two major disasters have been declared which included at least one county or city within the planning region since 1965. Numerous "emergency declarations have also been declared supporting federal reimbursement for emergency categories of the Public Assistance Program. One third of the events were hurricane disasters, one quarter were

associated with severe storms, one fifth were snow and ice related, a few drought and flood disasters, and several unique events were included like a West Nile Virus disaster declared on May 30, 2000, support for Hurricane Katrina evacuees and the Louisa Earthquake which impacted Goochland County. Flooding is often included in severe storm, hurricane, and coastal storm disasters.

A summary of the total events declared is shown in Appendix F – HIRA. Appendix F-1 lists the presidentially declared disasters that have occurred in the Richmond-Crater region planning districts since disaster and emergency records supplemented with federal disaster declarations up to and including 2020.

5.4 Flooding

Hazard Profile

A flood occurs when an area that is normally dry becomes inundated with water. Floods may result from the overflow of surface waters, overflow of inland and tidal waters, or mudflows. Flooding can occur at any time of the year, with peak hazards in the late winter and early spring. Snowmelt and ice jam breakaway contribute to winter flooding, and seasonal rain patterns contribute to spring flooding. Torrential rains from hurricanes and tropical systems are more likely to occur in late summer. Development of flood-prone areas tends to increase the frequency and degree of flooding. The duration of flood events vary depending on the specific characteristics of the rain event. Floodwaters generally recede rapidly after the rain event has ended, but can last from a few hours to a few days.

Flooding can occur along all waterways in the region. Localized riverine flooding can occur in areas not adjacent to a major body of water. Some areas of the region are subject to tidal flooding during tropical storms and nor'easters. Flood duration is typically shorter for hurricanes and tropical storms than for riverine floods or nor'easters because the storms tend to move faster and affect only 1 to 2 tidal cycles. The main impacts from flooding include:

- Inundation of low-lying residential neighborhoods and subsequent damage to structures, contents, garages, and landscaping;
- Impassable road crossings and consequential risk for people and cars attempting to traverse flooded crossings;
- Damage to public and private infrastructure, possibly including but not limited to water and sewer lines, bridge embankments, and both small and large drainageways;
- Damage to hazardous materials facilities in the floodplain, resulting in leaching or spilling of toxic chemicals into the flooded waterways of the region;
- In coastal areas, wave action responsible for shoreline damage, and damage to boats and facilities;
- Inundation of critical facilities, possibly including some fire stations, police facilities, public shelters, EOCs, and several publicly-owned buildings. Public shelter

availability is limited by the expected severity of flooding. (See Table 5.2 for number of critical facilities in flood hazard areas.)

- Recovery time needed to bring critical infrastructure, schools and employers back online. Of particular concern in the region are transportation routes, including school bus routes, housing for displaced residents and debris management.

Communities in the study area have outlined specific plans for activating their EOC, protecting critical facilities and taking specific drainage system actions when faced with an impending flood. Since power outages and threats to the water supply can result from both the wind and flood hazard (which may occur simultaneously in the region), residents are advised of appropriate precautions and specific low-lying areas are evacuated to protect the safety of residents and responders, and to minimize loss of life.

When severe floods occur, the regional economy is severely impacted by the inability of flooded homeowners to get back to work quickly, the slow rebound of closed or debris-strewn transportation routes, the closing of schools and businesses, and the general state of emergency. Power outages and boil-water advisories are common and can affect many thousands of residents and businesses in the region for several days or even weeks if the damage is severe. Severely-flooded homes and neighborhoods result in displaced residents, including schoolchildren. Loss of life due to people traversing flooded roads, remaining in or becoming trapped in flooded structures, and curiosity-seekers watching the flooding is possible. Flooded businesses that decide to close, move or cease operations in the region have an impact on land values and the labor force, as does flood damage to the facilities of large employers in the region. Time spent repairing flood damage versus productive value-added labor is costly to employers.

Many roadways in the region are particularly vulnerable to inundation and damage from floodwaters. As a result, flooding can limit access to certain vulnerable areas, cutting off some residents from emergency services, schools and other economic foundations.

Flood damage to property and populations can be devastating, both emotionally and financially. Flood damage to businesses may result in loss of income, wages, and tax revenues. Buildings, including homes and critical facilities, are susceptible to damage and severe foundation damage or collapse as a result of a severe flood. Debris from vegetation and man-made structures is hazardous to drivers and pedestrians. In addition, floods may threaten water supplies and water quality, initiate power outages and create mold in flooded buildings. Left untreated, mold can cause respiratory illness and other maladies in a building's occupants. Other possible secondary effects of flooding include outbreaks of disease, widespread animal illnesses, disrupted utilities, water pollution especially from hazardous materials facilities in the flooded area, fires, washed out roads and culverts, and formation of sinkholes.

Location and Spatial Extent

Much of the land in the region's floodplains is designated for agricultural uses. Some localities, however, allow residential uses within agriculture areas. Agriculture is the

dominant land use in Charles City, Dinwiddie, Goochland, Greensville, Hanover, New Kent, Powhatan Counties, Prince George, Surry and Sussex Counties. Henrico and Chesterfield Counties floodplain land use is primarily parks or buffered residential. Similarly, the floodplains in the Cities of Richmond and Petersburg are primarily industrial or park land.

Areas identified as vulnerable to flooding are depicted on FEMA's Flood Insurance Rate Maps (FIRMs). These maps were developed through the NFIP and show the existing potential flood hazard areas throughout the region based on the estimated 100-year floodplain (**Figure 5.3**). In addition to flood hazard areas identified on the FIRMs, Henrico County has also created Community-Identified flood hazard areas that represent the 100-year and 500-year floodplains in areas not captured by FEMA. The 100-year floodplain represents the areas susceptible to the 1% annual flood. The maps also show the 0.2% annual flood, or 500-year floodplain. The 100-year flood, or base flood, has at least a 26% chance of occurring over the life of a typical 30-year mortgage. FIRM data is available through several sources for more detailed viewing at the parcel level:

- Paper FIRMs are required to be available for viewing in each jurisdiction that participates in the NFIP;

- The Virginia Flood Risk Information System at https://consapps.dcr.virginia.gov/VFRIS/ allows online search and downloads of statewide flood hazard zone information and other pertinent water resources data;

- The FEMA Map Service Center at https://msc.fema.gov/portal/ is the official public source for digital flood hazard information produced in support of the NFIP (although the paper FIRMs mentioned above remain the legal tool for regulating floodplains); and,

- Several localities in the study area have property information viewer tools with a flood data layer, including the following:

  Chesterfield County - https://www.arcgis.com/apps/webappviewer/index.html?id=cd20724aa8c941a093b0df70f0c558ba

  Goochland County - https://gis.co.goochland.va.us/GoochlandPV/

  Greensville County and Emporia - https://www.webgis.net/va/greensville/

  Hanover County and Ashland - https://parcelmap.hanovercounty.gov/

  Henrico County - https://henrico.maps.arcgis.com/apps/webappviewer/index.html?id=e940e72a32244bf3ae9a8098766f2bdd

  City of Hopewell - https://qpublic.schneidercorp.com/Application.aspx?App=CityofHopewellVA&PageType=Search

  New Kent County - https://parcelviewer.geodecisions.com/NewKent/

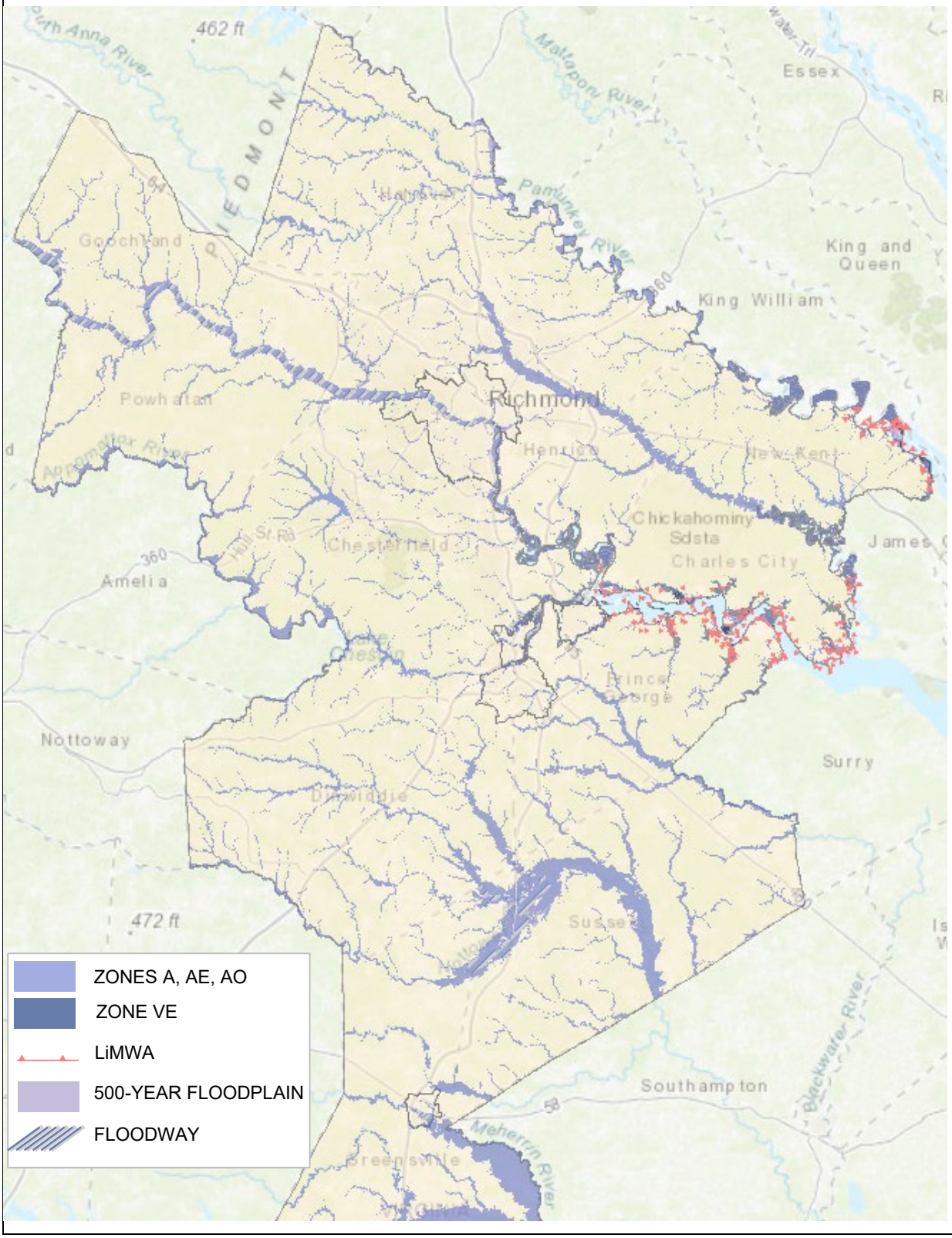
Powhatan County - https://powhatanvarealestate.org/ParcelViewer/

Prince George County - https://www.princegeorgecountyva.gov/business/gis_information/online_interactive_maps.php

City of Richmond - http://cor.maps.arcgis.com/home/webmap/viewer.html?webmap=d039492bec5346c8a75de1b6340da1c8&extent=-77.4795,37.5149,-77.4346,37.5348

Sussex County - https://parcelviewer.geodecisions.com/Sussex/

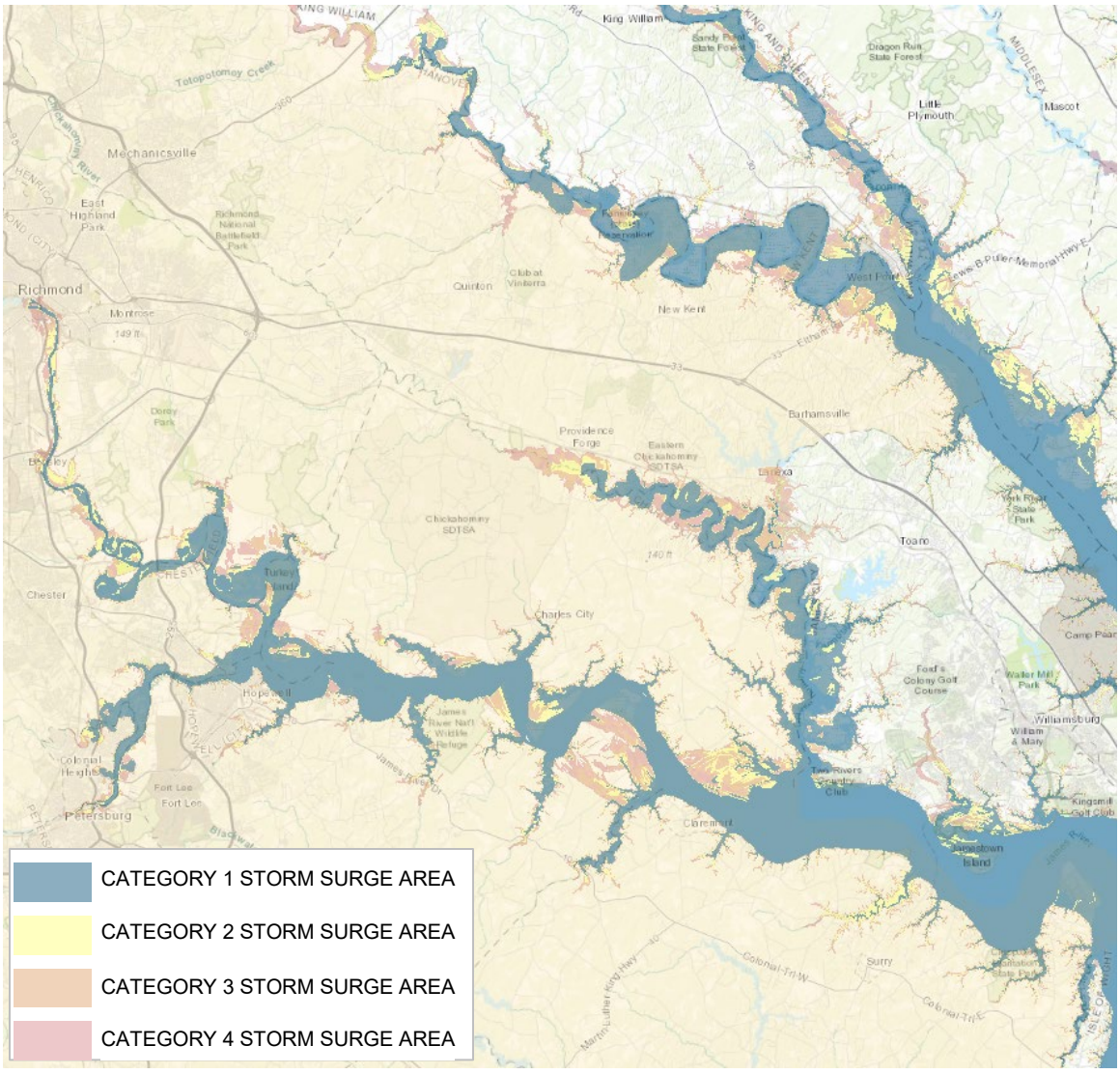
Figure 5.3: FEMA Flood Zones



Source: FEMA Flood Map Service Center, 2021

Figure 5.4a shows the most recent storm surge hazard areas that can be expected as the result of Category 1, 2, 3, and 4 hurricanes, based on the Sea, Lake and Overland Surge from Hurricanes (SLOSH) model. SLOSH is a computerized model run, conducted in this case by the U.S. Army Corps of Engineers, Norfolk District, to estimate storm surge heights resulting from hypothetical hurricanes by taking into account the maximum of various category hurricanes as determined by pressure, size, forward speed, and sustained winds. The regional analysis represents the composite maximum water inundation levels for a series of parallel tracks making landfall at various points along the coast. The SLOSH model, therefore, is best used for defining the "worst case scenario" of potential maximum surge for particular locations as opposed to the regional impact of one singular storm surge event.

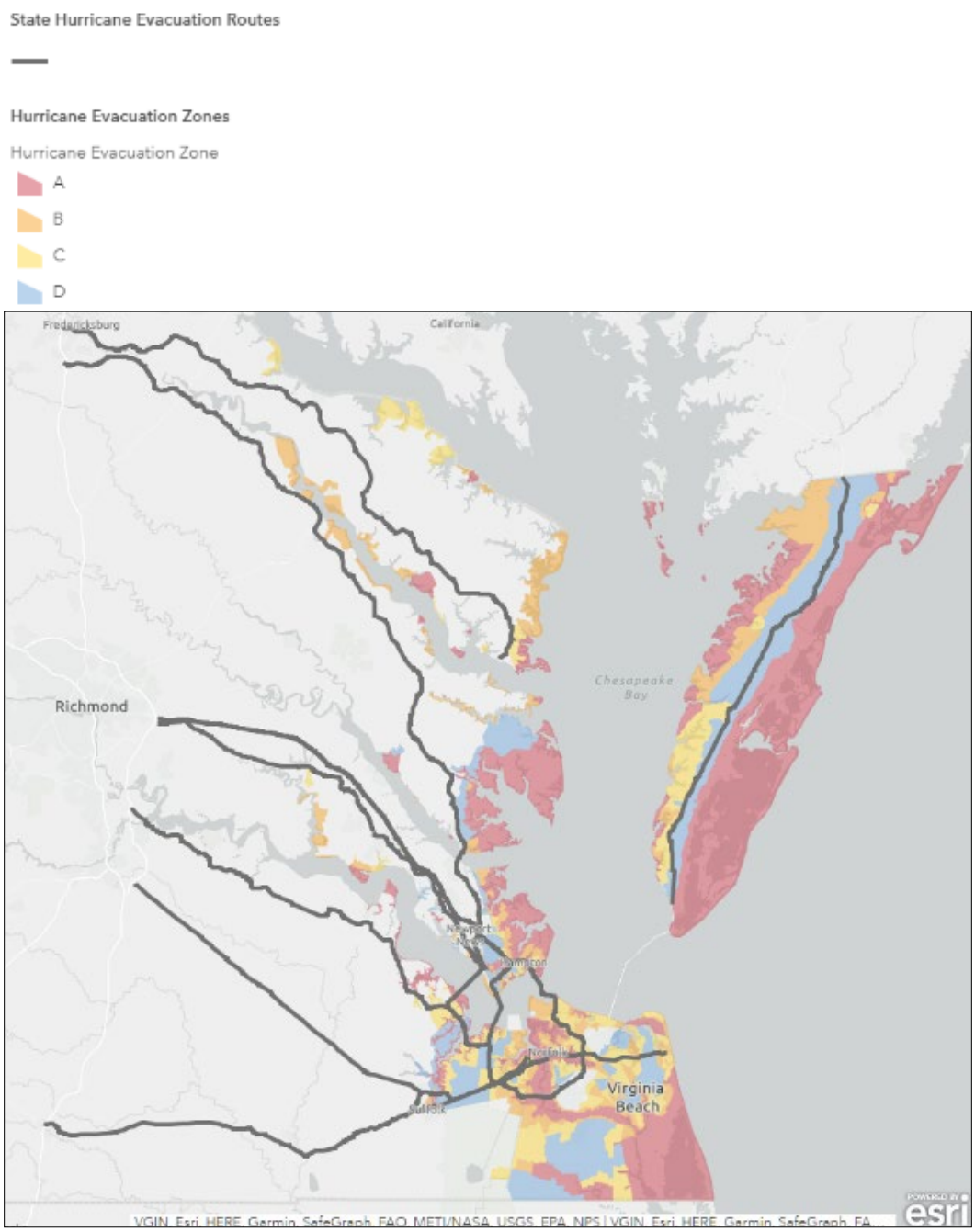
Figure 5.4a: Richmond-Crater Storm Surge Zones



Source: U.S. Army Corps of Engineers, Norfolk District, 2021

Figure 5.4b shows the Virginia Hurricane Evacuation Routes for Virginia, primarily from coastal regions inland. Termed the "Know Your Zone" initiative, this map and the effort to get the information engrained into residents' minds prior to impending hurricane-related flooding or high winds, emphasizes the importance of warning and evacuating residents and visitors well before weather conditions deteriorate. When a storm is approaching, emergency managers will determine which zones are most at risk considering the intensity, path, speed, tides and other meteorological factors. Emergency managers at the state and local level will work with local media and use social media and other tools to notify residents of impacted zones and what they should do to stay safe. Depending on the emergency, being safe might mean staying at home, a short trip to higher ground, or traveling to a different region of the state. Given the geography of the region and the reliance of the transportation system on tunnels and bridges, early evacuation is a crucial element in public safety.

Figure 5.4b: Virginia Hurricane Evacuation Routes



Source: VDEM, 2021

In addition to floodplains, tidal and non-tidal wetlands within all of the Richmond-Crater watersheds help store floodwaters, reduce erosion and filter pollutants. Wetlands are the transition area between aquatic and terrestrial habitats. A primarily low, marshy area, a wetland is saturated or even submerged all or part of the year, with soils that support unique plant and animal life. Wetlands work as a natural measure to help slow down the rising water from storms that may cause flooding, which is accomplished by acting as a giant sponge, absorbing and holding water during storms. Fast moving water is slowed by vegetation and temporarily stored in wetlands. Wetlands also filter pollutants carried by stormwater, which can be trapped by wetland vegetation. These excess nutrients are then used by the plants to promote growth.

Wetlands are resting, nesting, breeding, and spawning areas for many species of fish, shellfish, as well as other plant and animal life. More than one half of all threatened and endangered species depend on wetlands at one point of their life cycle. The study region spans a diverse range of habitats, including sandy beaches, salt marshes of the Chesapeake Bay, tidal fresh marshes, dry sandhills, seasonally wet ponds and blackwater swamps. These habitats support many rare and significant plant communities and rare species, including:

Mabee's Salamander	Ambystoma mabeei	State Threatened
Tiger Salamander	Ambystoma tigrinum	State Endangered
Henslow's Sparrow	Centronyx henslowii	State Threatened
Red-cockaded Woodpecker	Dryobates borealis	State and Federal Endangered
Peregrine Falcon	Falco peregrinus	State Threatened
Loggerhead Shrike	Lanius ludovicianus	State Threatened
Bachman's Sparrow	Peucaea aestivalis	State Threatened
Dwarf Wedgemussel	Alasmidonta heterodon	State and Federal Endangered
Yellow Lance	Elliptio lanceolata	State and Federal Threatened
Atlantic Pigtoe	Fusconaia masoni	State and Federal Threatened
Green Floater	Lasmigona subviridis	State Threatened
James Spinymussel	Parvaspina collina	State and Federal Endangered
Atlantic Sturgeon	Acipenser oxyrinchus	State and Federal Endangered
Blackbanded Sunfish	Enneacanthus chaetodon	State Endangered
Roanoke Logperch	Percina rex	State and Federal Endangered
Eastern Big-eared Bat	Corynorhinus rafinesquii macrotis	State Endangered
Tricolored bat (=Eastern pipistrelle)	Perimyotis subflavus	State Endangered
Sensitive Joint-vetch	Aeschynomene virginica	State and Federal Threatened
Virginia Quillwort	Isoetes virginica	State Endangered
Small Whorled Pogonia	Isotria medeoloides	State Endangered
New Jersey Rush	Juncus caesariensis	State Threatened
Michaux's Sumac	Rhus michauxii	Federal Endangered, State Threatened
Chaffseed	Schwalbea americana	Federal Endangered
Reclining Bulrush	Scirpus flaccidifolius	State Threatened

American Burying Beetle	Nicrophorus americanus	Federal Threatened
Virginia Piedmont Water Boatman	Sigara depressa	State Endangered
Swamp-pink	Helonias bullata	Federal Threatened, State Endangered
Narrow-leaved Spatterdock	Nuphar sagittifolia	State Threatened

Source: Virginia Natural Heritage Database Search, April 2022, online at: https://vanhde.org/species-search

Coastal wetlands absorb the erosive energy of waves, thus reducing further erosion. The vegetation provides a buffer to the shoreline from the wave action while the root systems provide support to help hold the soil together. Once plant material is removed or destroyed, the erosion potential increases dramatically. When any type of wetlands are filled in or drained, the areas designed by nature to control floodwaters from damaging storms, extreme high tides, and extreme precipitation are lost. In order to protect valuable natural communities and habitats for the rarest of plants and animals, Virginia through DCR has established natural area preserves. Existing natural area preserves in the region include: Cumberland Marsh in New Kent County; and Chub Sandhill in Sussex County.

Hazard History

Table 5.3 includes descriptions of major, recent flood events in the region. Events have been broken down by the date of occurrence and, when available, by individual community descriptions. Historical events pre-dating the 2011 version of this plan update can be found in Appendix F-2. The NCEI history reports minimal damages, no loss of life, and no injuries recorded in the 2016-2020 time period under examination; however, there were at least four water rescues during the period recorded in the database and others mentioned in news reports.

Table 5.3: History of Flood Events and Damages, 2011 – 2020*

Date	Damages
August 27, 2011	Hurricane Irene impacted the area with heavy rainfall and gusty winds which knocked power out to millions of people in the area. It took electrical crews several days to fully restore power in the planning area. Irene originated east of the Lesser Antilles and tracked north and northwest into the western Atlantic. The hurricane reached Category 3 intensity with maximum sustained winds of near 120 mph at its strongest point. The hurricane made an initial U.S. landfall in the eastern portions of the North Carolina Outer Banks on August 27, 2011, as a Category 1 hurricane. The storm then tracked north/northeast along the coast slowly weakening before making its final landfall in Brooklyn, New York on August 28 as a high-end tropical storm. Rainfall totals with the hurricane ranged from around two inches in western sections of the planning region to 5 to 9 inches in eastern sections closest to the coast. At its closest pass, Irene brought sustained winds of 30 to 45 mph with gusts of 60 to nearly 70 mph to the planning area. The winds downed power lines and trees throughout the area. A man was killed when a tree fell on his home near Colonial Heights. (Source: National Weather Service/Wakefield Office)
September 4, 2011	Tropical Storm Lee moved inland along the Mississippi/Louisiana Gulf Coast on September 4, 2011. The remnants of the weakening storm tracked northeast, producing rainfall over a wide swath extending from the Gulf Coast to New England.

Table 5.3: History of Flood Events and Damages, 2011 – 2020*	
Date	**Damages**
	Rainfall totals generally ranged from 4 to 8 inches in the planning area with the heaviest totals falling just east of Interstate 95. The rain fell on soils saturated only days earlier with Hurricane Irene's passage. The result was widespread flooding, particularly over the eastern sections of the planning region. Gusty winds in thunderstorms knocked down trees that had already been weakened from the hurricane resulting in thousands of power outages. (Source: National Weather Service/Wakefield Office)
May 18-19, 2018	Showers and thunderstorms associated with areas of low pressure along a frontal boundary produced heavy rain which caused lingering flooding across portions of central, south central, and eastern Virginia. Flooding occurred along the Chickahominy River, North Anna River, South Anna River, and Pamunkey River over a couple of days, with roads and low-lying areas near the river impacted the most. Numerous road closures in Charles City County, Chesterfield County (Otterdale Rd, Enon Church Rd off Rte 10), Dinwiddie County, Goochland County (Riddles Bridge Rd washed out), Hanover County (Horseshoe Bridge Rd, Greenwood Rd), Ashland, Henrico County (water rescue on Gayton Rd at Cedarbluff Dr, Patterson Ave, Old Springfield Rd, Laurel area, lanes of I-195 North near Broad St, Raintree area), New Kent County, Petersburg, Powhatan County, Prince George County, Richmond, Charles City County, and Hanover County. Canterbury Dam, a high hazard dam, overtopped in Henrico County causing significant impacts, including Pump Road being shut down. The county had to spend roughly $1M to fix the dam and provide overtopping protection.
June 2-3, 2018	Scattered showers and thunderstorms in advance of and along a frontal boundary produced heavy rain which caused flash flooding across portions of central Virginia. Flash flooding and many inundated roads reported in Henrico County with vehicle stuck in water on Cox Road, New Kent County with water on road at I-64, exit 220, Hanover County with a sinkhole reported near Huguenot Trail and Rte 288, Charles City County, and Hanover County with sinkhole at Crown Hill Road ($2000 damage) and Cross Corner Road washed out ($1000 damage).
June 7, 2019	Slow moving thunderstorms produced intense rainfall of 4 to 6 inches resulting in flash flooding on June 7th, causing flash flooding in Charles City County (portion of Rte 5 closed), Chesterfield County (portion of Turner Rd closed), Ashland (home flooded with $2000 damage), Hanover County (portions of East Patrick Henry Rd), Henrico County (flooding of roads in Glen Allen) and Wakefield (Hwy 460 closed at Main and Hwy 31, impacts to Virginia Diner and James River Equipment with $100,000 damage).
August 15, 2020	Scattered showers and thunderstorms associated with low pressure and a frontal boundary produced heavy rain which caused flash flooding across portions of central and southeast Virginia. Flooding reported in Chesterfield County (Old Hundred Rd, Mt Hermon Rd, water rescue at Otterdale Rd, Rte 10 in Chesterfield), Colonial Heights (2 water rescues), Hopewell, Petersburg, and northwest Prince George County.

**Flood history from 1950-2010 can be found in Appendix F-2.*
Source: NCEI, 2021

Table 5.4 provides the number of events and damage caused by recorded flood events for each jurisdiction. These results represent only events recorded by the NCEI storm events database for flood. Some of the events listed in the table may be regional in nature, impacting multiple jurisdictions. Significant tropical storm or hurricane events resulting in

flooding have been included although minor tropical storms may have resulted in flooding but may not have been recorded in the NCEI as flood events. See the tropical storm section for additional information. Chesterfield (41) and Henrico (30) Counties have the highest number of flood events, and Greensville County had over $1M in property damages during this time period.

Table 5.4: Flood Damage to Property and Crops, 1993 – October 2020

Jurisdiction	Flood Events	Property Damages	Crop Damages
Charles City County	14	-	-
Chesterfield County	41	$287,458	$2,986
City of Colonial Heights	8	$71,663	-
Dinwiddie County (inc. Town of McKenney)	11	$12,223	$3,285
City of Emporia	3	-	-
Goochland County	7	$38,818	$11,944
Greensville County (inc. Town of Jarratt)	13	$1,065,175	-
Hanover County (inc. Town of Ashland)	23	$163,993	$25,082
Henrico County	30	-	-
City of Hopewell	9	$71,663	
New Kent County	21	$109,340	-
City of Petersburg	17	$141,487	-
Powhatan County	13	$38,966	-
Prince George County	15	-	-
City of Richmond	16	$94,711	-
Surry County (inc. Towns of Claremont, Dendron, Surry)	22	$1,460,000	$750,000
Sussex County (inc. Towns of Stony Creek, Wakefield, Waverly)	18	$365,726	$62,187
Totals	**259**	**$2,461,223**	**$105,484**

Source: NCEI, February 3, 2021.

The most significant event in the past five years occurred June 7, 2019, in Sussex County. Slow moving thunderstorms produced intense rainfall of 4 to 6 inches resulting in flash flooding. Highway 460 was closed in both directions at Main Street and Highway 31 due to flooding. Flooding also impacted the Virginia Diner and James River Equipment. Property damages from this storm totaled $100,000.

Vulnerability Analysis

The vulnerability assessment for the flood hazard includes the findings of the qualitative assessment conducted, an overview of NFIP statistics, repetitive loss properties (as defined and identified by the NFIP), estimates of potential losses, future vulnerability, social

vulnerability, expected impacts from climate change and discussion on impacts related to mass evacuations.

As shown in **Table 5.5**, communities in the Richmond-Crater region joined the NFIP throughout the 1970s, 1980s and into the 1990s. In order to join the NFIP, each participating jurisdiction is required to adopt and enforce its own floodplain management ordinance. As a result, structures built after joining the NFIP are assumed to be less vulnerable to flood hazards than those built prior to joining, assuming other environmental conditions remain constant.

Table 5.5: Communities Participating in the NFIP as of March 15, 2021

Community	NFIP Entry Date	Current FIRM Effective Date
Charles City County	09/05/90	07/06/15
Chesterfield County	03/16/83	12/18/12
City of Colonial Heights	09/02/81	08/02/12
Dinwiddie County	01/17/79	10/21/21
Town of McKenney	11/20/81	No Special Flood Hazard Area identified
City of Emporia	09/30/77	07/07/09
Goochland County	03/01/79	12/02/08
Greensville County	09/29/78	07/07/09
*Town of Jarratt**	10/08/82	07/07/09
Hanover County	09/02/81	12/02/08
Town of Ashland	05/26/78	12/02/08
Henrico County	02/04/81	12/18/07
City of Hopewell	09/05/79	07/16/15
New Kent County	12/05/90	08/03/15
City of Petersburg	03/16/81	02/04/11
Powhatan County	09/15/78	02/06/08
Prince George County	05/01/80	06/02/15
City of Richmond	06/15/79	07/16/14
Sussex County	03/02/83	07/07/09
Town of Stony Creek	09/16/82	07/07/09
Town of Wakefield	03/12/14	07/07/09

*Jarratt is included in Greensville County for purposes of the NFIP.
Source: National Flood Insurance Program Community Status List, 2021

Table 5.6 provides data regarding the number of flood insurance policies and the value of those policies for NFIP-participating communities in the study area. As of April 8, 2021, there were 3,438 flood insurance policies-in-force in the region, an increase of 56 policies since June 2016. These policies amounted to more than $983 million in total insurance

coverage, an increase of 7-percent since 2016. With just over 1,400 claims filed, the NFIP has paid out $21.6 million in payments since 1978 in the Richmond-Crater region.

Just three communities in the study area have absorbed almost 84% of the NFIP claims: Richmond 52%; Henrico County 17% and Chesterfield County 15%. The Town of Surry is 0.4 miles from mapped SFHA, which is approximate Zone A of Green Swamp. The town has decided not to participate in the NFIP. In the course of investigating why Waverly is not in the NFIP, planners discovered that the boundaries of the town on the FIRM do not match State records. The FIRM town boundary is incorrect and should include SFHA of Spring Branch. A mitigation action to address this issue is included in this plan.

Table 5.6: NFIP Claim Statistics by Participating Jurisdiction												
Jurisdiction Name	**Policy Statistics**		**Claim Statistics**		**Policy Statistics**		**Claims Statistics**		**Policy Delta**		**Claims Delta**	
	2016		**1978-2016**		**2021**		**1978-2021**		**2016-2021**		**2016-2021**	
	Policies -In-Force	**Insurance In-Force**	**Total Claims**	**Total Payment**	**Policies-In-Force**	**Insurance In-Force**	**Total Claims**	**Total Payment**	**Policies -In-Force**	**Insurance In-Force**	**Total Claims**	**Total Payment**
Charles City County	20	$6,320,700	7	$42,606	21	$6,731,500	8	$51,299	1	$410,800	1	$8,693
Chesterfield County	864	$231,463,100	175	$2,580,112	903	$258,952,800	219	$3,265,460	39	$27,489,700	44	$685,348
Colonial Heights	112	$27,581,600	79	$1,061,117	93	$25,331,500	85	$1,201,552	-19	-$2,250,100	6	$140,435
Dinwiddie County	39	$10,729,600	2	$11,979	36	$10,374,600	2	$11,979	-3	-$355,000	0	$0
Town of McKenney	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0
Emporia	38	$5,400,900	10	$6,060	30	$5,403,500	13	$21,020	-8	$2,600	3	$14,960
Goochland County	47	$14,506,100	12	$137,267	56	$17,890,100	11	$126,623	9	$3,384,000	-1	-$10,644
Greensville County	17	$3,630,900	4	$26,145	14	$3,489,100	6	$28,061	-3	-$141,800	2	$1,916
Town of Jarratt	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0
Hanover County	177	$51,675,300	23	$253,608	207	$63,928,100	27	$359,874	30	$12,252,800	4	$106,266
Town of Ashland	44	$13,629,600	3	$4,655	50	$16,290,200	8	$22,009	6	$2,660,600	5	$17,354
Henrico County	986	$246,491,700	240	$2,978,970	1032	$274,960,700	303	$3,585,760	46	$28,469,000	63	$606,790
Hopewell	26	$7,607,000	11	$101,018	29	$9,569,900	17	$145,880	3	$1,962,900	6	$44,862
New Kent County	119	$34,367,100	29	$488,862	113	$33,582,000	31	$517,274	-6	-$785,100	2	$28,412
Petersburg	137	$38,183,500	76	$481,948	98	$30,180,900	88	$727,738	-39	-$8,002,600	12	$245,790
Powhatan County	30	$8,480,000	1	$4,867	38	$12,595,000	1	$4,867	8	$4,115,000	0	$0
Prince George County	94	$25,420,500	27	$223,737	92	$26,886,600	31	$248,986	-2	$1,466,100	4	$25,249
Richmond	586	$183,772,500	515	$10,666,886	582	$176,882,300	537	$11,133,693	-4	-$6,890,200	22	$466,807

Table 5.6: NFIP Claim Statistics by Participating Jurisdiction												
Jurisdiction Name	**Policy Statistics**		**Claim Statistics**		**Policy Statistics**		**Claims Statistics**		**Policy Delta**		**Claims Delta**	
	2016		**1978-2016**		**2021**		**1978-2021**		**2016-2021**		**2016-2021**	
	Policies -In-Force	**Insurance In-Force**	**Total Claims**	**Total Payment**	**Policies-In-Force**	**Insurance In-Force**	**Total Claims**	**Total Payment**	**Policies -In-Force**	**Insurance In-Force**	**Total Claims**	**Total Payment**
Sussex County	24	$5,016,700	12	$47,630	26	$6,565,700	12	$46,657	2	$1,549,000	0	-$973
Town of Stony Creek	22	$3,653,500	23	$96,039	15	$2,637,300	22	$96,039	-7	-$1,016,200	-1	$0
Town of Wakefield	0	$0	0	$0	3	$1,020,000	0	$0	3	$1,020,000	0	$0
Totals	**3,382**	**$917,930,300**	**1,249**	**$19,213,506**	**3,438**	**$983,271,800**	**1,421**	**$21,594,771**	**56**	**$65,341,500**	**172**	**$2,381,265**

Source: NFIP data, dated 6/30/2016 and 4/8/2021.

FEMA Repetitive Loss and Severe Repetitive Loss Properties

Nationwide, repetitive loss (RL) properties constitute 2% of all NFIP insured properties but are responsible for 40% of all NFIP claims. Mitigation for RL properties is a high priority for FEMA, and the areas in which these properties are located typically represent the most floodprone areas of a community.

The identification of RL properties is an important element in assessing local flood risk because the inherent characteristics of properties with multiple flood losses strongly suggest that they will be threatened by continual losses. RL properties are also important to the NFIP, since structures that flood frequently put a strain on NFIP funds. The NFIP defines an RL as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978.[7] A primary goal of FEMA is to reduce the numbers of structures that meet these criteria, whether through elevation, acquisition, relocation, or a flood control project that lessens the potential for continual losses.

According to FEMA, there are currently 158 RL properties within the Richmond-Crater region accounting for 468 losses. The specific addresses of the properties are maintained by FEMA, VDEM, and local jurisdictions, but are deliberately not included in this plan in accordance with the Privacy Act of 1974. More than $13.8 million has been paid in total repetitive losses, with an average claim of $30,000. **Table 5.7** shows the total number of properties, total number of losses experienced, and losses paid for all of the communities within the planning region. Historically, the majority of the RL properties are residential; however, a breakdown by property type was not provided by FEMA for this plan update.

A severe repetitive loss (SRL) property has: a) at least four NFIP claims payments of more than $5,000 each, with the cumulative amount of such claims payments exceeding $20,000; or b) at least two separate claims payments with the cumulative amount exceeding the market value of the building. As shown in Table 5.7, Chesterfield and Henrico Counties have the most SRL properties in the study area.

[7] The FEMA Hazard Mitigation Assistance Program defines RL as having incurred flood-related damage on 2 occasions, in which the cost of the repair, on the average, equaled or exceeded 25 percent of the market value of the structure at the time of each such flood event; and, at the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.

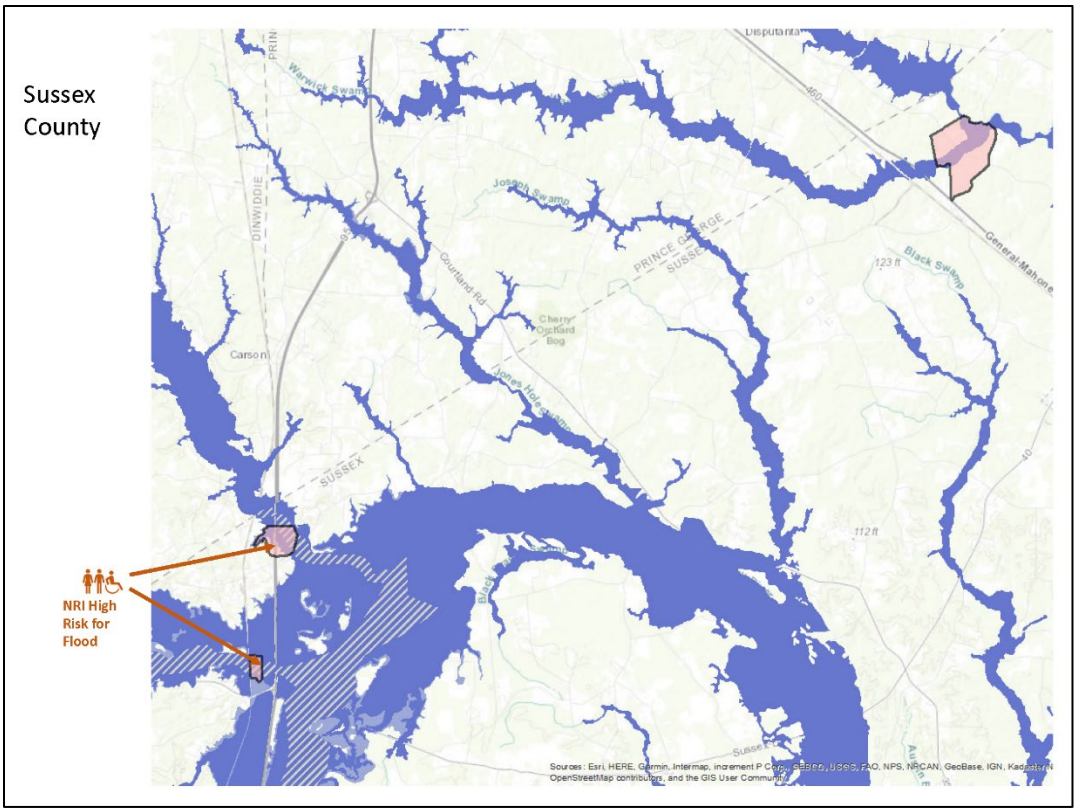
Table 5.7 Repetitive Flood Losses and Severe Repetitive Flood Losses				
Community	**Repetitive Flood Loss Detailed Data**			
Chesterfield County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	25	$1,359,017.04	77	$17,649.57
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	7	$691,300.59	33	$20,948.50
Claremont Town	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	4	$400,805.50	14	$28,628.97
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	3	$374,116.60	12	$31,176.38
Colonial Heights City	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	12	$912,220.30	37	$24,654.60
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	3	$324,780.80	14	$23,198.63
Dinwiddie County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	1	$67,506.04	4	$16,876.51
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	1	$67,506.04	4	$16,876.51
Emporia City	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	1	$15,358.28	3	$5,119.43
Goochland County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	1	$94,689.86	3	$31,563.29
Hanover County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	1	$134,119.83	2	$67,059.92

Table 5.7 Repetitive Flood Losses and Severe Repetitive Flood Losses

Community	Repetitive Flood Loss Detailed Data			
Henrico County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	25	$1,765,976.35	99	$17,838.14
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	5	$717,634.39	40	$17,940.86
Hopewell City	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	1	$38,658.56	2	$19,329.28
New Kent County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	3	$272,374.43	10	$27,237.44
Petersburg City	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	11	$530,383.70	31	$17,109.15
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	2	$101,438.10	9	$11,270.89
Prince George County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	3	$179,261.10	10	$17,926.11
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	2	$144,808.10	8	$18,101.02
Richmond City	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	63	$8,019,552.70	162	$49,503.41
	Severe Repetitive Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	1	$1,386,405.53	13	$106,646.58
Stony Creek Town	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	4	$47,479.36	8	$5,934.92
Sussex County	Repetitive Flood Losses			
	Number of Properties	Value of Losses	Number of Losses	Avg Payment Per Claim
	3	$31,120.50	6	$5,186.75

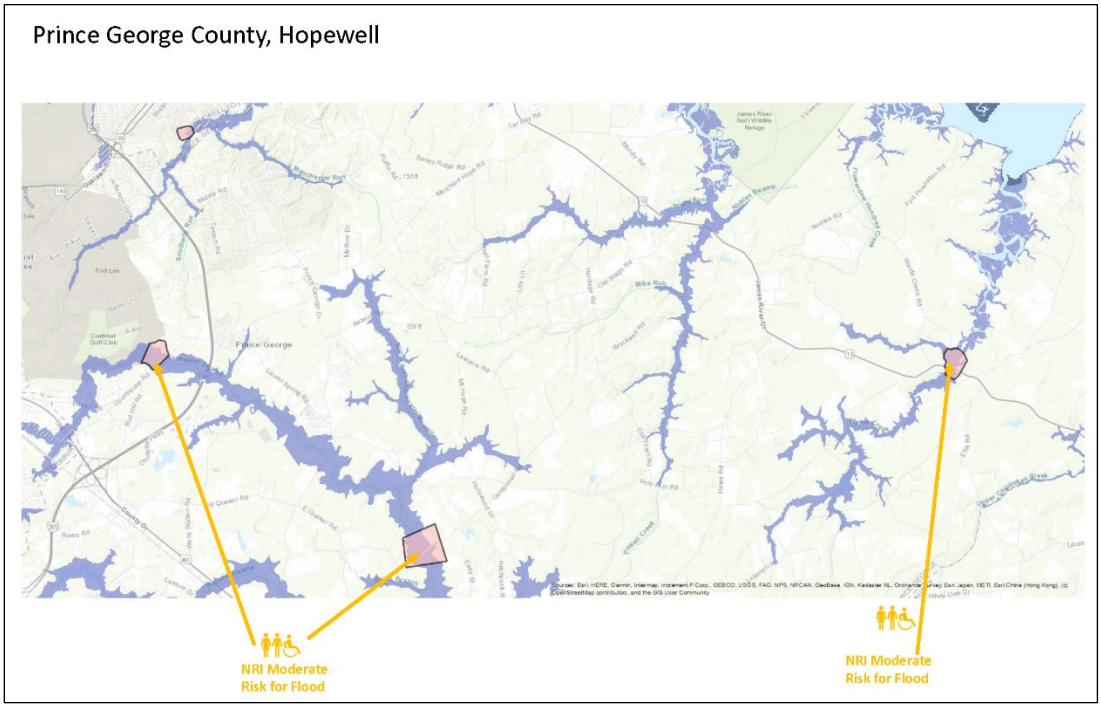
Figures 5.5a through 5.5j contain maps of the region's 59 repetitive loss areas. Each designated area shown in pink was identified by referencing maps of all historical NFIP flood claims, NFIP RL lists, the SRL list and, in some cases, Hazus results regarding predicted flood damages from a 100-year flood for individual structures. As shown in **Table 5.8**, there are 158 properties on FEMA's repetitive loss list and an additional 6,097 parcels identified as being within those repetitive loss areas. Other structures near the ones listed by the NFIP may have been uninsured during the floods, may have had single flood insurance claims, may be privately insured against flood, or may have had multiple claims under different policies that the claims system did not recognize as being the same repetitively flooded address. The NRI category for social vulnerability is noted for RL areas designated as "Relatively High" or "Relatively Moderate." There were no tracts in the Richmond-Crater region designated as "Very High" for social vulnerability to flood.

Figure 5.5a. Repetitive Loss Areas and National Risk Index Ratings of High or Moderate Risk



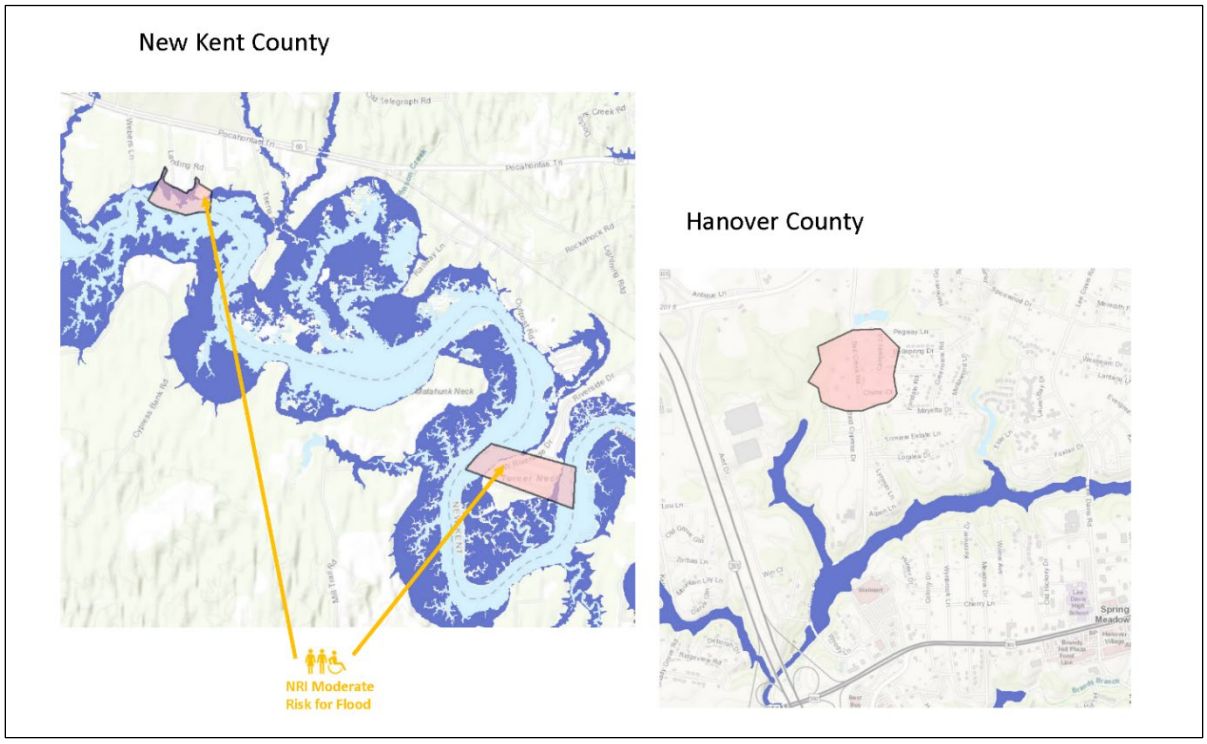
2021

Figure 5.5b. Repetitive Loss Areas and National Risk Index Ratings of High or Moderate Risk



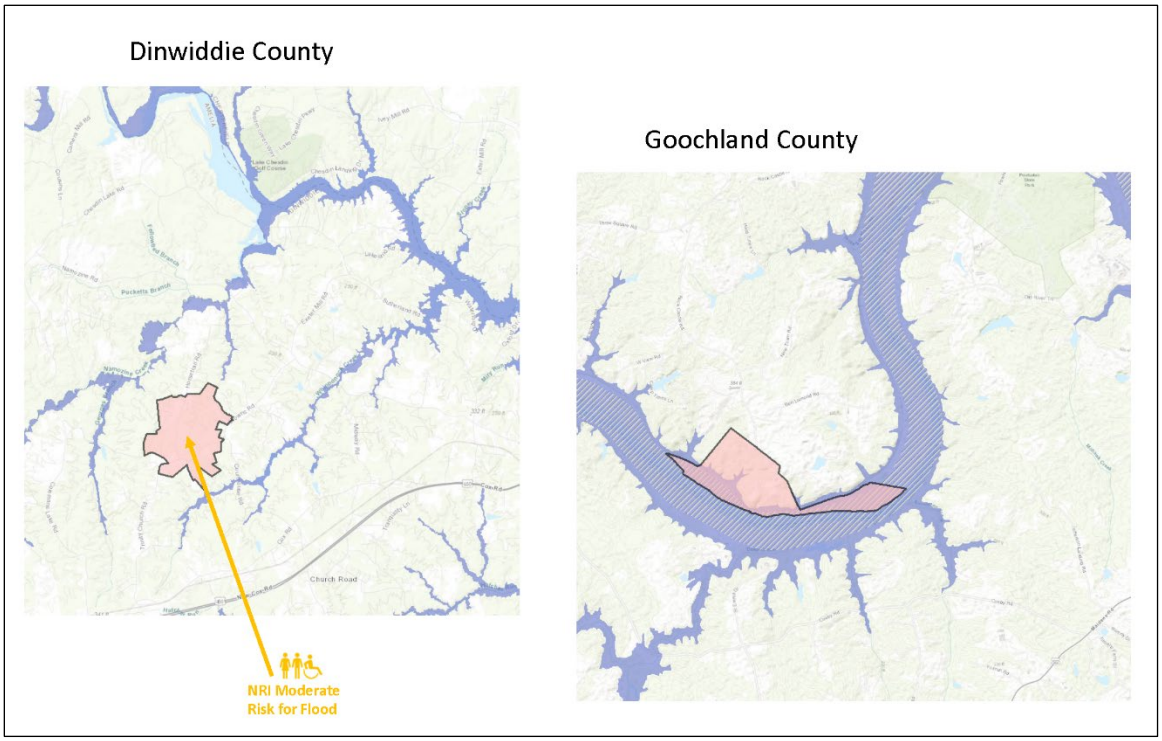
2021

Figure 5.5c. Repetitive Loss Areas and National Risk Index Ratings of High or Moderate Risk



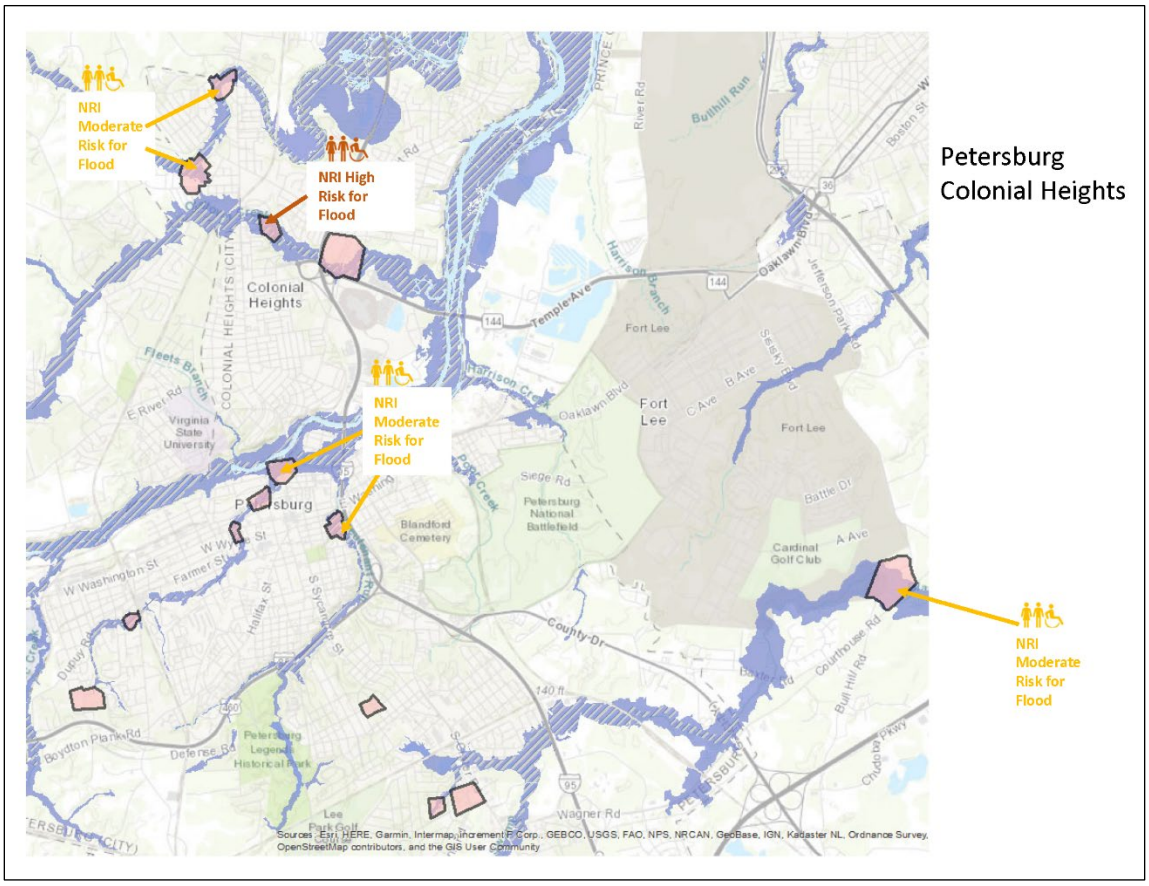
2021

Figure 5.5d. Repetitive Loss Areas and National Risk Index Ratings of High or Moderate Risk



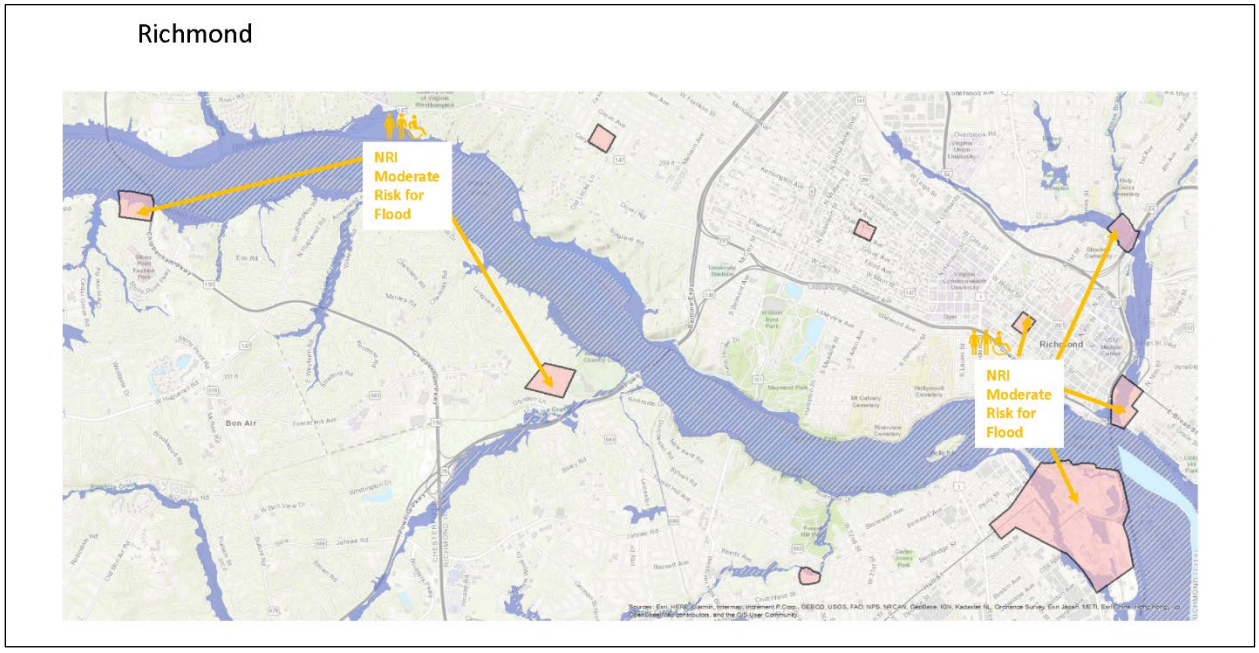
2021

Figure 5.5e. Repetitive Loss Areas and National Risk Index Ratings of High or Moderate Risk



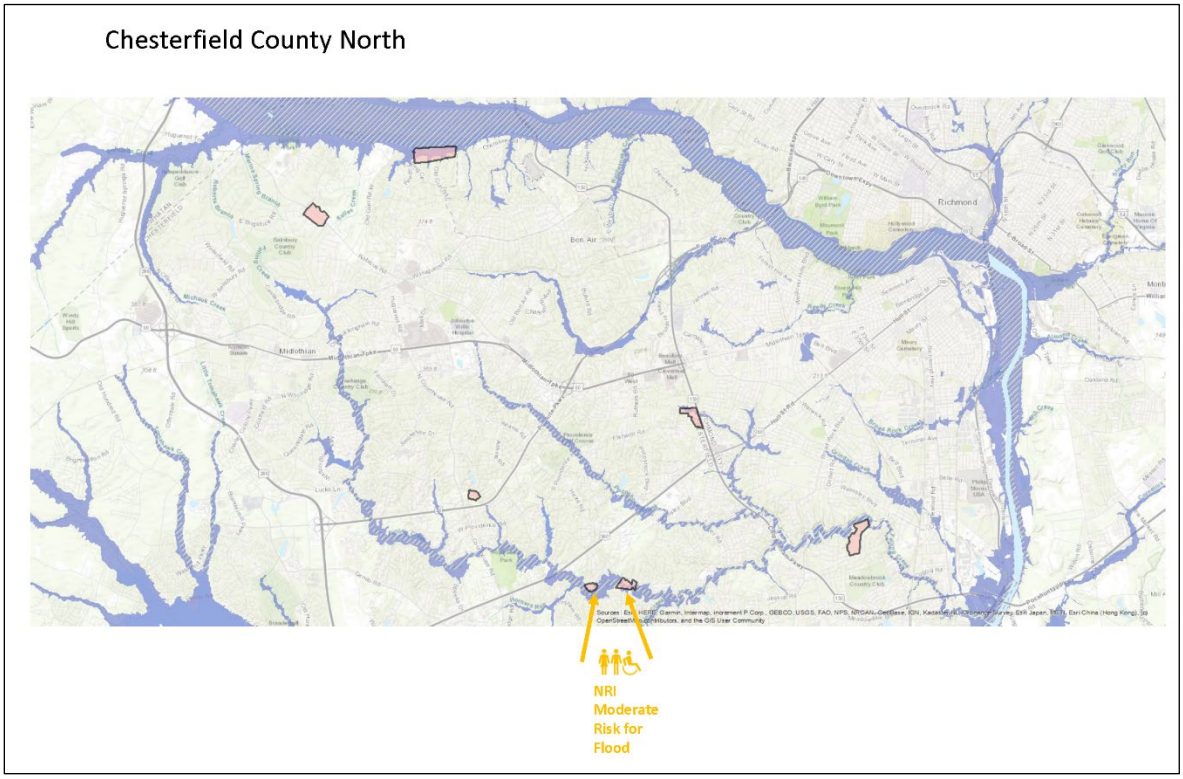
2021

Figure 5.5f. Repetitive Loss Areas and National Risk Index Ratings of High or Moderate Risk



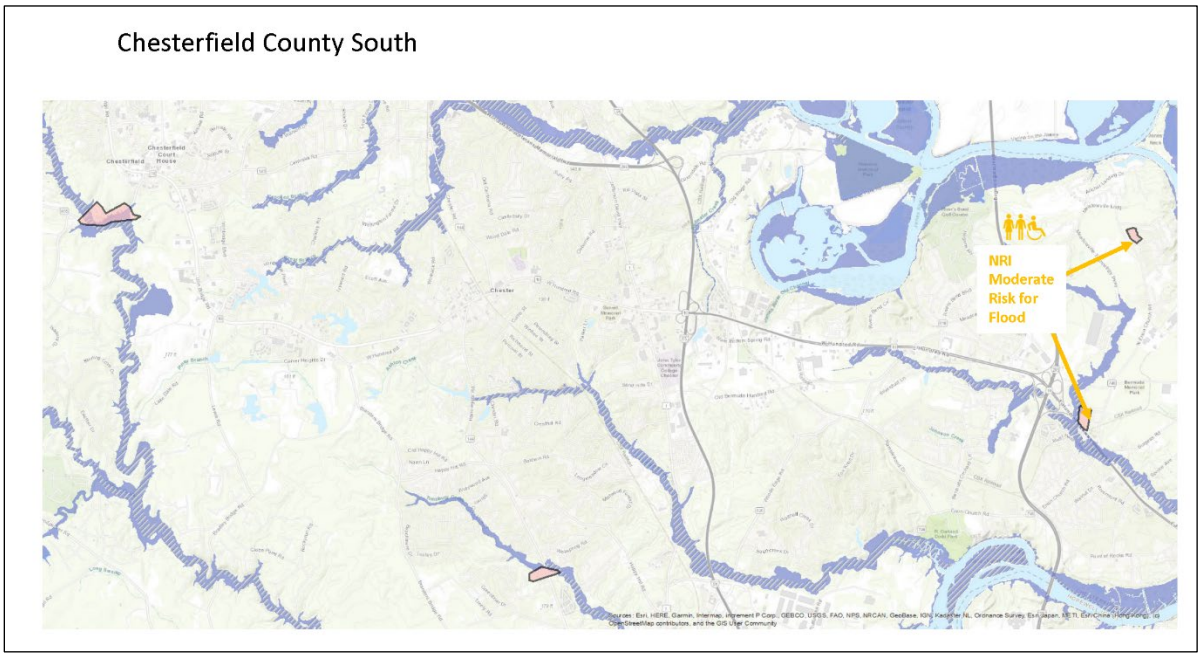
2021

Figure 5.5g. Repetitive Loss Areas and National Risk Index Ratings of High or Moderate Risk



2021

Figure 5.5h. Repetitive Loss Areas and National Risk Index Ratings of High or Moderate Risk

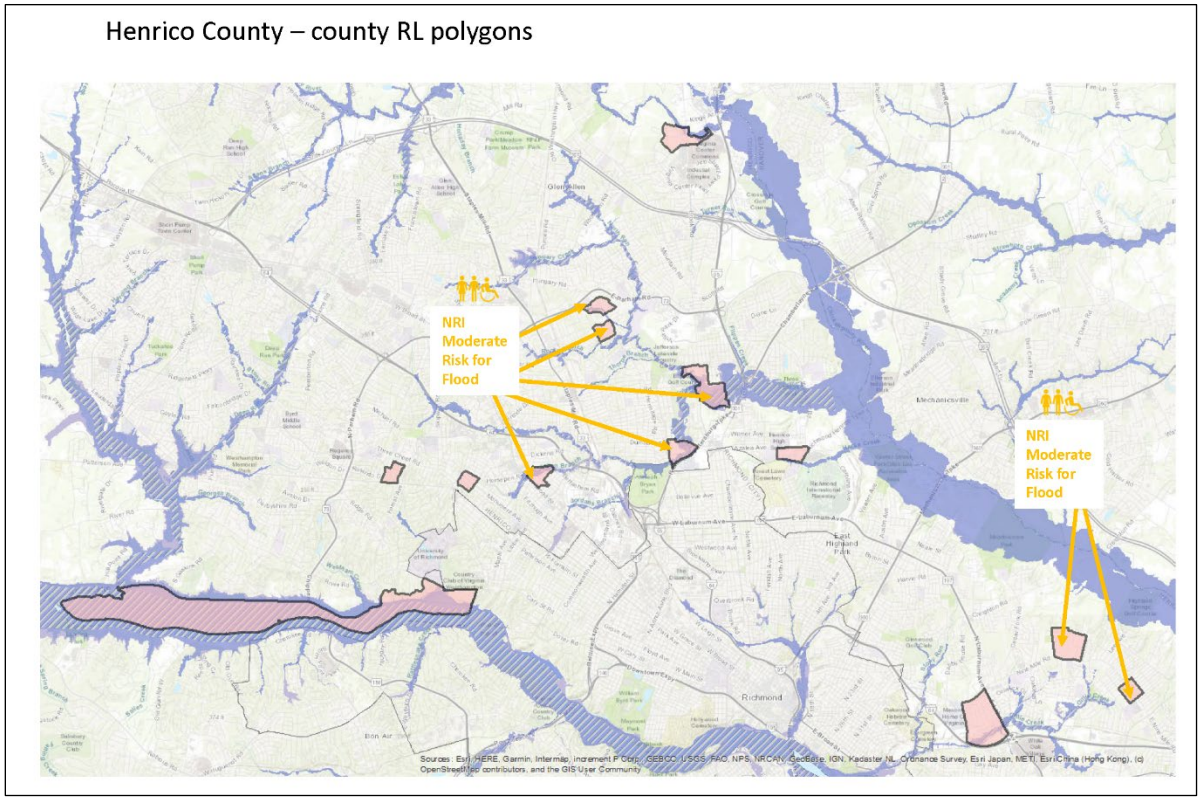


2021

Figure 5.5i. Repetitive Loss Areas and National Risk Index Ratings of High or Moderate Risk

2021

Figure 5.5j. Repetitive Loss Areas and National Risk Index Ratings of High or Moderate Risk



2021

Table 5.8: Repetitive Flood Loss Area Descriptions				
Community	Total Number of RL Areas	Number of High or Moderate Risk RL Areas	Estimated Number of Structures	Sources of Flooding
Goochland County	1	0	4	Overland flow of the James River in a large meander bend with broad floodplain on the north bank.
Hanover County	1	0	66	Area is outside the 100-year floodplain but lies between two tributaries to Beaverdam Creek.
Henrico County – from County RL polygons	13	7 Moderate	4,189	The northernmost RL area contains the 100-year floodplain of the Chickahominy River. In the western part of the county, a RL area lies outside the 100-year floodplain, near the headwaters of Little Westham Creek. One area is within the 100-year floodplain along Horespen Branch, with another area near the headwaters of Horsepen Branch. A large RL area lies along the northern bank of the James River, with the majority of the polygon within the 100-year floodplain. In the central part of the county, there are five areas with 100-year floodplain in the North Run and Upham Brook watersheds, with two along North Run Tributary 2, one at the confluence of North Run and Upham Brook, and one near the confluence of Upham Brook and Jordans Branch. Another nearby area is located in the upper portion of the Horse Swamp Creek 100-year floodplain. There are three eastern RL areas: one within the Gillies Creek 100-year floodplain, along Gillies Creek Tributary 9, near the confluence of Gillies Creek Tributary 2 and Gillies Creek Tributary 8; one area is outside of the floodplain but upstream of Tributary A to Gillies Creek Tributary 1; and one area is outside of the floodplain but upstream to Chickahominy River Tributary 17.
New Kent County	2	2 Moderate	175	Both areas are low-lying groups of residential structures in the meander bends of the Chickahominy River. The Chickahominy Shores neighborhood is on an oxbow named Turner Neck, with houses outside the 100-year floodplain, but within the storm surge zones for most hurricane categories.
Richmond	9	6 Moderate	774	The largest RL area is South Richmond, on the south side of the James River, across from Downtown. Two other areas are in the 100-year floodplain of Cannon Branch that flows between Downtown Richmond and Church Hill before entering the James River. An RL area exists along the Reedy Creek floodplain and floodway, south of Forest Hill Park, while another is in the 100-year floodplain of the James River, east of downtown near Chippenham Parkway. The remaining four areas are outside the 100-year floodplain and have stormwater-related causes.
Chesterfield County	11	4 Moderate	377	Four RL areas are along Falling Creek, or an unnamed tributary of Falling Creek near Chippenham Mall. Structures in the northernmost RL area are primarily in the 100-year floodplain of the James River, near the intersection of Old Gun Road and Cherokee Road. There are 41 structures in an RL area downstream of the Swift

Table 5.8: Repetitive Flood Loss Area Descriptions				
Community	Total Number of RL Areas	Number of High or Moderate Risk RL Areas	Estimated Number of Structures	Sources of Flooding
				Creek Lake Dam, while two other RL areas are on Timsbury Creek and an unnamed tributary of Johnson Creek. Three of the RL areas are outside the 100-year floodplain.
Colonial Heights	4	1 High, 2 Moderate	102	All four RL areas contain 100-year flood and designated floodway segments. The waterway sources are: Swift Creek (2 areas); and Oldtown Creek. The flooding to 2 apartment buildings in one area was due creek flooding during Hurricane Isabel in 2003. The flood waters rose above the 1st floor onto the 2nd floor. In 2004 the City did debris cleanup in the creek to remediate the problem. Since that time there has been little to no flooding.
Dinwiddie County	1	1 Moderate	32	Area is outside the 100-year floodplain but lies between Whipponock Creek to the south and Georges Branch to the west. Georges Branch is a tributary to Namozine Creek.
Emporia	1	1 Moderate	12	Suspected backwater flow from the Rt 58 bridge over a tributary to Metcalf Branch. Part of the RL area is designated Zone A, but no detailed study appears to have been done.
Hopewell	1	0	51	Structures are in an area outside the detailed-study 100-year floodplain and floodway of Bailey Creek, a tributary of the James River. Bailey Creek, in general, has a relatively flat watershed; the lower reaches are swampy, and flow is very sluggish.
Petersburg	9	3 Moderate	295	Five of the RL areas are along Brickhouse Run, a tributary to the Appomattox River with its headwaters in southern Petersburg. Lieutenant Run has a large backwater floodplain with designated floodway south of Washington Street that has repetitive flood losses. Poor drainage near Blackwater Swamp in the southeastern region of the City has resulted in 2 RL areas, and another RL area is not associated with any water bodies near Walnut Hill at Weyanoke Street and Arch Street.
Prince George County	2	2 Moderate	36	A low-lying part of Blackwater Swamp just north of the confluence with Dicks Branch contains over half the structures and lies within the 100-year floodplain of Blackwater Swamp. The remaining structures appear to be flooded by Wards Creek, downstream of the Rt 10 crossing and within the 100-year floodplain
Claremont	1	0	45	The single RL area is outside the 100-year floodplain as mapped by FEMA. Source of flooding suspected to be stormwater-related.
Stony Creek	1	1 High	69	The RL area is part of the floodway and 100-year floodplain of Stony Creek, east of Main Street, south of Crowder Lane toward Lee Ave on the south.
Sussex County	2	1 High	28	The westernmost area is within the 100-year floodplain of the tributaries that feed the Nottoway River near Stony Creek. The eastern RL area is along Warwick Swamp at its confluence with the Blackwater Swamp.

Estimates of Potential Losses

For the updated flood vulnerability analysis, participating communities were asked to share as much information as possible about individual structures in their communities, including:

- address;
- year built;
- number of stories;
- building cost;
- content cost;
- building type;
- square footage;
- construction class;
- foundation type;
- occupancy/use code; and/or
- Elevation Certificate data or lowest floor elevation.

As part of the flood hazard vulnerability assessments, analysts used the datasets provided by each community to construct the necessary base datasets required by Hazus to conduct a detailed, Level 2 hazard assessment wherever there are detailed FEMA flood studies. The following highlights the data source and processing methodology for each of the input datasets required by Hazus:

Flood Hazard Data and Depth Rasters

Geospatial analysts obtained the most recent effective Digital Flood Insurance Rate Map databases from the FEMA Map Service Center for the region. The 100-year floodplain boundary and associated Base Flood Elevations (BFE) were used as the flooding source input to Hazus for calculating the loss estimations.

User Defined Facilities (Building Data)

Communities provided building data in the form of either parcels, building footprints or address points. The datasets were inconsistent across the communities, but from each dataset, analysts were able to determine the basic structural attributes (i.e., value, foundation type, occupancy class, etc.) required by Hazus to perform a loss estimation. In some cases, Hazus appears to have counted structures as impacted or flooded when the parcel intersected the 100-year floodplain, but not necessarily the structure footprint, which may have artificially inflated some of the impacts.

Because of either a lack of structure-specific data or a lack of FEMA-determined BFEs in the community, the following communities were studied using a Level 1 analysis only: Charles City County, Colonial Heights, Greensville County, New Kent County, Prince George County and Sussex County. The Level 2 studies for Dinwiddie County and Powhatan County were supplemented with Level 1 analyses in areas where detailed BFEs were not available.

First Floor Elevations (FFE)

Each structure was assigned a relative FFE according to the guidelines listed in the Hazus Flood Model Technical Manual. These values were neither surveyed nor field verified but were instead algorithmic estimates provided by Hazus and subsequently adjusted for the region. This data input is identified as a potential area for increasing the accuracy of the model output in future updates to the plan. By collecting and using real-world data on FFEs, the model will provide more accurate results for individual structures.

Using the depth rasters and building data listed above, a building level 100-year flood vulnerability analysis was conducted. Hazus uses the associated 100-year depth at each structure and compares that to the assigned FFE to determine the predicted depth of flooding at each structure. Then, using depth damage curves, Hazus determines the building and content damage percentage for each structure, which corresponds to a dollar figure based on the assessed value of each structure.

Table 5.9 provides a detailed listing of the number of structures expected to be damaged, and the dollar losses predicted. In the previous regional hazard mitigation plan, the flood vulnerability results were run using a vastly different methodology, thus comparing the results and outcomes is not meaningful.

Table 5.9: Hazus 100-Year Flood Damage Vulnerability Results						
Analysis Type	**Community**	**Number of Buildings Moderately Damaged (41-50% of Value)**	**Number of Buildings Substantially Damaged (>50% of Value)**	**Building Losses**	**Content Losses**	**Inventory Losses**
Hazus Level 1	**Charles City County -** Residential	0	0	$820,000	$410,000	$0
	Commercial	0	0	$50,000	$130,000	$0
	Industrial	0	0	$10,000	$10,000	$0
	Other	0	0	$60,000	$290,000	$20,000
	Total	0	0	$940,000	$840,000	$20,000
	Colonial Heights – Residential	10	9	$21,290,000	$12,270,000	$0
	Commercial	0	0	$3,790,000	$9,130,000	$150,000
	Industrial	0	0	$270,000	$440,000	$70,000
	Other	0	0	$380,000	$1,710,000	$10,000
	Total	10	9	$25,730,000	$23,560,000	$23,0000
	Greensville County - Residential	0	0	$1,420,000	$690,000	$0
	Commercial	0	0	$100,000	$360,000	$0
	Industrial	0	0	$80,000	$180,000	$20,000
	Other	0	0	$20,000	$140,000	$0
	Total	0	0	$1,630,000	$1,360,000	$20,000
	New Kent County – Residential	1	2	$4,980,000	$257,000	$0
	Commercial	0	0	$170,000	$470,000	$20,000
	Industrial	0	0	$70,000	$100,000	$10,000
	Other	0	0	$20,000	$150,000	$0
	Total	1	2	$5,240,000	$3,290,000	$30,000
	Prince George County - Residential	2	2	$7,090,000	$370,000	$0

Table 5.9: Hazus 100-Year Flood Damage Vulnerability Results						
Analysis Type	**Community**	**Number of Buildings Moderately Damaged (41-50% of Value)**	**Number of Buildings Substantially Damaged (>50% of Value)**	**Building Losses**	**Content Losses**	**Inventory Losses**
	Commercial	0	0	$660,000	$1,470,000	$30,000
	Industrial	0	0	$190,000	$420,000	$70,000
	Other	0	0	$40,000	$3,320,000	$0
	Total	2	2	$7,980,000	$5,910,000	$90,000
	Sussex County – Residential	0	0	$1,710,000	$810,000	$0
	Commercial	0	0	$530,000	$1,730,000	$50,000
	Industrial	0	0	$80,000	$130,000	$30,000
	Other	0	0	$150,000	$780,000	$40,000
	Total	0	0	$2,470,000	$3,440,000	$110,000
Hazus Level 2	**Chesterfield County –** Residential	302	898	$419,240,000	$177,100,000	$0
	Commercial	10	4	$54,300,000	$99,560,000	$8,000,000
	Industrial	2	4	$17,250,000	$40,510,000	$5,190,000
	Other	0	7	$79,260,000	$411,960,000	$630,000
	Total	314	913	$570,061,000	$729,134,000	$13,820,000
	Dinwiddie County – Residential	1	6	$835,000	$285,000	<$500
	Commercial	0	0	$0	$0	$0
	Industrial	0	0	$0	$0	$0
	Other	0	0	$0	$0	$0
	Total	1	6	$835,000	$285,000	<$500
	Emporia – Residential	15	26	$8,930,000	$4,520,000	$0
	Commercial	0	0	$410,000	$800,000	$330,000
	Industrial	0	0	$0	$0	$0

Table 5.9: Hazus 100-Year Flood Damage Vulnerability Results						
Analysis Type	**Community**	**Number of Buildings Moderately Damaged (41-50% of Value)**	**Number of Buildings Substantially Damaged (>50% of Value)**	**Building Losses**	**Content Losses**	**Inventory Losses**
	Other	0	0	$0	$0	$0
	Total	15	26	$9,339,000	$5,326,000	$333,000
	Goochland County – Residential	10	61	$59,094,000	$23,816,000	$0
	Commercial	0	1	$1,180,000	$4,390,000	$18,000
	Industrial	1	0	$984,000	$1,918,000	$214,000
	Other	0	0	$490,000	$2,130,000	$0
	Total	11	62	$61,751,000	$32,256,000	$231,000
	Hanover County – Residential	72	215	$140,154,000	$58,688,000	$0
	Commercial	0	0	$3,610,000	$12,918,000	$4,455,000
	Industrial	0	0	$8,066,000	$23,534,000	$3,669,000
	Other	90	164	$126,577,000	$221,005,000	$170,576,000
	Total	162	379	$278,407,431	$316,143,853	$178,700,249
	Henrico County – FEMA SFHA only – Residential	197	383	$196,010,000	$109,085,000	$0
	Commercial	4	5	$78,984,000	$132,874,000	$193,000
	Industrial	2	0	$14,976,000	$36,655,000	$756,000
	Other	2	2	$30,138,000	$109,468,000	$0
	Total	205	390	$320,109,000	$388,081,000	$949,000
	Hopewell – Residential	16	15	$83,036,000	$39,785,000	$0
	Commercial	0	0	$5,765,000	$18,917,000	<$500
	Industrial	0	0	$29,104,862	$93,067,919	<$500
	Other	0	0	$0	$0	$0
	Total	16	16	$117,906,000	$151,770,000	<$500

Table 5.9: Hazus 100-Year Flood Damage Vulnerability Results						
Analysis Type	**Community**	**Number of Buildings Moderately Damaged (41-50% of Value)**	**Number of Buildings Substantially Damaged (>50% of Value)**	**Building Losses**	**Content Losses**	**Inventory Losses**
	Petersburg – Residential	7	23	$20,988,000	$11,738,000	$0
	Commercial	2	1	$2,267,000	$7,500,000	<$500
	Industrial	1	1	$5,826,000	$17,724,000	<$500
	Other	0	0	$0	$0	$0
	Total	10	25	$29,080,810	$36,961,004	<$500
	Powhatan County – Residential	3	62	$21,462,000	$7,014,000	<$500
	Commercial	0	0	$0	$0	$0
	Industrial	0	0	$0	$0	$0
	Other	0	0	$0	$0	$0
	Total	3	62	$21,462,000	$7,014,000	<$500
	Richmond – Residential	49	92	$79,071,000	$41,606,000	$0
	Commercial	2	6	$57,905,000	$82,338,000	<$500
	Industrial	7	12	$64,014,789	$146,556,947	<$500
	Other	0	3	$9,123,051	$19,266,061	$0
	Total	58	113	$210,114,000	$289,767,000	<$500
Supplementary Level 1 Analysis of Zone A areas	**Dinwiddie County –** Residential	0	0	$4,830,000	$3,580,000	$0
	Commercial	0	0	$120,000	$410,000	$0
	Industrial	0	0	$20,000	$40,000	$0
	Other	0	0	$50,000	$260,000	$0
	Total	0	0	$5,010,000	$4,290,000	<$500
	Powhatan County – Residential	0	0	$8,890,000	$4,770,000	$0

Table 5.9: Hazus 100-Year Flood Damage Vulnerability Results						
Analysis Type	**Community**	**Number of Buildings Moderately Damaged (41-50% of Value)**	**Number of Buildings Substantially Damaged (>50% of Value)**	**Building Losses**	**Content Losses**	**Inventory Losses**
	Commercial	0	0	$200,000	$610,000	$0
	Industrial	0	0	$100,000	$150,000	$10000
	Other	0	0	$120,000	$730,000	$10000
	Total	0	0	$9,310,000	$6,260,000	$30,000
Totals		**827**	**1987**	**$1,677,375,241**	**$2,005,687,857**	**$194,565,249**

Source: Hazus

Clearly, much of the Richmond-Crater region is susceptible to costly damage resulting from flood events and Figures 5.5a through 5.5j indicate where the flood risk is highest. The densely developed areas of the region (Chesterfield County, Hanover County, Henrico County and Richmond) have the highest numbers of repetitive losses and highest predicted number of structures expected to be damaged in a 100-year flood event based on the Hazus data.

The repetitive flood loss areas shown in Figures 5.5a through 5.5j indicate where within each community the flood damage has historically been highest and can be expected to continue into the future without large-scale mitigation measures to reduce flood vulnerability.

Vulnerability to stormwater flooding caused by precipitation and/or stormwater management infrastructure issues was not directly evaluated due to insufficient and inconsistent data across the study area. Although some municipalities have made progress in evaluating this specific type of flooding and have started collecting data to reflect historic occurrences and future vulnerabilities, data are not available to express quantitative risk in a meaningful way for the whole region.

Annualized NCEI Events and Damages

The NCEI flood events have been annualized and summarized in **Table 5.10**. Recurrence intervals can be estimated using the number of flood occurrences over a period of time. According to the NCEI database, there have been 259 recorded flood events for the region that have caused notable floods in the past 27 years, for a flood recurrence interval of approximately 9.6 events per year, with each event averaging about $91,000 in property and around $3,900 in crop damages, for a total of about $95,000 in average annual losses.

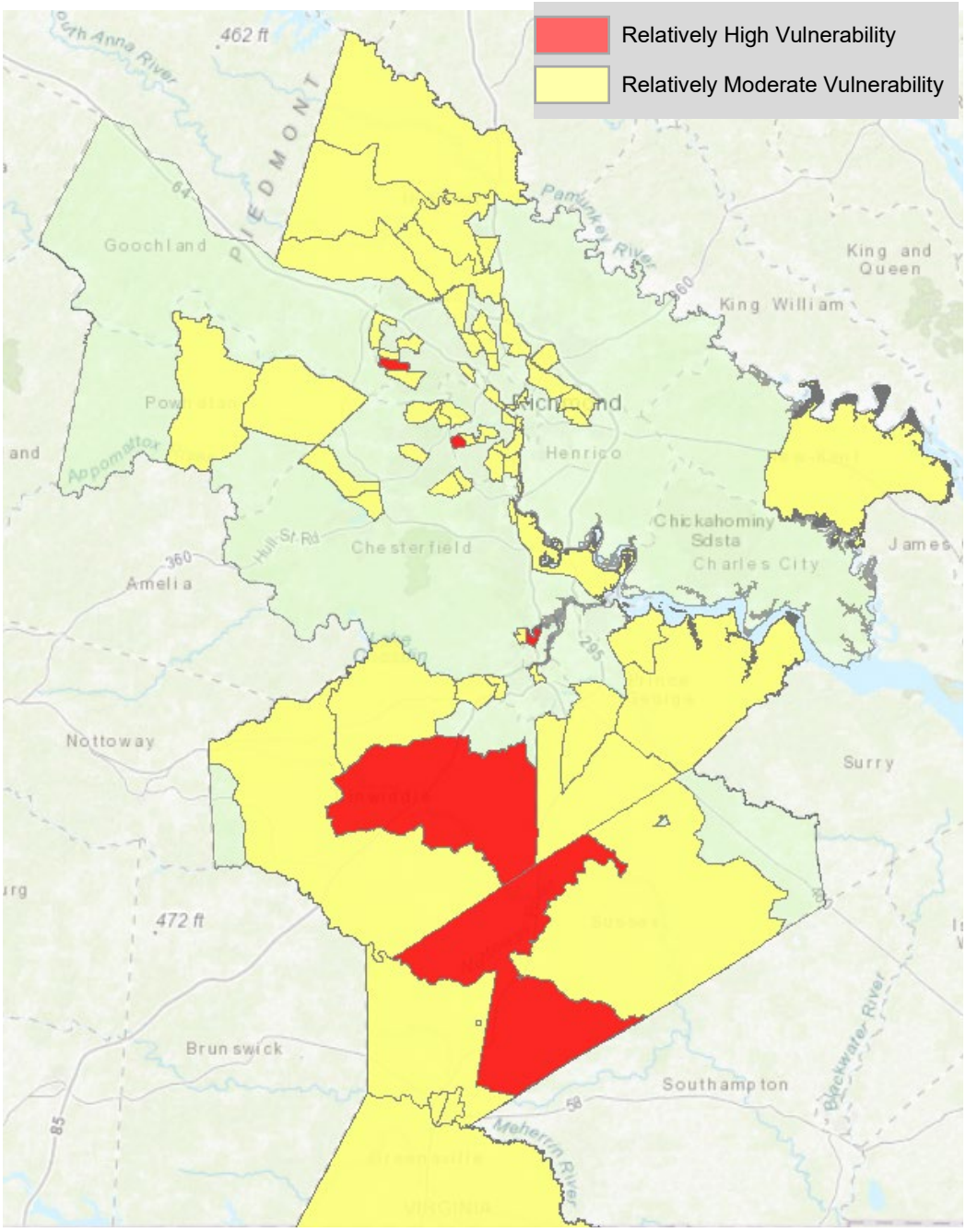
Table 5.10: Annualized Flood Events and Losses, 1993 - 2020				
Jurisdiction	**Annualized Number of Events**	**Annualized Property Losses**	**Annualized Crop Losses**	**Annualized Total Losses**
Charles City County	0.52	$0	$0	$0
Chesterfield County	1.52	$10,647	$111	$10,757
City of Colonial Heights	0.30	$2,654	$0	$2,654
Dinwiddie County (inc. Town of McKenney)	0.41	$453	$122	$574
City of Emporia	0.11	$0	$0	$0
Goochland County	0.26	$1,438	$442	$1,880
Greensville County (inc. Town of Jarratt)	0.48	$39,451	$0	$39,451
Hanover County (inc. Town of Ashland)	0.85	$6,074	$929	$7,003
Henrico County	1.11	$0	$0	$0
City of Hopewell	0.33	$2,654	$0	$2,654
New Kent County	0.78	$4,050	$0	$4,050
City of Petersburg	0.63	$5,240	$0	$5,240
Powhatan County	0.48	$1,443	$0	$1,443
Prince George County	0.56	$0	$0	$0
City of Richmond	0.59	$3,508	$0	$3,508
Surry County (inc. Towns of Claremont, Dendron, Surry)	0.81	$54,074	$27,778	$81,852
Sussex County (inc. Towns of Stony Creek, Wakefield, Waverly)	0.67	$13,545	$2,303	$15,849
Totals	**9.59**	**$91,156**	**$3,907**	**$95,063**

Source: NCEI

Social Vulnerability

Social vulnerability to flood hazard for the Richmond Crater region is shown in **Figure 5.6**, categorized by Census tract. For legibility and simplicity, only areas designated "Relatively High" or "Relatively Moderate" are shown. There were no areas of "Very High" social vulnerability to flood in the Richmond-Crater region. The map shows two large tracts of relatively high social vulnerability to flood at the boundary between Dinwiddie and Sussex Counties, as well as another tract on the south shore of Swift Creek in Colonial Heights rated as relatively high. The tract at the northeast corner of the intersection of Chippenham Parkway and Midlothian Turnpike in Richmond is rated relatively high, as is another tract just north of Patterson Avenue in Henrico County, at the boundary with Goochland County.

Figure 5.6: Social Vulnerability to Flood Hazards



Source: National Risk Index, FEMA 2021

Note: The Town of Surry has relatively moderate social vulnerability for flooding.

Future Vulnerability, Land Use and Climate Change Impacts

Future vulnerability will be determined, in part, by local officials. Flood hazard and SLOSH maps are available to indicate what areas of the region are most vulnerable to flood and flood-related hazards. These planning tools are currently used to help guide development away from hazardous areas. Local officials are responsible for enforcing local floodplain management regulations, flood damage prevention ordinances, and other forms of development policies that restrict new development in flood hazard areas. Additional discussion of actions these communities have taken to guide land use and reduce future flood vulnerability is provided in Section 6, the Capability Assessment.

An unusual component of future flood vulnerability in the study area is the likelihood of mass evacuation (due to flooding and tropical storms from nearby coastal areas) *into* the Richmond-Crater region. Mass evacuations from urban areas can strain a community's resources and cause gridlock on major transportation routes, overcrowding of hospitals and shelters, and increased load on local utilities' infrastructures leading to potential failure.

A mass evacuation of significant proportions has not impacted the area in the past two decades. In anticipation of Hurricane Floyd in September 1999, more than three million people were evacuated from Florida to the North Carolina coastline, and to a lesser extent from the Virginia coast. Although the majority of these evacuations were from North and South Carolina coasts to inland areas of those states, some limited impact was experienced in the planning region.

The probability of a mass evacuation impacting the planning region includes factors such as the probability and location of the hazard that would make such an evacuation necessary, as well as sociological considerations. An influx of evacuees as a result of a mass evacuation has the potential to overload infrastructure and support systems. Impacted segments might include transportation, public safety, medical facilities and shelters, utilities, and depending on the duration of the evacuation, potentially the education sector. Jurisdictions located along major evacuation routes are more likely to be impacted.

In its June 2021 report entitled *The Impact of Climate Change on Virginia's Coastal Areas*, the Virginia Academy of Science, Engineering, and Medicine (VASEM), laid out the consequences of climate change for Virginians.[8] VASEM is a nonprofit organization consisting of members of the National Academies of Science, Engineering, and Medicine who reside or work in Virginia as well as other Virginians who are leaders in these fields. The most immediate consequence of climate change is sea level rise, caused primarily by melting ice and glaciers and thermal expansion. Additional consequences related to flooding include more recurrent flooding (higher frequency of occurrence for damaging floods), extreme rainfall and inundation of septic systems. The report projects that, particularly in urban areas, recurrent flooding will have a disproportional impact on racial and ethnic minorities, the poor, the elderly, renters, non-native English speakers, and those with mobility challenges. Exposure to a growing number of flood-prone facilities regulated

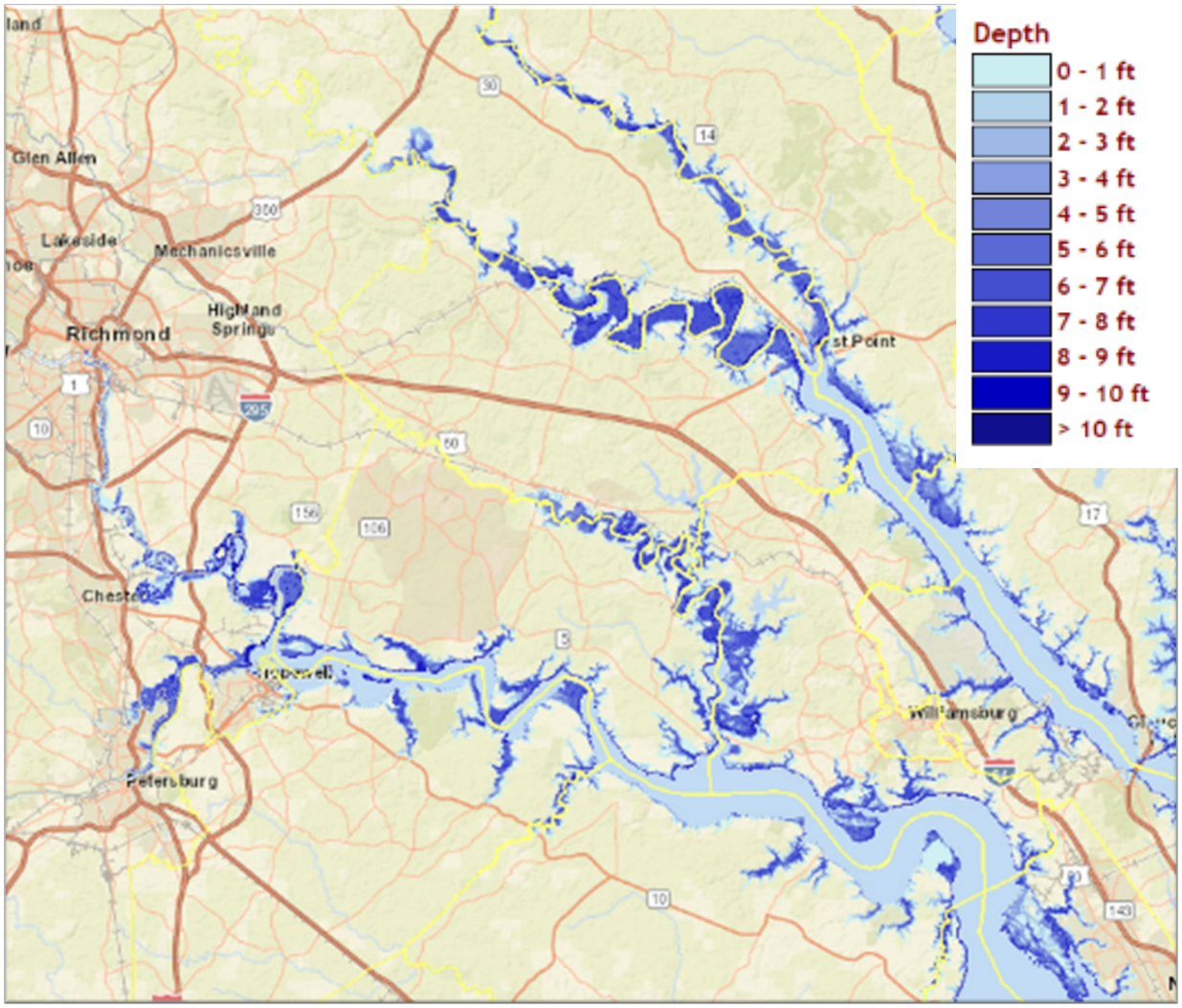
[8] http://www.vasem.org/wp-content/uploads/2021/08/VASEM_VirginiasCoastalAreasReport_FINAL.pdf

for toxic and hazardous substances as sea levels rise is another concern, particularly on the James River, between Richmond and Hampton Roads. Impacts in rural areas are more likely to be centered around soil quality, such as water-logged soils in flood-prone areas, increased salinity due to saltwater intrusion and septic system failures that affect public health.

The sea level rise curve chosen by the Commonwealth for planning purposes (NOAA's "intermediate-high" projection) is shown for each of the affected communities in the study area in **Figure 5.7**. This map is from the Virginia Institute of Marine Science (VIMS) Sea Level Rise Projection tool available online at: http://cmap2.vims.edu/SeaLevelRise_Depth/SLRDepth_revised4.html.

Using this same projection for sea level rise, Old Dominion University and the Commonwealth Center for Recurrent Flooding Resiliency researchers have quantified their projections for impacts from sea level rise, categorized by the Commonwealth's planning districts. PlanRVA and Crater PDC combined are expected to see almost 5,000 parcels, 600 structures, and 14 miles of roadway flooded or otherwise impacted by sea level rise by 2080.

Figure 5.7: Sea Level Rise Projection for year 2100, Intermediate High Scenario



Source: VIMS Sea Level Rise Projection tool accessed online 2021 at:
http://cmap2.vims.edu/SeaLevelRise_Depth/SLRDepth_revised4.html

Increased levels of precipitation from storm events sometimes overwhelm existing municipal stormwater management systems in the region, which can result in roadway flooding, safety and access concerns, and issues with water quality and treatment capacity. As precipitation events become more intense and flashy, the ability of the existing stormwater management systems to collect, convey, treat, and discharge flow will be further reduced. In some parts of the study area, increased high tide levels due to sea level rise may impact or block the discharge points, creating further cause for storm flooding.

The average annual number of days with heavy precipitation is expected to increase in the future as a result of climate change. This increased precipitation will have an impact on the frequency of regional flooding, especially riverine flooding, but may also impact coastal

flooding. Heavy precipitation events can easily overwhelm existing infrastructure, causing failure of stormwater culverts, bridge scour, and overland flooding affecting areas and structures that do not normally flood. Increased heavy precipitation can impact dams and, over time, influence flood frequency curves that are used for a variety of insurance, building safety and planning purposes.

According to 2022 data from the Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA)[9] , under a moderate emissions scenario, Glen Allen can expect that for the period 2066 to 2095, the average number of days per year with rainfall greater than 1 inch will be 7.8 days, which is 27% more than in the period between 1976 and 2005. Approximately the same percentage increase is expected across the PlanRVA portion of the region; the Crater PDC portion of the study area was not studied. On the other hand, the number of days with rainfall greater than 3 inches is 0.2, 63% more than in 1976-2005 for Glen Allen. The predictions for days with this severe rainfall are not uniform across the Plan RVA region and range from a low of 30-percent increase in parts of Prince George County, to an 83-percent increase in Richmond.

5.5 Flooding Due to Impoundment Failure

Hazard Profile

Flooding due to impoundment failure refers to a collapse, overtopping, breaching, or other failure that causes an uncontrolled release of water or sludge from an impoundment, resulting in downstream flooding. Dam or levee failures can occur with little warning. Intense storms may produce a flood in a few hours or even minutes from upstream locations. Flash floods can occur within six hours of the beginning of heavy rainfall, and impoundment failure may occur within hours of the first signs of breaching. Other failures and breeches can take much longer to occur, from days to weeks, because of debris jams or the accumulation of melting snow.

Dam risk can be categorized as either incremental, non-breach, or residual. Incremental risk is the risk (both likelihood and consequences) to the pool area and downstream floodplain occupants that can be attributed to the presence of the dam should the dam breach prior or subsequent to overtopping, or undergo component malfunction or misoperation, where the consequences considered are over and above those that would occur without dam breach. The consequences typically are due to downstream inundation, but loss of the pool can result in significant consequences in the pool area upstream of the dam. Non-breach risk refers to risk in the reservoir pool area and affected downstream floodplain due to 'normal' dam operation of the dam (e.g., large spillway flows within the design capacity that exceed channel capacity) or 'overtopping of the dam without breaching' scenarios. Residual risk is the risk that remains after all mitigation actions and risk reduction actions have been completed. With respect to dams, FEMA defines residual risk

[9] Mid-Atlantic Regional Integrated Sciences and Assessments: https://public.tableau.com/views/Climate_summary_rainfall_20181112_PUBS/3b?:embed=y&:toolbar=n&:embed_code_version=3&:loadOrderID=0&:display_count=y&:origin=viz_share_link

as “risk remaining at any time”. It is the risk that remains after decisions related to a specific dam safety issue are made and prudent actions have been taken to address the risk. It is the remote risk associated with a condition that was judged to not be a credible dam safety issue.[10]

Hazard Profile: Dam Failure

Failure of dams may result in catastrophic localized damages. Vulnerability to dam failure is dependent on dam operations planning and the nature of downstream development. Depending on the elevation and storage volume of the impoundment, the impact of flooding due to dam failure may include loss of human life, economic losses such as property damage and infrastructure disruption, and environmental impacts such as destruction of habitat. Flooding following a dam failure may occur due to any one or a combination of the following causes:

- Prolonged periods of rainfall and flooding;
- Inadequate spillway capacity;
- Internal erosion caused by embankment or foundation leakage or piping, or earth movement resulting from an earthquake;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the cross section of the dam and abutments, or maintain gates, valves, or other operational components;
- Improper design, including the use of improper construction materials and construction practices;
- Negligent operation, including failure to remove or open gates or valves during high flow periods;
- Failure of upstream dams on the same waterway;
- High winds, which can cause significant wave action and result in substantial erosion; or
- Intentional criminal acts.

Dams are classified in Virginia by the DCR, with a hazard potential depending on the downstream losses estimated in event of failure. Hazard potential is not related to the structural integrity of a dam but strictly to the potential for adverse downstream effects if the dam were to fail. State regulatory requirements administered by DCR, such as the frequency of dam inspection, the standards for spillway design, and the extent of emergency operations plans, are dependent upon the dam classification. **Table 5.11** provides additional information on these classes and the possible effects on downstream areas if failure were to occur.

[10] FEMA, *Rehabilitation of High Hazard Potential Dams Grant Program Guidance*, June 2020.

Table 5.11: Virginia Dam Classification System		
Hazard Potential	**Description**	**Inspection**
High (Class I)	Failure will cause probable loss of life or serious economic damage (to buildings, facilities, major roadways, etc.)	Annual, with inspection by a professional engineer every 2 years.
Significant (Class II)	Failure may cause loss of human life or appreciable economic damage (to buildings, secondary roadways, etc.)	Annual, with inspection by a professional engineer every 3 years.
Low (Class III)	Failure would result in no expected loss of human life, and cause no more than minimal economic damage	Annual, with inspection by a professional engineer every 6 years.

Source: 2018 Commonwealth of Virginia Hazard Mitigation Plan

The owner of each regulated high, significant, or low hazard dam is required to apply to DCR for an Operation and Maintenance Certificate. The application must include an assessment of the dam by a licensed professional, an Emergency Action Plan, and the appropriate fee(s), submitted separately. An executed copy of the Emergency Action Plan or Emergency Preparedness Plan must be filed with the appropriate local emergency official and the Virginia Department of Emergency Management. The Virginia Soil and Water Conservation Board (VSWCB), a division of DCR, issues Regular Operation and Maintenance Certificates to the dam owner for a period of six years. If a dam has a deficiency but does not pose imminent danger, the board may issue a Conditional Operation and Maintenance Certificate, during which time the dam owner is to correct the deficiency. After a dam is certified by the board, annual inspections are required either by a professional engineer or the dam owner, and the Annual Inspection Report is submitted to the regional dam safety engineer.

Dam risk can be classified as incremental, non-breach or residual risk. Incremental risk is the risk (likelihood and consequences) to the pool area and downstream floodplain occupants that can be attributed to the presence of the dam should the dam breach prior or subsequent to overtopping, or undergo component malfunction or misoperation, where the consequences considered are over and above those that would occur without dam breach. The consequences typically are due to downstream inundation, but loss of the pool can result in significant consequences in the pool area upstream of the dam. Non-breach risk is the risk in the reservoir pool area and affected downstream floodplain due to 'normal' dam operation of the dam (e.g., large spillway flows within the design capacity that exceed channel capacity) or 'overtopping of the dam without breaching' scenarios. Residual risk is the risk that remains after all mitigation actions and risk reduction actions have been completed. With respect to dams, FEMA defines residual risk as "risk remaining at any time" (FEMA, 2015, p A-2). It is the risk that remains after decisions related to a specific dam safety issue are made and prudent actions have been taken to address the risk. It is

the remote risk associated with a condition that was judged to not be a credible dam safety issue.[11]

At this time, limited information is available to conduct an analysis of incremental, non-breach and residual risk relative to the high hazard potential dams in the region. Please refer to Section 3.11: Flooding Due to Impoundment Failure of the *2018 Commonwealth of Virginia Hazard Mitigation Plan*, as amended, for additional information regarding the statewide approach to dam risk. That section of the state's plan is hereby incorporated by reference.

The Commonwealth of Virginia relies upon FEMA's definition of risk: "Risk is the product of the likelihood of a structure being loaded, adverse structural performance, and the magnitude of the resulting consequences." Risk data are compiled in the state's Dam Safety Inventory System (DSIS) for each high hazard dam. DCR, VDEM and local emergency and planning staff are given copies of emergency action plans and plans include detailed information on risk to the following:

- Dwellings
- Schools
- Hospitals
- Businesses
- Railroads:
- Utilities:
- Parks:
- Golf Course
- Public Trails
- Emergency Infrastructure.

The summary impacts shown in **Table 5.12** are drawn from the information in DSIS and the Emergency Action Plans (EAPs) for the high hazard potential dams, These data represent how Virginia summarizes significant economic, environmental and social impacts from a dam incident. Factors considered in risk assessment include the population at risk, land use, inspection condition assessment and any missing studies such as stability analyses under normal and extreme loading conditions (seismic and hydrologic), and any measures underway that affect the operational status, such as drawdowns or temporary pumps and siphons, when dams are compromised.

Owners of impounding structures are required to have dam break inundation zone maps that meet the standards of the Virginia Impounding Structure Regulations. The properties that are identified within the dam break zone are recorded in the dam safety emergency

[11] FEMA, Rehabilitation of High Hazard Potential Dams Grant Program Guidance, June 2020

action plan for that impoundment. DCR is pursuing efforts to make this information available in a digital form, but it is not currently available for all dams. The 2018 *Commonwealth of Virginia Hazard Mitigation Plan* indicates that such data would greatly improve ability to identify impact and vulnerability due to dam inundation.

Table 5.12 lists the high hazard dams in the study area from DCR's database and includes key details regarding each dam's basic characteristics, EAP status and a summary of expected impacts resulting from dam failure. The impacts are based on modeling requirements for high hazard dams that include two scenarios: 1) sunny day breach (incremental risk); and 2) probable maximum flood (non-breach risk). Appendix I provides a list of all dams in the study area from the DCR database, as well as the EAPs for each of the high hazard dams. The high hazard dams that have latitude and longitude characteristics identified in the U.S. Army Corps of Engineers' National Inventory of Dams are shown in Figure 5.8.

In addition to dams located within the study area, there are several high hazard dams upstream of the study area that could impact the region if the dam(s) were to fail or overtop, including:

Louisa County – Lake Anna Dam and Reservoir, Gordonsville Dam, South Anna Dam #22, South Anna Dam #6b, South Anna Dam #3, South Anna Dam #4, South Anna Dam #5;

Fluvanna County – Bremo Power Station Dam, Lake Monticello Dam, Fluvanna Ruritan Da, Bremo Power Station East Ash Pond Dam, Lake Monticello Settlement Pond Dam;

Cumberland County – Willis River Dam #6, Cobbs Creek Regional Water Supply Dam, Cobbs Creek Regional Water Supply Reservoir Saddle Dam, Cobbs Creek Regional Water Supply Reservoir Dam Perimeter Dam;

Amelia County – Bridgeforth Mill Dam;

Nottaway County – Nottoway Lake Dam.

Information on these dams is available through the State's DSIS program and the USACE NID.

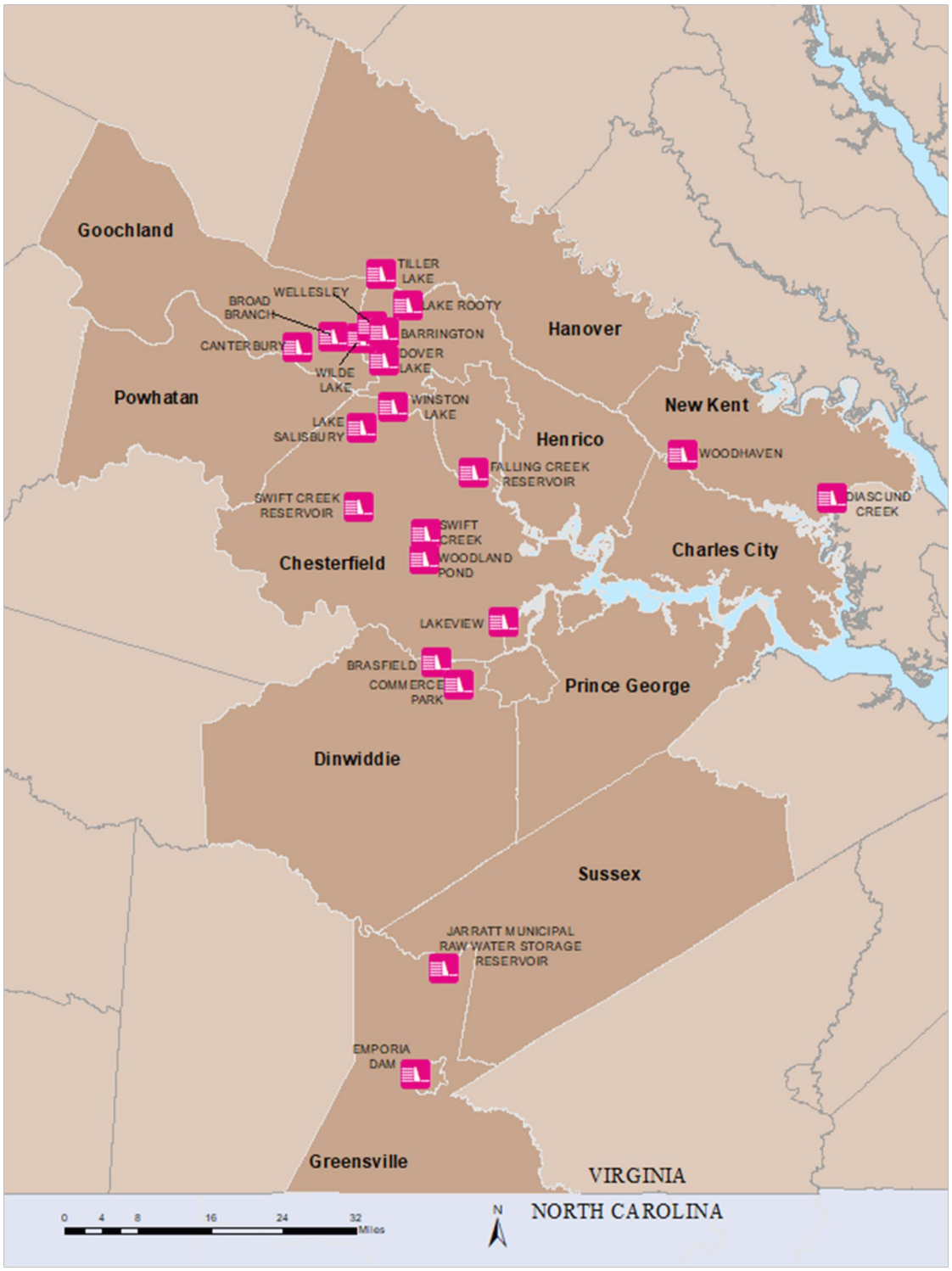
Table 5.12: High Hazard Dams in the Richmond-Crater Region								
Jurisdiction	**Dam Name**	**Dam Type**	**Year Built**	**Reservoir Purpose**	**Top Height (Feet)**	**Top Capacity (Acre-Feet)**	**EAP Status (Last Approval)**	**Downstream Impacts**
Chesterfield County	Cosby Dam	Gravity	1956	Recreation	17	85	Expired (11/15/2014)	Not provided
	Lake Crystal Dam				18	64		Not provided
	Lake Salisbury Dam	Earth	1973	Recreation	38	990	Expired (11/30/2010)	1,870 homes, 6 roads, 2 dams downstream
	Margaret Dam	Buttress	1961	Water Supply & Recreation	35	410	Expired (3/9/2007)	25 roadways, 208 homes
	Swift Creek Dam	Gravity	1936	Recreation	30.5	7,564	Current (1/3/2018)	32 homes, 1 business, 1 road
	Swift Creek Reservoir Dam	Earth	1965	Water Supply & Recreation	44	50,590	Current (4/8/2019)	2,000 homes, 400 businesses, 1 road
	Wake Lake Dam	Earth	2019	Recreation	15.5	88.71	Current (10/21/2019)	24 houses, 4 businesses, 1 golf course, 8 roads
	Woodland Pond	Earth	1970	Recreation	35	1,870	Current (8/23/2019)	9 homes, 1 golf course, 3 roads
Chesterfield County, City of Richmond	Falling Creek Reservoir Dam	Buttress	1952	Recreation	34	1,511	Current (3/31/2018)	Not provided
Chesterfield & Dinwiddie County	Brasfield Dam	Gravity	1968	Water Supply & Hydro-electric	55	79,500		Not provided
Dinwiddie County	Commerce Park Dam	Earth	1900	Recreation & Flood Control	12	149.4	Expired (1/9/2013)	52 homes, 1 business, 3 roads
Richmond	Winston Lake Dam	Earth	2008	Recreation	28	39	Current (12/15/2017)	2 homes, 2 roads
Goochland County	Broad Branch Dam	Earth	1992	Recreation	29	1,188	Current (5/26/2015)	5 homes, 4 roads
	Dover Lake Dam	Earth	1958	Irrigation & Recreation	41	4,198	Expired (6/1/2012)	3 homes, 1 railroad, 1 road

Table 5.12: High Hazard Dams in the Richmond-Crater Region								
Jurisdiction	**Dam Name**	**Dam Type**	**Year Built**	**Reservoir Purpose**	**Top Height (Feet)**	**Top Capacity (Acre-Feet)**	**EAP Status (Last Approval)**	**Downstream Impacts**
Hanover County, Henrico County	Tiller Lake Dam	Earth	2000	Irrigation	13	87.33	Expired (1/1/2010)	8 homes
Henrico County	Barrington Dam	Earth		Fire Protection & Recreation	16.5	100	Current (11/4/2014)	13 homes, 2 downstream dams
	Canterbury Dam	Earth	1965	Recreation	13	162	Current (5/18/2021)	200 homes, 5 businesses, 1 road
	Echo Dam	Earth	1900	Recreation	19	139	Current (5/5/2021)	73 homes, 1 park, 3 roads including I-295
	Lake Overton Dam	Earth	1970	Recreation	18	106	Expired (9/8/2005)	Not provided
	Lake Rooty Dam	Earth			22	142	Expired (5/15/2014)	8 homes
	Wellesley Dam	Earth	1987	Recreation	29	131.3	Expired (5/17/2021)	19 homes, 1 downstream dam
Petersburg	Wilcox Dam	Earth	1900	Recreation	18	200.29	Current (10/30/2020)	113 homes, 2 businesses, 1 hospital, 1 railroad, 10 roads, 1 downstream dam
Powhatan County	Mill Quarter Lake Dam	Earth	1974	Recreation	36	2,159	Expired (7/15/2012)	44 homes, 1 business, 1 road
	Upper Powhatan Dam	Earth	1810	Recreation	26.75	750	Expired (5/9/2008)	2 roads, 1 dam downstream
Colonial Heights	Lakeview Dam	Gravity	1920	Hydro-electric & Recreation	38.6	610	Current (1/1/2018)	Not provided
Emporia, Greensville County	Emporia Dam	Gravity	1908	Hydro-electric & Water Supply	42.5	9,500	Expired (1/31/2012)	Not provided
Greensville County	Jarratt Municipal Raw Water Storage Reservoir Dam	Earth	2018	Water Supply	51	3,682	Current (6/2/2020)	5 homes, 2 roads, 1 dam downstream

Table 5.12: High Hazard Dams in the Richmond-Crater Region								
Jurisdiction	**Dam Name**	**Dam Type**	**Year Built**	**Reservoir Purpose**	**Top Height (Feet)**	**Top Capacity (Acre-Feet)**	**EAP Status (Last Approval)**	**Downstream Impacts**
James City County, New Kent County	Diascund Creek Dam	Earth	1961	Water Supply & Recreation	35	29,093	Current (8/18/2016)	208 homes, 25 roads
New Kent County	Woodhaven Dam	Rockfill	1961	Recreation	23	1297	Current (8/7/2020)	10 homes, 1 railroad, 2 roads

Source: DCR, Dam Safety Inventory System, accessed April 2021

Figure 5.8: High Hazard Dams in the Richmond-Crater Region



Source: USACE National Inventory of Dams, 2021

Hazard Profile: Levee/Floodwall Failure

FEMA defines a levee as 'a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water to reduce the risk from temporary flooding.' Much like dams, levees and floodwalls require regular maintenance and inspection. Many of the causes and effects of levee failure are similar to dam failure. Though levees can reduce some flood risks, they do not eliminate risks. By creating a false sense of safety, communities may invest in development in levee-impacted areas and thus increase the flood risk. Flood risks associated with levees can change over time: if levees are not properly maintained, the risk of failure may increase, resulting in catastrophic flooding. Similarly, if flood hazards change or exceed design protection levels, overtopping of levels can be disastrous.

A levee designed to provide flood protection from at least the 1% annual chance flood is eligible for accreditation by FEMA. When accredited, the area protected by the levee will be mapped as a moderate risk zone instead of a high-risk zone on the FIRM.

The James River Levee System in Richmond secured FEMA levee accreditation in 2012. Other levees in Virginia have never been recognized as providing 100- year protection or have been de-accredited. De-accreditation does not necessarily mean the levee no longer can provide 100-year flood protection but may mean that the community or levee owner did not provide the necessary documentation to prove protection.

The James River Levee System (**Figure 5.9**) is a local system of flood protection with a total length of 17,327 feet (3.28 miles) and protects 750 acres valued at approximately $153 million. The line of protection extends across the mouth of Shockoe Valley to 12th Street. The wall is designed to protect those areas located behind it against a flood with an average recurrence interval of 280 years. The project was dedicated on October 21, 1994, at a cost of $143 million.

The line of protection extends from just west of the Manchester bridge, continues along the river's edge to the west side of Interstate 95, turns south, then west, crossing the CSX Railway mainline tracks, and tying into high ground at Goodes Street. The entire system consists of multiple components in addition to the levees and floodwall:

- A partially rip-rapped earthen levee;
- A concrete floodwall;
- Three overlooks (9th & Semmes, Hull & Mayo Bridge, and 12th & Byrd);
- Six roadway closures;
- Six railroad closures;
- Four personnel closure locations;
- Two combined roadway/railroad closures;
- Three pump stations; and
- Three designated ponding areas.

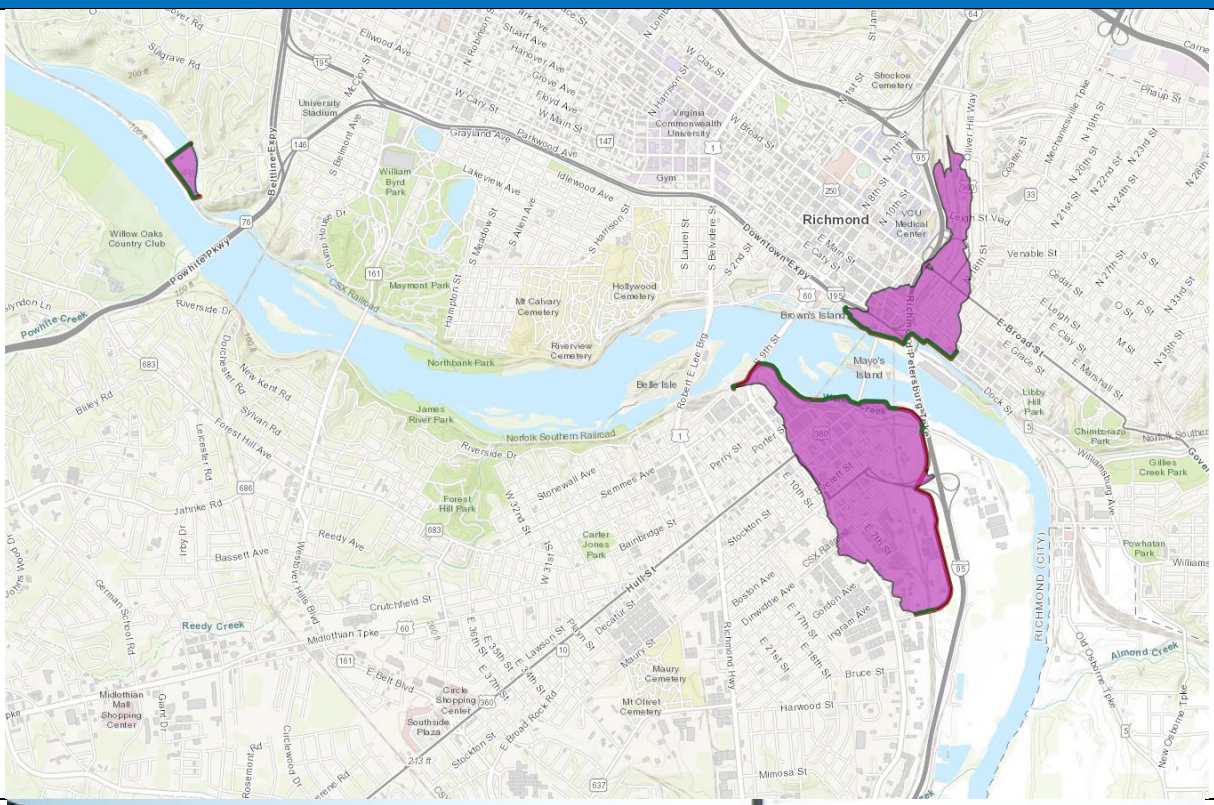
The northern alignment is comprised of one component – a concrete floodwall that is approximately 4,500 feet long with height variations from five to 29 feet. The southside alignment has three components:

- One earthen levee, approximately 9,000 feet long;
- A combination bin wall/levee, approximately 2,000 feet long; and
- A concrete floodwall, approximately 2,000 feet long.

Interior runoff from the watershed in excess of the capacity of the pump station during high river stages will be collected or backed up into the ponding areas. After the river recedes, all ponding areas will drain by gravity through their respective outlets.

Risk for the levee system is considered low. The south portion of the project protects a population of 1,271 people, 146 structures, and property valued at $397 million. The estimated population protected by the levee is 2,578 people, with 296 structures, and property valued at $501 million.

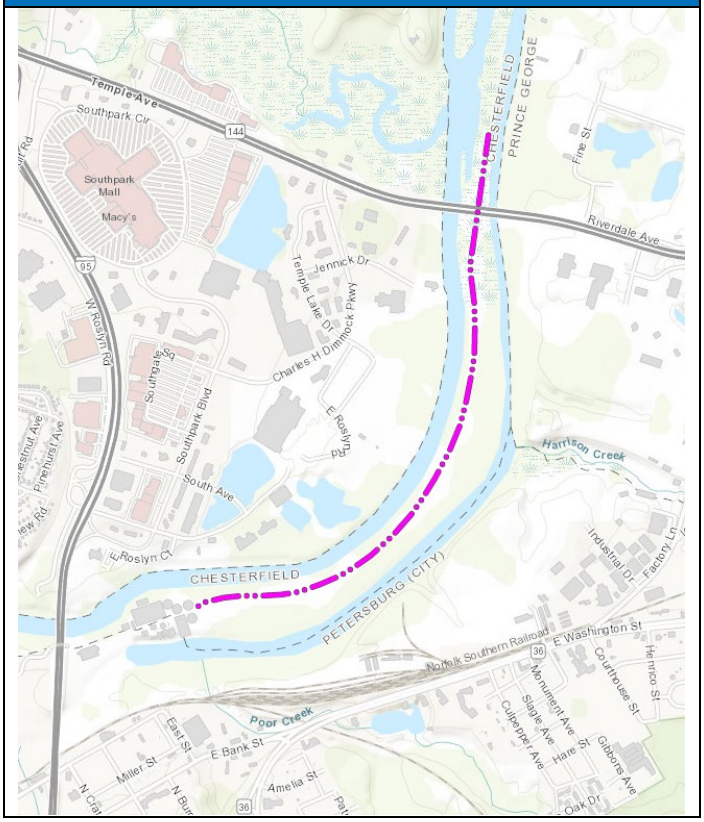
Figure 5.9: James River Levee System, Richmond



Source: U.S. Army Corps of Engineers, [National Levee Database](#) and the City of Richmond Department of Public Utilities, 2021

The Appomattox River Levee in Colonial Heights is not accredited by FEMA as providing 100-year flood protection. The embankment is 1.44 miles long, lying on a bend in the river as it exits the Petersburg area and turns north toward Back Creek and Gilliams Island (**Figure 5.10)**.

Figure 5.10: Appomattox River Levee, Colonial Heights



Source: U.S. Army Corps of Engineers, National Levee Database, *2021*

Hazard History

There are no comprehensive databases of historical dam failures or flooding following a dam failure or levee failure in Virginia. Most failures occur due to lack of maintenance of dams in combination with major precipitation events, such as hurricanes and thunderstorms. The 2018 *Commonwealth of Virginia Hazard Mitigation Plan* lists two notable events in the study area.

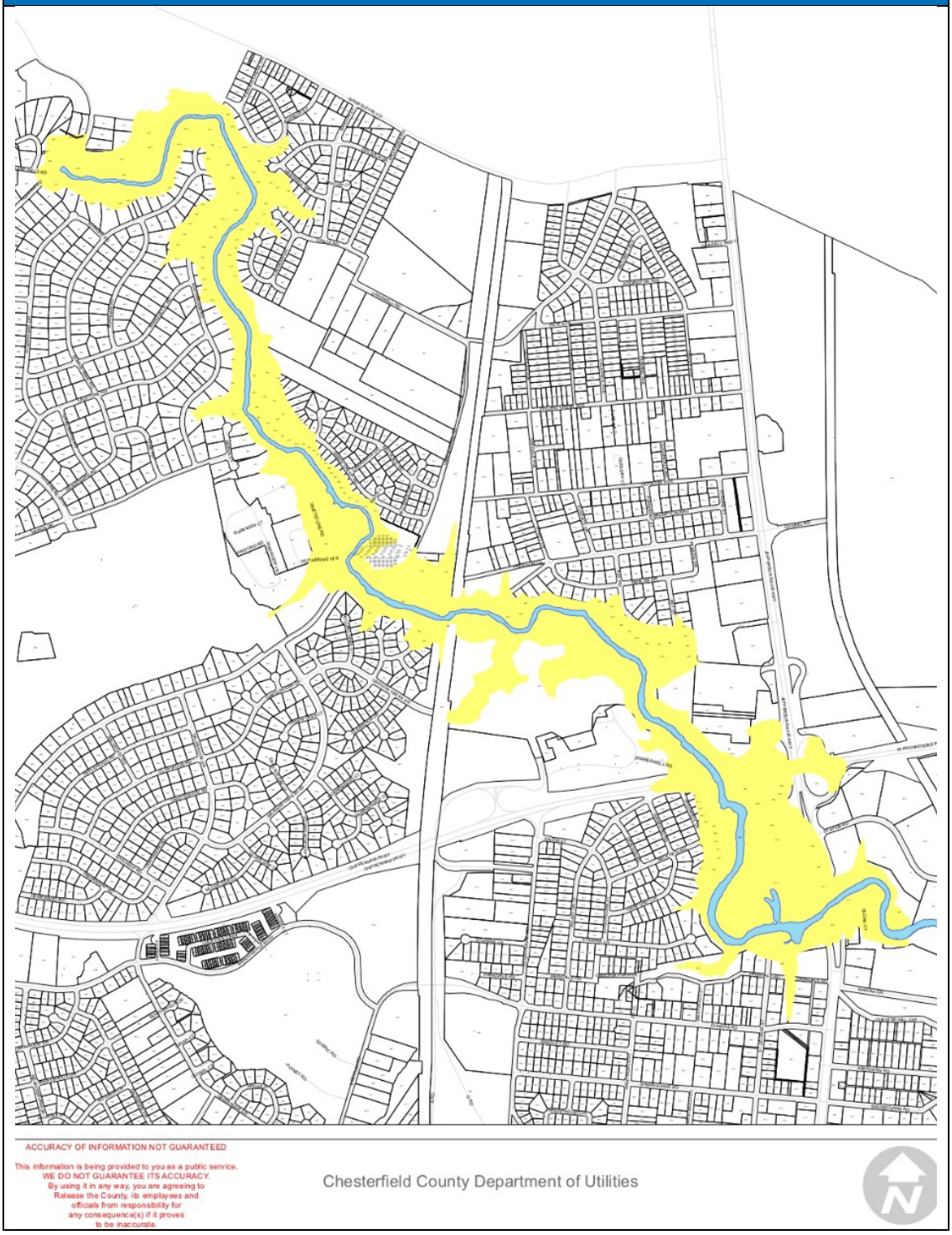
- The Powhatan Lakes Dam failed due to a heavy storm during June 2004 and caused over one million dollars in damage. The eventual breaching of the upper dam led to the subsequent chain-reaction breaching of the lower dam. According to the Virginia Department of Wildlife Resources, local news sources indicated that as much as five inches of rain may have fallen within a two-hour period.

- Falling Creek Dam in Chesterfield County was overtopped during Tropical Storm Gaston flooding in late summer 2004 with evacuations ordered for hundreds of families. Also, on the evening of August 15, 2020, officials issued an evacuation order for more than 150 residences in several neighborhoods near Falling Creek Dam and opened a shelter for evacuees. At 5:45pm that day, the dam was at a stage three flood advisory with a water level over 100 feet. By the next morning, the water levels had decreased, and the evacuation order was lifted. See **Figure 5.11** below that shows the dam inundation areas for this dam.
- Several dams in Virginia failed or were overtopped following Tropical Depression Ernesto in 2006.

In May 2018, Canterbury Dam in Henrico County overtopped after a rainfall event triggered severe flooding. The dam is an earthen dam along Deep Run Creek and impounds an approximately 12-acre recreational lake in the Short Pump neighborhood. The incident caused significant impacts, including Pump Road being shut down and damage to the downstream section of the dam. To prevent future damage from rainfall events, the county prioritized renovations to the dam. A detailed dam failure analysis to determine the downstream inundation area was conducted, as well as an alternatives analysis to determine renovation options. The county decided to spend roughly $1M to fix the dam and provide overtopping protection to protect the impoundment from failure during passage of the required spillway design storm event.

Installation of improvements to Canterbury Dam
Source: Timmons Group

Figure 5.11: Falling Creek Dam Inundation Areas, in Chesterfield County and Colonial Heights



Source: Chesterfield County Department of Utilities, undated

Social Vulnerability

The location of the study area high hazard dams was overlaid on the foundational social vulnerability map from the NRI. The analysis indicates that 5 dams are located in areas of relatively moderate or relatively high social vulnerability (no dams were in areas of Very High social vulnerability):

Emporia Dam – Relatively High;

Jarratt Municipal Raw Water Storage Reservoir, Brasfield Dam, Falling Creek Reservoir, Dover Lake – Relatively Moderate.

A small portion of the area protected the James River Levee System in Richmond is an area of relatively moderate social vulnerability. The Appomattox River Levee in Colonial Heights lies between an area of relatively high social vulnerability to the northwest near Southpark Mall, and an area of relatively moderate social vulnerability to the east in Petersburg.

According to DCR, social vulnerability is a factor in assessing grant applications prepared by dam owners in the region. Project engineers are also responsible for addressing impacts on historical and cultural impacts in accordance with state and federal regulations.

Future Vulnerability, Land Use and Climate Change

Based on historical experience and the fact that the dams in the study area are aging, precipitation patterns are increasingly more frequent and severe as a result of climate change, and the dams are categorized as High Hazard, there is a moderate probability of a future event involving a dam or levee failure in the study area. There is not expected to be a problem with mass evacuation due to a dam or levee failure, although evacuation on a smaller regional scale is likely and is capably managed by local emergency managers.

5.6 Severe Wind Events (including Tropical Storms, Derechos and Nor'easters)

Wind can be one of the most destructive forces of nature. Strong winds can erode mountains and shorelines, topple trees and buildings, and destroy a community's critical utilities and infrastructure. The analysis in this section focuses on hurricane and tropical storm winds as the most likely type of widespread wind hazards to occur in the region, though more localized damage from high winds also can be caused by straight-line wind events (*i.e.,* derechos), nor'easters, thunderstorms, and tornadoes. Thunderstorms, lightning and tornadoes are discussed in separate subsections of this HIRA.

Hazard Profile

A tropical cyclone is the generic term for a low pressure, non-frontal synoptic scale low-pressure system over tropical or sub-tropical waters with organized convection and definite

cyclonic surface wind circulation. Tropical cyclones rotate counterclockwise throughout the Northern Hemisphere. Depending on strength, these weather systems are classified as hurricanes or tropical storms. They are called tropical depressions when wind speed is less than 39 mph, but become tropical storms when their wind speeds are between 39 mph and 73 mph. When wind speeds reach 74 mph the system is classified as a hurricane. Tropical cyclones involve both atmospheric and hydrologic characteristics, such as severe winds, storm surge flooding, high waves, coastal erosion, extreme rainfall, thunderstorms, lightning, and, in some cases, tornadoes. Storm surge flooding can push inland, and riverine flooding associated with heavy inland rains can be extensive. High winds are associated with hurricanes, with two significant effects: building damage and power outages due to airborne debris and downed trees.

The hurricane season in the North Atlantic runs from June 1 until November 30, with the peak season between August 15 and October 15. The average hurricane duration after landfall, is 12 to 18 hours. Wind speeds may be reduced by 50% within 12 hours after the storm reaches land.

Tropical storms are capable of producing great amounts of rain in a short period of time. For example, the Richmond-Crater region experienced more than 12 inches of rain during Tropical Depressions Camille, Isabel and Gaston over a short duration. These high rates of precipitation may cause flash floods and mudslides. The runoff eventually drains into the large rivers which may still be flooding for days after the storm has passed. To complicate matters, storm surge flooding can push inland as was experienced in Claremont and Sunset Beach in Surry County during Hurricane Isabel. Riverine and urban flooding associated with heavy inland rains can be extensive. Many areas of the Coastal Plain region are flat, and intense prolonged rainfall tends to accumulate without ready drainage paths. Storm surge or coastal flooding, and riverine flooding are discussed separately in this HIRA.

Typically occurring in the summer in the Northern Hemisphere, a *derecho* (from the Spanish, meaning “straight”) is a wide, long-lived, straight-line windstorm. Derechos are often associated with a fast-moving group of severe thunderstorms forming a mesoscale convective system. Similar to a regular thunderstorm’s gust front, a derecho’s wind remains sustained for a greater period of time and may exceed hurricane force. The system may remain active for hours or even days as it moves over land.

Similar to hurricanes, nor’easters are coastal storms capable of causing substantial damage to coastal areas in the Eastern United States due to their strong winds and heavy surf. Nor'easters are named for the winds that blow in from the northeast and drive storms up the East Coast along the Gulf Stream, a band of warm water that lies off the Atlantic coast. They are caused by the interaction of the jet stream with horizontal temperature gradients and generally occur during the fall and winter months when moisture and cold air are plentiful.

Nor'easters are known for dumping heavy amounts of rain and snow, producing hurricane-force winds, and creating high surf that causes severe beach erosion and coastal flooding. There are two main components to a nor'easter: (1) a Gulf Stream low-pressure system (counterclockwise winds) generated off the southeastern U.S. coast, gathering warm air and moisture from the Atlantic, and pulled up the East Coast by strong northeasterly winds at the leading edge of the storm; and (2) an Arctic high-pressure system (clockwise winds) which meets the low-pressure system with cold, arctic air blowing down from Canada. When the two systems collide, the moisture and cold air produce a mix of precipitation and have the potential for creating dangerously high winds and heavy seas. As the low-pressure system deepens, the intensity of the winds and waves increase and can cause serious damage to coastal areas as the storm moves northeast. The coastal counties in the eastern portion of the study area are susceptible to the flooding and high wind impacts from nor'easters.

Extreme wind events pose a danger in the region because they can result in localized or widespread power outages, property damage, falling trees, toppled utility poles and damaged buildings. Mobile homes can be particularly vulnerable to high winds, especially if improperly installed. Injury or death to people can result from falling objects or flying debris. Communication and electricity may be lost for days, and roads can be impassable due to standing water, fallen trees and debris. Local businesses can be closed for extended periods of time due to building and content damage, loss of utilities, and transportation challenges. Extreme wind events can blow over tractor trailers on the highway and make driving difficult in a high-profile vehicle or lightweight vehicle. High winds can turn trash cans, lawn and patio furniture, and other property into projectiles resulting in further property damage.

Most deaths in extreme wind events (from wind) are caused by trees falling onto cars or homes. Dead trees or trees weakened by drought, disease, rotting, or pest infestations are the most susceptible to falling. Property owners using chainsaws to remove fallen debris or generators and grills for cooking when power outages occur also account for many deaths and injuries in the aftermath of severe wind events.

Magnitude or Severity

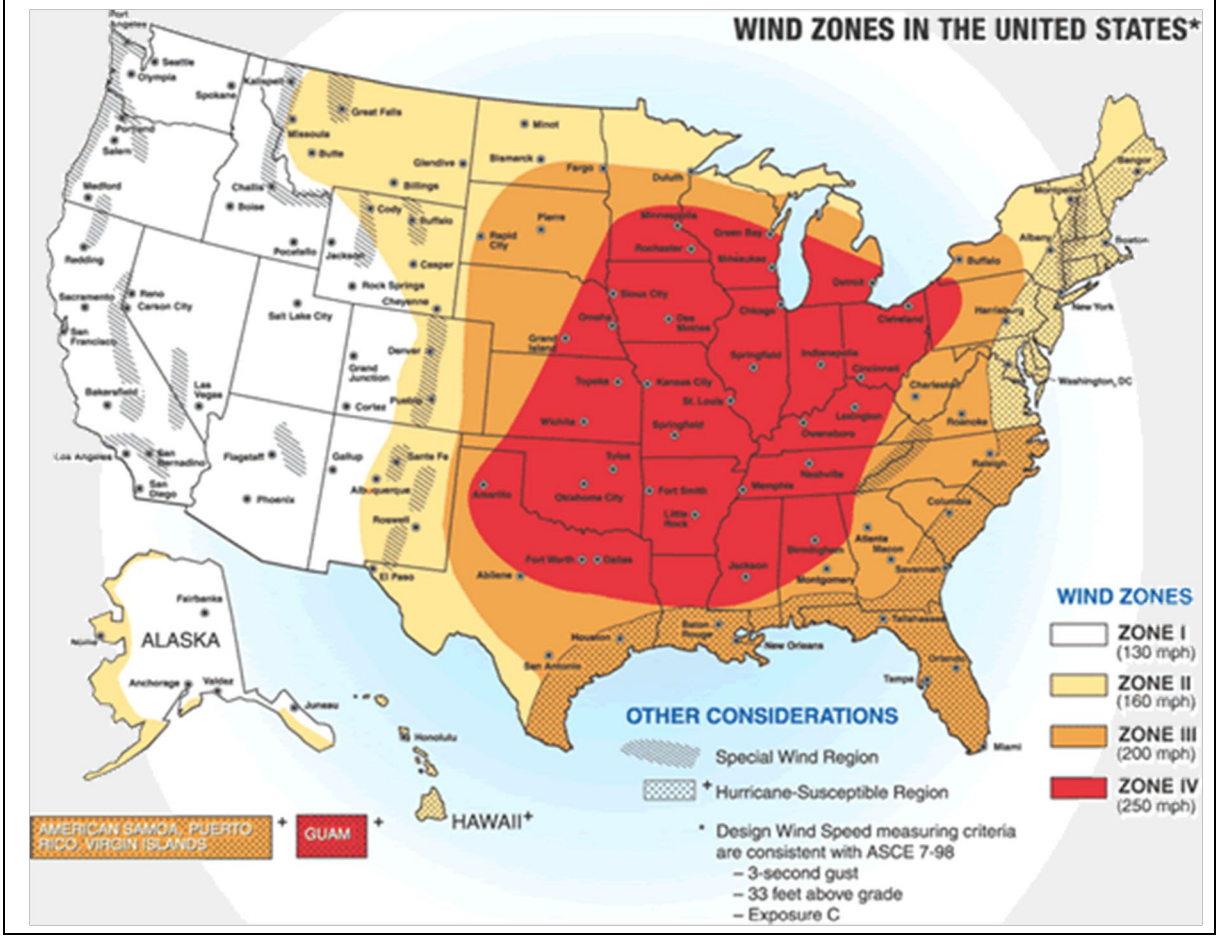
The strength of a hurricane is classified according to wind speed using the Saffir-Simpson Hurricane Damage Scale. This scale provides an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf in the landfall region. **Table 5.13** provides a description of typical damages associated with each hurricane category.

Table 5.13: Saffir-Simpson Hurricane Damage Scale			
Hurricane Category	**Sustained Winds (mph)**	**Damage Potential**	**Description**
1	74–95	Minimal	Minimal damage to unanchored mobile homes along with shrubbery and trees. There may be pier damage and coastal road flooding, with storm surge 4–5 feet above average.
2	96–110	Moderate	Moderate damage potential to mobile homes and piers, as well as significant damage to shrubbery and trees with some damages to roofs, doors, and windows. Impacts include flooding 2-4 hours before arrival of the hurricane in coastal and low-lying areas. Storm surge can be 6–8 feet above average.
3	111–130	Extensive	Extensive damage potential. There will be structural damage to small residences and utility buildings. Extensive damage to mobile homes and trees and shrubbery. Impacts include flooding 3-5 hours before the arrival of the hurricane cutting off the low-lying escape routes. Coastal flooding has the potential to destroy small structures, with significant damage to larger structures as a result of the floating debris. Land that is lower than 5 feet below mean sea level can be flooded 8 or more miles inland. Storm surge can be 6–12 feet above average.
4	131–155	Extreme	Extreme damage potential. Curtain wall failure as well as roof structure failure. Major damage to lower floors near the shoreline. Storm surge generally reaches 13–18 feet above average.
5	> 155	Catastrophic	Severe damage potential. Complete roof failure on residence and industrial structures, with complete destruction of mobile homes. All shrubs, trees, and utility lines blown down. Storm surge is generally greater than 18 feet above average.

Hazard History

Figure 5.12 shows how the frequency and strength of extreme wind events vary across the United States. The map was produced by FEMA and is based on 40 years of tornado history and more than 100 years of hurricane history. Zone IV, the darkest area on the map, has experienced both the greatest number of tornadoes and the strongest tornadoes. As shown by the map key, wind speeds in Zone IV can be as high as 250 mph. Most of the planning region falls within Zone II (winds up to 160 mph) and is considered to be susceptible to hurricanes.

Figure 5.12: Wind Zones in the United States



Source: FEMA, 2011

The Richmond-Crater region is categorized by the American Society of Civil Engineers in its *Minimum Design Loads for Buildings and Other Structures* (ASCE 7) as located in a 90-mph wind zone, based on a 50-year recurrence interval. Based on ASCE 7, the potential wind speed for an event with a 100-year recurrence interval was estimated to be 107% of the 50-year wind speed, or 96.3 mph. The Virginia Uniform Statewide Building Code (VUSBC) requires a 90 mph minimum design wind speed.

High wind events have occurred in every portion of the region. There are no proven indicators to predict specifically where high winds may occur, and wind events can be expansive enough to affect the entire area. The counties on the eastern side of the region are closer to the coast and might experience higher wind speeds from tropical storms or nor'easters that affect Virginia, North Carolina or the northeast United States.

Based on NCEI historical data dating back to the mid-1990s, there have been two deaths and 36 injuries in the region that have resulted from wind, and approximately eight deaths that have resulted from hurricanes. **Table 5.14** includes descriptions of damaging tropical storm and hurricane events in the region, of which there are several. Events have been broken down by the date of occurrence and when available, by individual community descriptions. When no community-specific description is available, the general description applies to the entire region. Although NCEI and VDEM were the primary source of general descriptions, other sources are referenced where more specific information was available.

Table 5.14: History of Wind Events and Damages, 2010–2020*

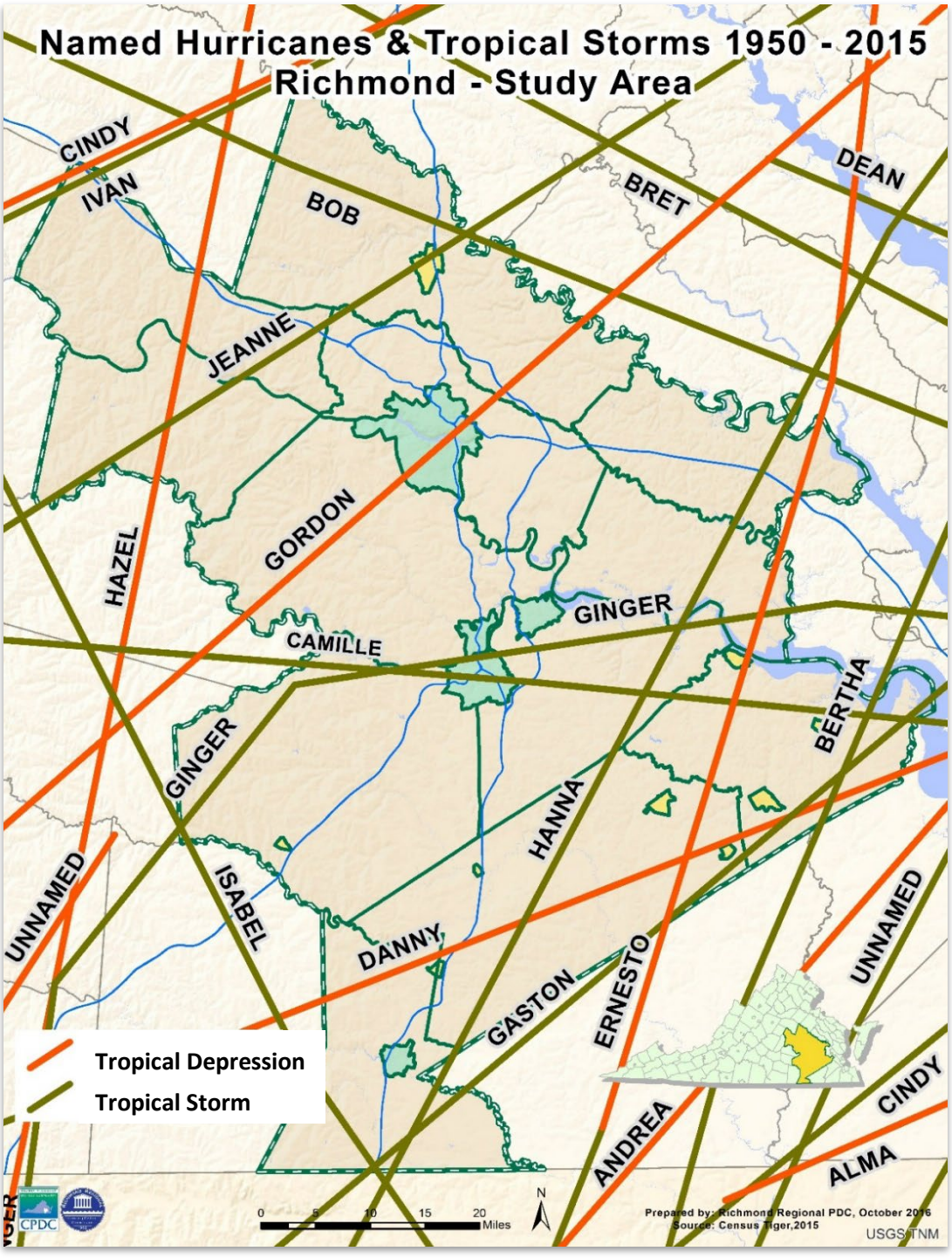
Date	Damages
June 28, 2010	Scattered severe thunderstorms in advance of a cold front produced damaging winds across portions of central Virginia. Trees were downed across eastern portions of Chesterfield County. Trees downed on a home caused the house to collapse in the Sherwood Ridge Subdivision. There was one minor injury. Property damage of $100,000 incurred.
August 27, 2011	Hurricane Irene – See full description in Flood section.
September 4, 2011	Hurricane Lee – See full description in Flood section.
June 29, 2012	A devastating line of thunderstorms known as a derecho moved east-southeast at 60 miles per hour (mph) from Indiana in the early afternoon to the Mid-Atlantic region around midnight. Winds were commonly above 60 mph with numerous reports of winds exceeding 80 mph. Some areas reported isolated pockets of winds greater than 100 mph. Nearly every county impacted by this convective system suffered damages and power outages. To make matters worse, the area affected was in the midst of a prolonged heat wave. Unlike many major tornado outbreaks in the recent past, this event was not forecast well in advance. Warm-season derechos, in particular, are often difficult to forecast and frequently result from subtle, small-scale forcing mechanisms that are difficult to resolve more than 12-24 hours in advance. (Source: http://www.nws.noaa.gov/os/assessments/pdfs/derecho12.pdf)
October 26, 2012	Hurricane Sandy made landfall along the southern New Jersey shore on October 29, 2012, causing historic devastation and substantial loss of life. The National Hurricane Center (NHC) Tropical Cyclone Report estimated the death count from Sandy at 147 direct deaths. In the United States, the storm was associated with 72 direct deaths in eight states: 2 in Virginia. The storm also resulted in at least 75 indirect deaths (i.e., related to unsafe or unhealthy conditions that existed during the evacuation phase, occurrence of the hurricane, or during the post-hurricane/clean-up phase). These numbers make Sandy the deadliest hurricane to hit the U.S. mainland since Hurricane Katrina in 2005, as well as the deadliest hurricane/post-tropical cyclone to hit the U.S. East Coast since Hurricane Agnes in 1972. (Source: http://www.nws.noaa.gov/os/assessments/pdfs/Sandy13.pdf)

Table 5.14: History of Wind Events and Damages, 2010–2020*	
Date	**Damages**
October 12, 2018	Michael was downgraded to extra-tropical shortly after the eye passed over the Virginia-North Carolina border. Winds were 45-50 knots in the region. Wind-related property damages of $19,000 were reported.
October 20, 2019	Nestor was extra-tropical by the time it passed through the region, with wind speeds of 40 knots. The slow-moving disorganized eye passed through the southern part of the study area, between Wakefield and Windsor, and then turned eastward and crossed the James River into Newport News. Wind-related property damages of $6,000 were reported.
August 4, 2020	Isaias was a tropical storm with wind speeds of 60 knots when passing through study area. Gusting winds caused power outages and torrential rains caused flooding that closed roads and bridges. According to the *Richmond Times-Dispatch*, 34 roads in the region were impassable. The paper also reported that the Richmond Metropolitan area had over 28,000 power outages. The storm spawned several tornados, but none reported in the study area. Tropical storm-related property damages of $100,000 were reported in Surry County.

**History from 1827-2010 in Appendix F-4*
Source: NCEI, 2021

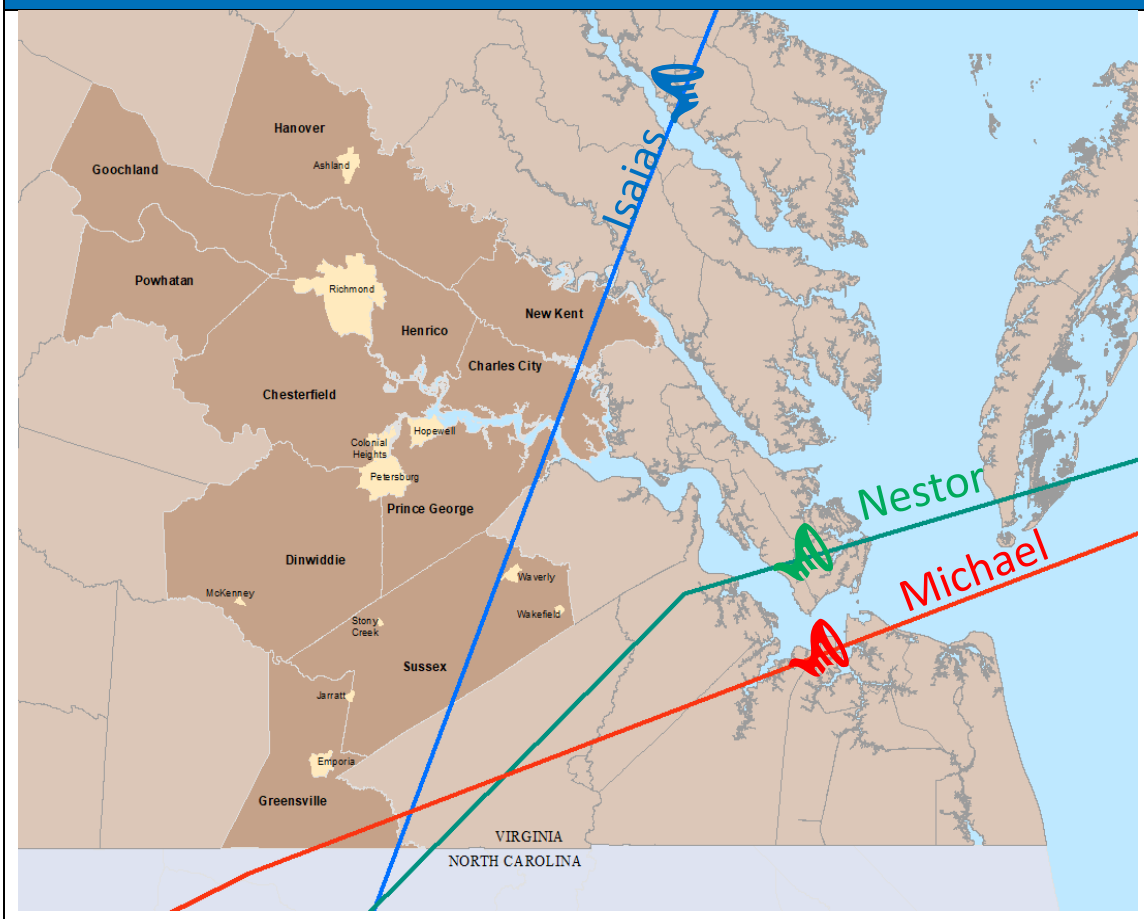
The NOAA Coastal Services Center maintains historical hurricane, tropical storm, and tropical depression track data dating back to the mid-1880s. **Figure 5.13** shows all tropical system and hurricane tracks through and near the region between 1950 and 2015. **Figure 5.14** provides a map of the most recent hurricane or tropical storm tracks between 2015 and 2020.

Figure 5.13: Named Hurricane and Tropical Cyclone Tracks, 1950–2015



Source: NOAA Coastal Services Center, 2021

Figure 5.14: Regionally Significant Hurricane and Tropical Cyclone Tracks, 2015- 2020



Source: NOAA Coastal Services Center, 2021

Vulnerability Analysis

Historical evidence shows that the Richmond-Crater region is vulnerable to damaging storm-force winds, whether associated with coastal storms like nor'easters, tropical storms such as hurricanes, or straight-line winds such those generated by a thunderstorm derecho. As shown in Figure 5.13 above, 36 hurricanes or tropical storms have passed within 75 miles of the region since the first unnamed hurricane in 1854. This equates to a 22-percent annual chance that a storm will similarly impact the region.

Table 5.15 analyzes the historical annual hurricane occurrences in the region with Prince George, Surry and Dinwiddie counties reporting the highest historical annual damages.

Table 5.15: Annualized Hurricane Events and Losses, 1993 - 2020				
Jurisdiction	**Annualized Number of Events**	**Annualized Property Losses**	**Annualized Crop Losses**	**Annualized Total Losses**
Charles City County	0.074	$3,296	$23,741	$27,037
Chesterfield County	-	-	-	-
City of Colonial Heights	-	-	-	-
City of Emporia	-	-	-	-
City of Hopewell	-	-	-	-
City of Petersburg	-	-	-	-
City of Richmond	-	-	-	-
Dinwiddie County	0.074	$214,074	$90,741	$304,815
Goochland County	0.037	$0	$10,481	$10,481
Greensville County	0.074	$8,111	$1,852	$9,963
Hanover County	0.074	$3,704	$14,815	$18,519
Henrico County	0.000	$0	$0	$0
New Kent County	0.074	$926	$4,519	$5,444
Powhatan County	0.037	$148,148	$13,296	$161,444
Prince George County	0.074	$314,815	$229,630	$544,444
Surry County	0.222	$232,111	$81,481	$313,593
Sussex County	0.111	$3,963	$37,037	$41,000
Totals	**0.852**	**$929,148**	**$507,593**	**$1,436,741**

Source: NCEI, 2020

Detailed loss estimates for the wind damage associated with the tropical storm hazard were developed based on probabilistic scenarios using Hazus (Level 1 analysis). **Table 5.16** shows estimates of potential building damage for the 100-year return period, and annualized total losses. In summary, the region may be susceptible to an estimated total of approximately $178 million in building damages from a 100-year wind event, equating to $9.7 million average annual damages.

Table 5.16: Estimates of Potential Building Damage – 100-Year Wind Only Event					
Community	**Building Damage**	**Contents & Inventory Damage**	**Income Losses**	**Total***	**Annualized Total Losses**
Charles City County	$969,000	$532,000	$0	$1,501,000	$125,000
Chesterfield County	$49,095,000	$7,696,000	$59,000	$56,850,000	$2,271,000
Colonial Heights	$3,645,000	$529,000	$24,000	$4,198,000	$174,000
Dinwiddie County	$8,111,000	$2,181,000	$194,000	$10,486,000	$252,000
Emporia	$953,000	$279,000	$11,000	$1,243,000	$90,000
Goochland County	$2,860,000	$1,297,000	$0	$4,157,000	$201,000
Greensville County	$1,562,000	$571,000	$1,000	$2,134,000	$137,000
Hanover County	$9,861,000	$5,123,000	$1,000	$14,985,000	$1,347,000
Henrico County	$24,076,000	$2,623,000	$58,000	$26,757,000	$2,059,000
Hopewell	$3,641,000	$843,000	$28,000	$4,512,000	$222,000
New Kent County	$2,337,000	$1,386,000	$0	$3,723,000	$441,000
Petersburg	$6,891,000	$1,429,000	$213,000	$8,533,000	$326,000
Powhatan County	$5,715,000	$3,128,000	$0	$8,843,000	$265,000
Prince George County	$8,093,000	$2,298,000	$24,000	$10,415,000	$412,000
Richmond	$14,589,000	$1,380,000	$140,000	$16,109,000	$1,235,000
Sussex County	$3,185,000	$1,012,000	$89,000	$4,286,000	$147,000
Totals	$145,583,000	$32,307,000	$842,000	$178,732,000	$9,704,000

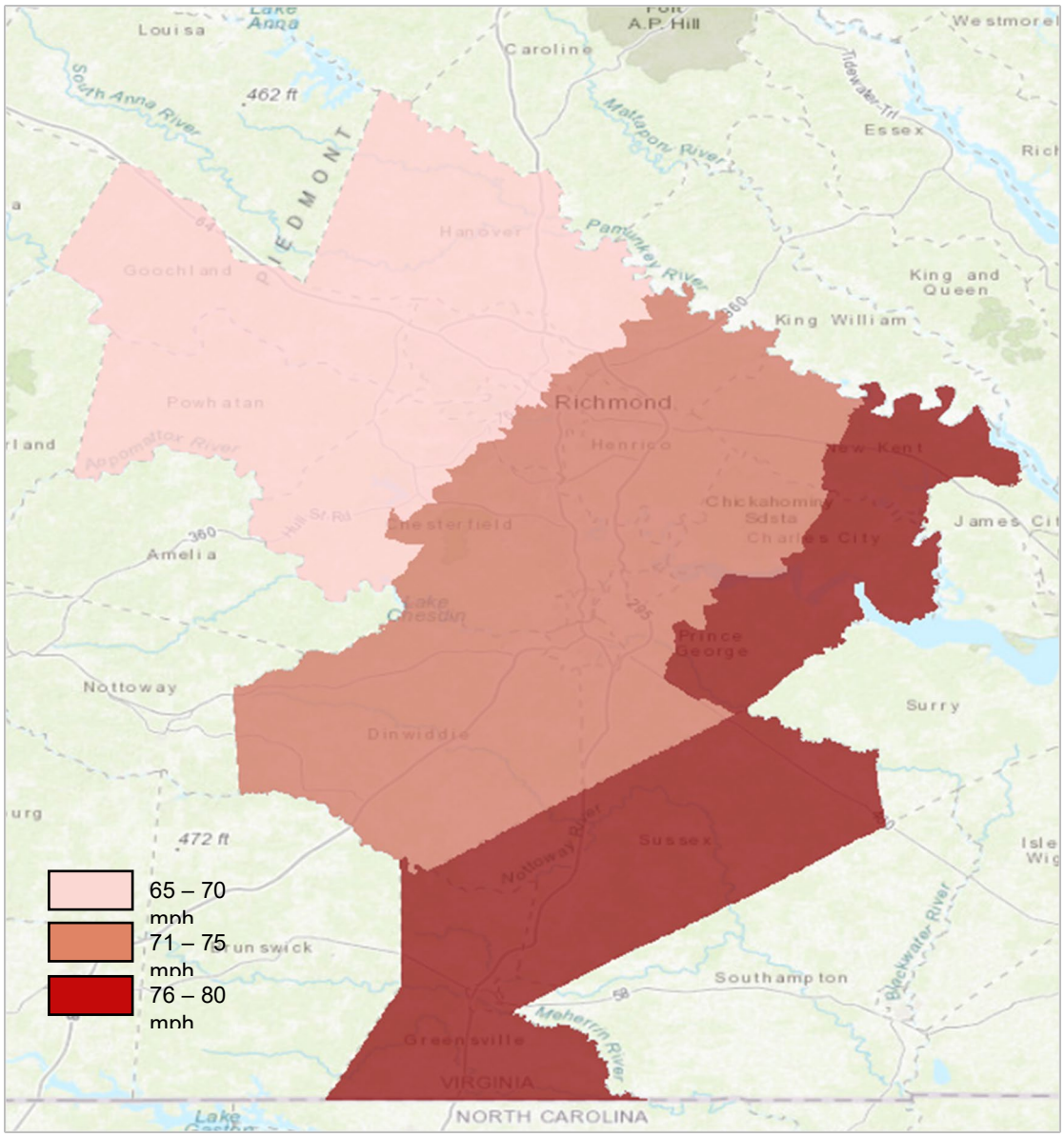
** income losses from relocation, lost wages, and lost rental income*
Source: Hazus

Based on the data in Table 5.16, Chesterfield County, Hanover County, Henrico County and the City of Richmond have the highest annualized total losses from wind associated with a 100-year wind event. These communities are also the most vulnerable for flood, so these 3 communities are considered the most vulnerable to the combined wind and flooding effects of Tropical Storms. Prince George County, Dinwiddie County and Hanover County are also very vulnerable to wind effects from the 100-year wind event. Emporia, Charles City County and Greensville County are significantly further west, have less overall development, and are thus less likely to experience the devastating impacts of wind than the remainder of the Richmond-Crater region. Annualized losses for the region total just over $9.7 million, but vary remarkably throughout the area, with Emporia having annualized damages of $90,000 and Chesterfield County with over $2.2 million.

Figure 5.15 provides a map of winds expected from the 100-year event across the study area, also modeled through Hazus. Consistent with the expected exposure to hurricane

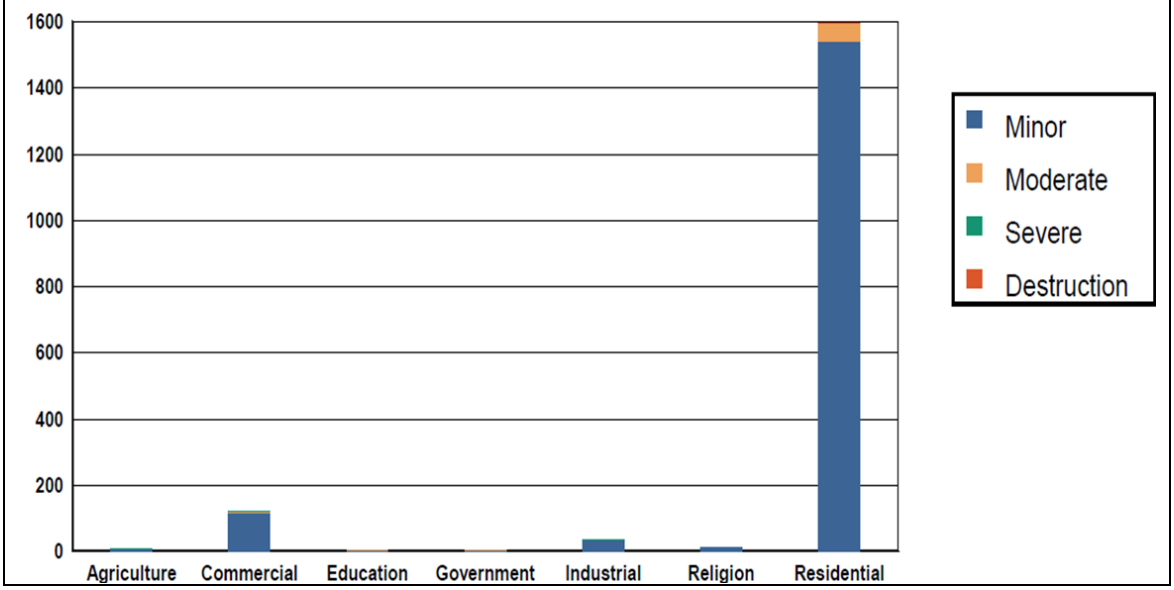
force winds near the coast, the most vulnerable area to high winds is typically in the eastern portion of the study area. Areas west of Richmond and into the Virginia Piedmont region are less susceptible.

Figure 5.15: 100-year Return Period Peak Gusts (mph)



Source: Hazus, 2021

Figure 5.16: Expected Building Damage by Occupancy, 100-year Wind Event



Source: Hazus, 2021

Hazus was also used to model summary building damage estimates based on percentage of damage (by damage state) for the 100-year return period (**Figure 5.16**). These data can be useful when used in conjunction with Table 5.16 above because building wind damage can range from minor, easily repairable damage to gutters or roof features, to destruction of roofs and buildings from fallen trees, or structural failure.

For this update, Hazus was used to model a recurrence of Hurricane Hazel, which struck the Central Virginia region in 1954. The storm track was unique; it approached central Virginia from the south. On October 15, the storm made landfall near the North Carolina/South Carolina line and is estimated to have been a Category 4 storm at that time. As it moved north across North Carolina, Hazel became extratropical over Raleigh. Hazel rocketed north over Central Virginia at a forward speed of 50 miles per hour and brought with it wind gusts of 79 miles per hour in Richmond. But the speed of the storm kept the damage from being devastating. Many homes in Richmond lost roofs.

An examination of Hazel using modern building exposure data was possible through Hazus. **Table 5.17** provides a summary of the damage data for this "what-if" scenario, examining the damage caused if a storm similar to Hurricane Hazel struck the Richmond-Crater study area in the 21st century. Total estimated losses are over $2.3 billion, with most significant damages in Chesterfield County, Hanover County, Henrico County, and the City of Richmond.

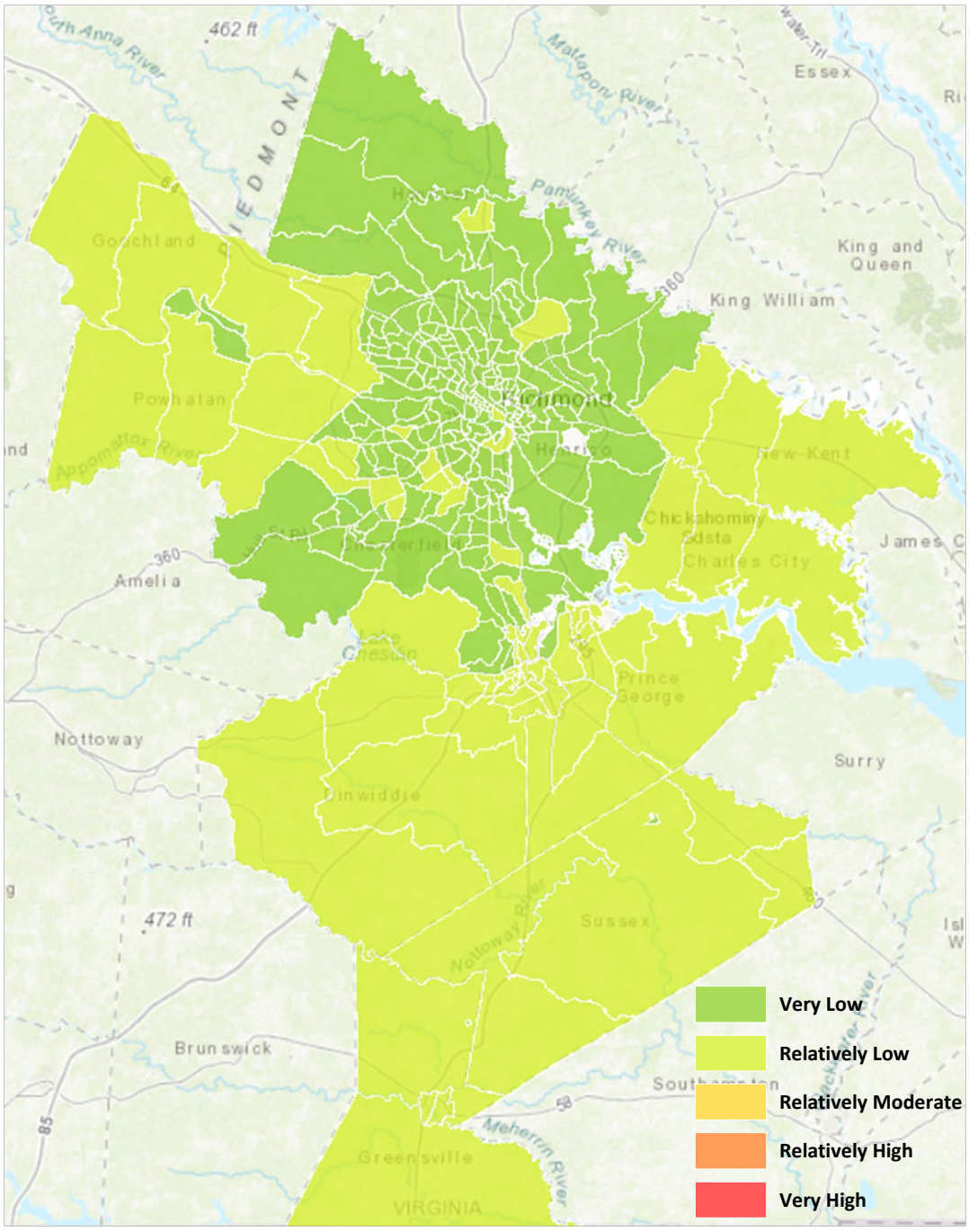
Table 5.17: Estimates of Potential Building Damage – Hurricane Hazel in 2021				
Community	**Building Damage**	**Contents & Inventory Damage**	**Income Losses**	**Total***
Charles City County	$6,537,000	$3,091,000	$190,000	$9,818,000
Chesterfield County	$504,598,000	$93,278,000	$36,964,000	$634,840,000
Colonial Heights	$23,552,000	$4,123,000	$2,858,000	$30,533,000
Dinwiddie County	$38,661,000	$11,292,000	$3,342,000	$53,295,000
Emporia	$8,258,000	$2,574,000	$1,239,000	$12,071,000
Goochland County	$27,418,000	$9,446,000	$1,175,000	$38,039,000
Greensville County	$12,319,000	$4,491,000	$1,150,000	$17,960,000
Hanover County	$209,059,000	$89,736,000	$10,711,000	$309,506,000
Henrico County	$513,786,000	$88,870,000	$50,033,000	$652,689,000
Hopewell	$22,906,000	$5,225,000	$2,076,000	$30,207,000
New Kent County	$20,972,000	$10,843,000	$462,000	$32,277,000
Petersburg	$41,072,000	$9,539,000	$5,277,000	$55,888,000
Powhatan County	$31,513,000	$14,209,000	$874,000	$46,596,000
Prince George County	$32,559,000	$9,329,000	$1,464,000	$43,352,000
Richmond	$302,153,000	$48,356,000	$45,582,000	$396,091,000
Sussex County	$7,234,000	$2,306,000	$415,000	$9,955,000
Totals	**$1,802,597,000**	**$406,708,000**	**$163,812,000**	**$2,373,117,000**

** Also includes income losses from relocation, lost wages, and lost rental income.*
Source: Hazus

Social Vulnerability

The NRI data for social vulnerability to hurricanes are shown in **Figure 5.17**. Most of the urbanized portion of the study area is shown as having very low social vulnerability, while the more rural land use areas are shown as having relatively low social vulnerability. This disparity could be a result of the lack of recorded hurricane or tropical storm losses for the cities in the region. Table 5.15 above (Annualized Hurricane Events and Losses, 1993 – 2020) shows that the NCEI database does not include any recorded events for any of the cities in the study area. Therefore, the modeling included a large number of no loss or low loss events.

Figure 5.17: National Risk Index, Hurricane Risk Rating



Source: National Risk Index, FEMA 2021

Note: The Town of Surry has relatively moderate social vulnerability for hurricane.

Future Vulnerability, Land Use and Climate Change

The type of building construction has a significant impact on potential damages from high wind events in the future, as type of construction is also a key factor in determining the life of a structure. Basic building types in declining order of wind vulnerability are manufactured, non-engineered wood, non-engineered masonry, lightly engineered and fully engineered buildings. The primary residential construction type in the study area is wood framed, varying from single story to multiple stories, although some masonry and steel properties are present as well. With the prevalence of non-engineered, wood-framed structures throughout the Richmond-Crater region, a majority of structures in the area could be classified as having a high level of vulnerability to damages due to a high wind event in the future. Using Hazus, an analysis of the damage caused by a 100-year frequency wind event indicates that 815 wood-framed structures would have minor, moderate or severe damage, while 723 masonry structures would have minor, moderate or severe damage.

All future structures built in the Richmond-Crater region will likely be exposed to hurricane and tropical storm-force winds and may also experience damage not accounted for in the loss estimates presented in this section. The VUSBC continues to reduce vulnerability of newly constructed buildings to the wind hazard.

The VASEM 2021 report concludes that the research on climate change impacts in the study region is conflicted regarding increased frequency of Atlantic Coast hurricanes. However, the report indicates consensus that there will be an increase in average cyclone intensity, precipitation rates, and the number of strong storms. Strong storms combined with sea level rise are particularly alarming for the eastern region of the study area. Even in rural areas in the western portion of the study area, increasing storm intensity can damage crops and soil in addition to vulnerable agricultural structures.

Similar to the discussion in the subsection above regarding flooding, mass evacuations due to coastal wind events, particularly tropical storms, is a possibility. However, the last time a mass evacuation impacted the area was Hurricane Floyd in September 1999. Transportation disruptions and impacts on infrastructure are the most likely problems that communities in the study area may experience.

5.7 Tornadoes

Hazard Profile

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. According to the NWS, tornado wind speeds normally range from 40 to more than 200 mph. The most violent tornadoes (EF5) have rotating winds of 200 mph or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles.

Each year, an average of over 1,200 tornadoes is reported nationwide, resulting in an average of 80 deaths and 1,500 injuries. They are more likely to occur during the spring and early summer months of March through June and can occur at any time of day but are likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small, short-lived tornadoes can inflict tremendous damage. Highly destructive tornadoes may carve out a path over a mile wide and tens of miles long.

Magnitude or Severity

The destruction caused by tornadoes ranges from light to devastating depending upon the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damages to structures of light or wood-framed construction such as residential homes (particularly mobile homes) and tend to remain localized in impact. The traditional Fujita Scale for tornadoes, introduced in 1971, was developed to measure tornado strength and associated damages. Starting in February of 2007, an "enhanced" Fujita (EF) Scale was implemented, with somewhat lower wind speeds at the higher F-numbers, and more thoroughly refined structural damage indicator definitions. **Table 5.18** provides a summary of the EF Scale. Assigning an EF Scale rating to a tornado involves the following steps:

- Conduct an aerial and ground survey over the entire length of the damage path;
- Locate and identify damage indicators in the damage path;
- Consider the wind speeds of all damage indicators and assign an EF Scale category for the highest wind speed consistent with wind speeds from the other damage indicators;
- Record the basis for assigning an EF scale rating to a tornado event; and
- Record other pertinent data related to the tornado event.

Table 5.18: Enhanced Fujita (EF) Scale for Tornadoes	
EF-Scale Number	**3 Second Gusts (mph)**
F0	65-85
F1	86-110
F2	111-135
F3	136-165
F4	166-200
F5	over 200

Source: NWS Storm Prediction Center

In Virginia, tornadoes primarily occur from April through September, although tornadoes have been observed in every month. Low-intensity tornadoes occur most frequently; tornadoes rated F2 or higher are very rare in Virginia, although F2, F3, and a few F4 storms have been observed. According to the *2013 Commonwealth of Virginia, Mitigation Plan*, Virginia ranks 28th in terms of the number of tornado touchdowns reported between 1950 and 2006. The 2018 update did not provide an updated ranking.

Tornadoes are high-impact, low-probability hazards. The net impact of a tornado depends on the storm intensity and the vulnerability of development in its path. Because the path of each tornado is unique to each event, general descriptions of impacts in the study area can be drawn from the impacts of previous storms (see also **Table 5.19** below). Communities rarely activate EOCs before tornadoes due to the short warning times, but after extreme events with catastrophic damage that displace a large number of residents, such activation may become necessary.

In the Richmond-Crater region, a high intensity tornado, while rare, can be expected to impact almost everything within the storm's path: homes, especially those constructed prior to the use of building codes; infrastructure, especially above-ground power lines in the commercial zones and bridges throughout the region; cars and personal property; landscape elements such as trees, fences and shrubs; and even human lives. Downed trees can block roadways, impeding traffic and blocking access and egress if any of the region's thoroughfares are impacted. Manufactured homes are particularly vulnerable to damage in the event of tornadoes, as well, particularly if they were placed outside of flood zones and before building codes were in effect requiring foundation tie-downs.

Tornadoes associated with tropical cyclones are somewhat more predictable. These tornadoes occur frequently in September and October when the incidence of tropical storm systems is greatest. They usually form around the perimeter of the storm, and most often to the right and ahead of the storm path or the storm center as it comes ashore. These tornadoes commonly occur as part of large outbreaks and generally move in an easterly direction. Tracking and prior notification by the National Weather Service and local news media helps save lives locally.

Most tornado strikes in the region have been F0 or F1 and the effects were somewhat less than as described above for severe storms. Critical damage to structures in the tornado's

path is common, with indiscriminate damage to public-and privately-owned structures, some infrastructure, and downed trees that make transportation difficult. In areas adjacent to the path, minor damage, especially to roofs and windows from trees and flying debris, can also be expected. While downed trees may block transportation routes and result in power outages for some customers, these impacts are typically cleared within a few days.

Hazard History

Table 5.19 includes descriptions of major tornado events that have touched down and been recorded in the region since 2011. Prior events are included in Appendix F-5. Events have been broken down by the date of occurrence and, when available, by individual community descriptions. When no community description is available, the general description applies to the entire region. Although not comprehensive in terms of tornado fatalities and injuries, the NCEI database indicates that since 1950 there have been 11 deaths and 348 injuries in the region due to tornadoes.

Table 5.19: History of Tornado Events and Damages, 2011–2020*

Date	Description	Damages
April 16, 2011	**Dinwiddie County:** Tornado path started on Doyle Road west of Glebe Road and then tracked east-northeast to the Five Forks area of Dinwiddie County. Hundreds of trees were either downed or snapped off. Numerous power lines were also downed, and there were several homes and outbuildings with minor to moderate damage. Most significant damage was on Patillo Road at Wooded Lane, and on Wilkinson Road near Shannon Drive. EF-1	**$1,500,000 (property)** **5 injuries**
April 27, 2011	**Goochland County:** Scattered severe thunderstorms well in advance of a cold front produced damaging winds, large hail, and several tornadoes across portions of central Virginia. Tornado tracked from Bridgewater Bluff to Pony Farm Road, crossing Interstate 64. Numerous trees were downed or sheared off. The tornado tracked into Louisa County. EF1	**$25,000 (property)**
April 28, 2011	**Hanover County:** Scattered severe thunderstorms in advance of a cold front produced damaging winds and one tornado across portions of central and eastern Virginia. Tornado paralleled Old Ridge Road for 1.5 miles before crossing Coatesville Road. The tornado then tracked northeast approximately 1 mile and crossed Old Ridge Road. Numerous trees were downed or sheared off. A single tree fell on a house on Old Ridge Road causing minor roof damage. EF1	**$25,000 (property)**
October 13, 2011	**New Kent County:** Tornado first touched down along Emmaus Church Road or Route 609 just into New Kent County north of U.S. Route 60. The NWS Storm Survey rated the tornado as an EF1 with winds estimated at 95 mph as it reached the Woodhaven Shores Subdivision on both sides of Kent Lake. According to county emergency management, over 30 homes were damaged in the Woodhaven Shores Subdivision on both sides of Kent Lake, primarily due to trees falling on	**$1,000,000 (property)**

Table 5.19: History of Tornado Events and Damages, 2011–2020*		
Date	**Description**	**Damages**
	homes. Damage was most extensive along and adjacent to Lakeshore Drive which surrounds Kent Lake. EF1 damage extended just to the north of Kent Lake and included two barns that were destroyed along Ashland Farm Road. The tornado then weakened to a high-end EF0 and turned northeast as it crossed north of Interstate 64. Damage at GW Watkins Elementary School included aluminum roofing panels that were popped off along with a few busted windows. EF0 damage was observed farther northeast with several trees downed or snapped off along Talleysville Road near Old River Road. The tornado lifted just before entering King William County. EF-1	
June 1, 2012	Scattered severe thunderstorms in advance of a cold front produced damaging winds, large hail and several tornadoes across portions of central and eastern Virginia. **Petersburg:** The tornado tracked approximately 3 miles beginning on the western edge of Fort Hayes Common where a couple of trees were damaged. It then continued northeast through portions of the Battlefield Park, Oakhurst and East Walnut Hill sections of Petersburg. The tornado then crossed Interstate 95 causing minor damage, mainly windows blown out and signs damaged just east of the intersection of Route 460 and Hickory Hill Road. The last damage or debris was observed on the north side of the Petersburg National Battlefield. The tornado damage was characterized by trees, large limbs and power lines down. A number of trees fell on homes. The most significant damage occurred in the East Walnut Hill neighborhood and the northeast sections of the Oakhurst neighborhood. EF0 **Hanover County:** A brief tornado touched down just west of Highway 301 tracking southeast. The tornado knocked down numerous trees blocking roads including Highway 301. Tornado downed numerous trees and produced some minor structural damage in the Hadensville area of Goochland County. EF0	**$175,000 (property)** **5 injuries**
June 25, 2012	**Goochland County:** Scattered severe thunderstorms in advance of a cold front produced damaging winds, large hail and a tornado across portions of central and eastern Virginia. EF0	**$15,000 (property)**
June 30, 2012	**Hanover County:** The tornado downed numerous trees and produced some minor structural damage in the area. The tornado initially touched down near Williamsville Acres Lane, then tracked south southeast before lifting east of Mechanicsville near the intersection of Crown Hill Road and State Route 628. EF-0	**$15,000 (property)**
May 22, 2014	**Prince George County:** _ The tornado was confirmed near the city of Prince George. The storm intensified northwest of Richmond, then produced wind damage in the City of Richmond, with trained storm spotters periodically reporting a funnel cloud in the Metro as it raced southeast. At 5:45 p.m., a tornado touched down on Kurnas Lane, destroying a shed, snapping trees and causing minor damage to a home. The tornado was rated an EF-0, with winds of 70 mph. It was 25	**$50,000 (property)**

Table 5.19: History of Tornado Events and Damages, 2011–2020*		
Date	**Description**	**Damages**
	yards wide and was on the ground for 75 yards. No injuries were reported. EF-0 **Sussex County:** The tornado was confirmed near Waverly in Sussex County at 6:20 p.m. The tornado developed just north of Highway 460 and south of Petersburg Road, about mile northwest of Waverly. It moved south and crossed Highway 460 just north of Waverly. It struck an auto parts store, causing minor damage. Many large trees were uprooted along Highway 460, and the highway was closed due to trees on the road. The tornado tracked southward to North Church Street, causing minor damage to the First Baptist Church. Many large trees fell into the nearby cemetery, causing damage. The tornado moved across New Street, snapping trees and damaging homes. The tornado lifted shortly after crossing Highway 460 on the west side of Waverly. This tornado was classified as an EF-0 tornado, with winds of 75 mph. It was 100 yards wide and was on the ground for 1.5 miles. No injuries were reported. EF-0 (Source: http://wtvr.com/2014/05/23/two-tornadoes-confirmed-from-may-22-storm/)	
June 27, 2015	**Hanover County:** Scattered severe thunderstorms along a warm front and in advance of a cold front produced damaging winds, a weak tornado, and heavy rain across portions of central and eastern Virginia. A weak tornado touched down several times in Hanover County. It began just north and east of the Interstate 295 and Interstate 95 interchange. It then tracked east northeast for about 3.5 miles, crossing Route 301 before lifting and dissipating. Minor damage to tops of trees occurred. EF0	$2000 (property)
Feb 24, 2016	**Waverly:** NWS storm survey concluded that an EF1 tornado occurred near Waverly. The tornado began a few miles south southwest of Waverly, moved fast through the town of Waverly, then ended about five miles north northeast of Waverly in Surry County. Maximum winds were between 100 and 110 mph. Numerous trees were downed, with two mobile homes destroyed and several homes and businesses damaged. EF-1	$2,600,000 (property damage) 3 deaths, 8 injuries
May 5, 2017	**Mosely:** Tornado tracked from near the Norfolk Southern Railroad northeast to near the intersection of Bradbury Road (VA-672) and Moseley Road (VA-605). Many trees were found snapped or uprooted along this route, including several onto homes. EF-0 **McKenney:** Tornado tracked from Brunswick County into Dinwiddie County. The tornado continued north northeast into Dinwiddie County along Old White Oak Road. It crossed Old White Oak Road near Route 40, then continued north northeast before a visible damage path ended just north of Lew Jones Road. Numerous trees were uprooted or sheared off, and there was significant damage to a few homes and one large shed was destroyed. Also, there was extensive crop damage, as well as damage to farm equipment and land damage. EF-1	$578,000 (property) $40,000 (crops)

Table 5.19: History of Tornado Events and Damages, 2011–2020*		
Date	**Description**	**Damages**
	Dinwiddie County: Information obtained from the Dinwiddie County emergency manager and the Virginia Department of Forestry suggests a tornado touched down in timberland in northern Dinwiddie County. The tornado first touched down north of Route 460, to the west northwest of Sutherland, then tracked north northeast, ending near Namozine Road. Extensive damage to trees occurred along the path, with no damage to structures. EF-1	
September 17, 2018	**Rockville:** A brief EF1 tornado touched down just northwest of the intersection of Echo Meadows Road and Rockville Road in Hanover County. The storm then moved north northeast, causing numerous trees to be uprooted or snapped. In addition, an open shed was completely destroyed, with numerous round bales of hay moved into the field to the north. The tornado then lifted near Franklin Hills Drive. EF-1 **Hallsboro**: The tornado first crossed Beaver Bridge Road and then Beach Road. The bulk of the structural damage occurred in the Hampton Park Neighborhood. It then crossed Hull Street and entered Moseley, before dissipating near the Fox Club Parkway. EF-1 **Richmond:** An EF1 tornado touched down in the Stony Point area of the City of Richmond just south of West Huguenot Road. The tornado then tracked northward into Tuckahoe before lifting just south of Three Chopt Road. Numerous trees were downed or snapped with air conditioning units blown off the West End Church near West Parham Road. EF-1 **Bon Air:** Beginning in Winterpock, the tornado started as a weak EF1 before moving into a residential area north of River Road. The tornado reached peak intensity (EF2) when it crossed Hull Street Road. At this point, it took off the roof of Gabe's and damaged several other businesses. After crossing Hull Street Road, it destroyed the Old Dominion Warehouse, where one person was killed, and one was injured. It remained an EF2 until about Gregwood Drive, completely destroying trees and damaging other structures. It then quickly weakened to an EF0 as it reached Powhite Parkway and continued as an EF0 toward Route 60 in Bon Air. One death and one injury were reported. EF-2 **Pilkinton:** This was a weak tornado that uprooted a few trees and snapped some tree limbs. EF-0 **Richmond:** The tornado briefly touched down on New Kent Road where numerous trees were snapped. EF-0 **Richmond:** The tornado touched down on West Wood Avenue, then onto Confederate Avenue and Lamont Street where numerous trees and several power poles were snapped. EF-0 **Richmond:** The tornado touched down in the City of Richmond on the north side of the James River between Byrd Park and the Powhite Parkway. The tornado continued across the Powhite Parkway into the	$1,078,000 (property) 1 death, 1 injury

Table 5.19: History of Tornado Events and Damages, 2011–2020*		
Date	**Description**	**Damages**
	Windsor Farms section of the City of Richmond. The tornado mainly snapped and uprooted trees along its path. EF-0 **Atlee:** Public video of a tornado touchdown near Atlee High School. Tornado touched down briefly then lifted off the ground causing no damage. EF-0 **Richmond:** The tornado touched down near Stratford Road, then moved north across Chippenham Parkway, and ending near Cherokee Road where numerous trees and several power poles were snapped. EF-0	
October 11, 2018	**Lanexa:** A tornado touched down on Colony Trail in Lanexa where it downed several trees and damaged four homes before lifting near the intersection of Colony Trail and Waterside Drive. EF-0	$50,000 (property)
April 19, 2019	**Gaskins:** The tornado touched down approximately 1/2 mile west of Creek Road in rural southeast Greensville County. The tornado tracked north northeast over rural portions of Greensville County before finally lifting one mile north of Moores Lane. The tornado mostly snapped trees along its path. EF-0 **Dahlia:** The tornado tracked from Northampton County, NC, into Greensville County, VA. The tornado tracked across Skippers Road where additional trees were snapped. The tornado then briefly lifted while shifting its track slightly east, while remaining in Greensville County. EF-0 **Skippers:** The same tornado that started in Northampton County NC, shifted its track slightly east within Greensville County, VA and touched down again near Taylor`s Mill Road. From there, the tornado continued northeast crossing Caney Swamp and causing EF1 damage to numerous trees along Little Low Ground Road. The tornado then continued into extreme southwest Southampton County. EF-1 **Emporia:** The tornado touched down near the intersection of Brink Road and Collins Road, about 3 miles southwest of Emporia, VA in Greensville County. The tornado snapped trees and did damage to a couple of outbuildings along its path. Minor damage also occurred at a shopping center in Emporia. The tornado lifted just north of town. EF-0 **Newville:** The tornado touched down just south of Sussex Drive about 4 miles east of Stony Creek in Sussex County. It then traveled northeast and crossed Jerusalem Park Road near Courthouse Road, before continuing northeast across General Mahone Highway and lifting before reaching Centerville Road in Prince George County. The tornado mostly uprooted and snapped trees along its path. A garage was also destroyed from a tree falling on it. EF-0 **Burrowsville:** The tornado touched down near Fireside Drive in Disputanta causing some downed trees and a car port to be blown over, consistent with EF0 damage. The tornado continued moving north northeast across Webb Road and then Lebanon Road, Cedar Lane and Pole Run Road. Many trees were snapped or uprooted, and	$293,000 (property)

Table 5.19: History of Tornado Events and Damages, 2011–2020*		
Date	**Description**	**Damages**
	numerous sheds and outbuildings received significant damage or were destroyed between Lebanon Road and Pole Run Road. This area was where the EF1 damage occurred. The tornado lifted north of Pole Run Road before Route 10. There was additional tree damage along Hines Road just north of Newville. EF-1 **Ruthville:** The National Service in Wakefield confirmed an EF2 tornado just northeast of Charles City. The tornado touched down just east of The Glebe Lane about 1.7 miles northeast of Charles City causing some trees to be uprooted and snapped along Ruthville Road. Soon after crossing Ruthville Road, the tornado intensified to an EF2, causing extensive damage to Charles City Rod and Gun Club. The roof of the building was lifted off and blown partially off. In addition, the south facing exterior wall was blown in. The tornado continued tracking northeast, crossing Old Elam Cemetery Road and then The Glebe Lane, causing extensive tree damage including snapped and uprooted trees consistent with EF1 damage. The tornado then weakened to an EF0, before lifting just northeast of Sturgeon Point Road. EF-2	

**History from 1790-2010 in Appendix F-5*
Source: NOAA, NCEI data through 11/30/2020, accessed 3/18/21.

By far, the most memorable tornado in the region's history since 1950 occurred in the summer of 1993, affecting Petersburg, Colonial Heights, Prince George County and Hopewell. August 6, 1993, started out quietly for southeastern Virginia, with highs in the mid-70s and partly cloudy skies. However, as a warm front moved north across Richmond and Henrico County and an approaching low pressure center moved in, these clouds disappeared leading to intense warming throughout the day. Unfortunately, the mild temperatures and high humidity levels in place that day were two of the key ingredients that allowed a warm August afternoon to turn into an historical and deadly evening. (Source: https://www.weather.gov/akq/severe_Aug061993)

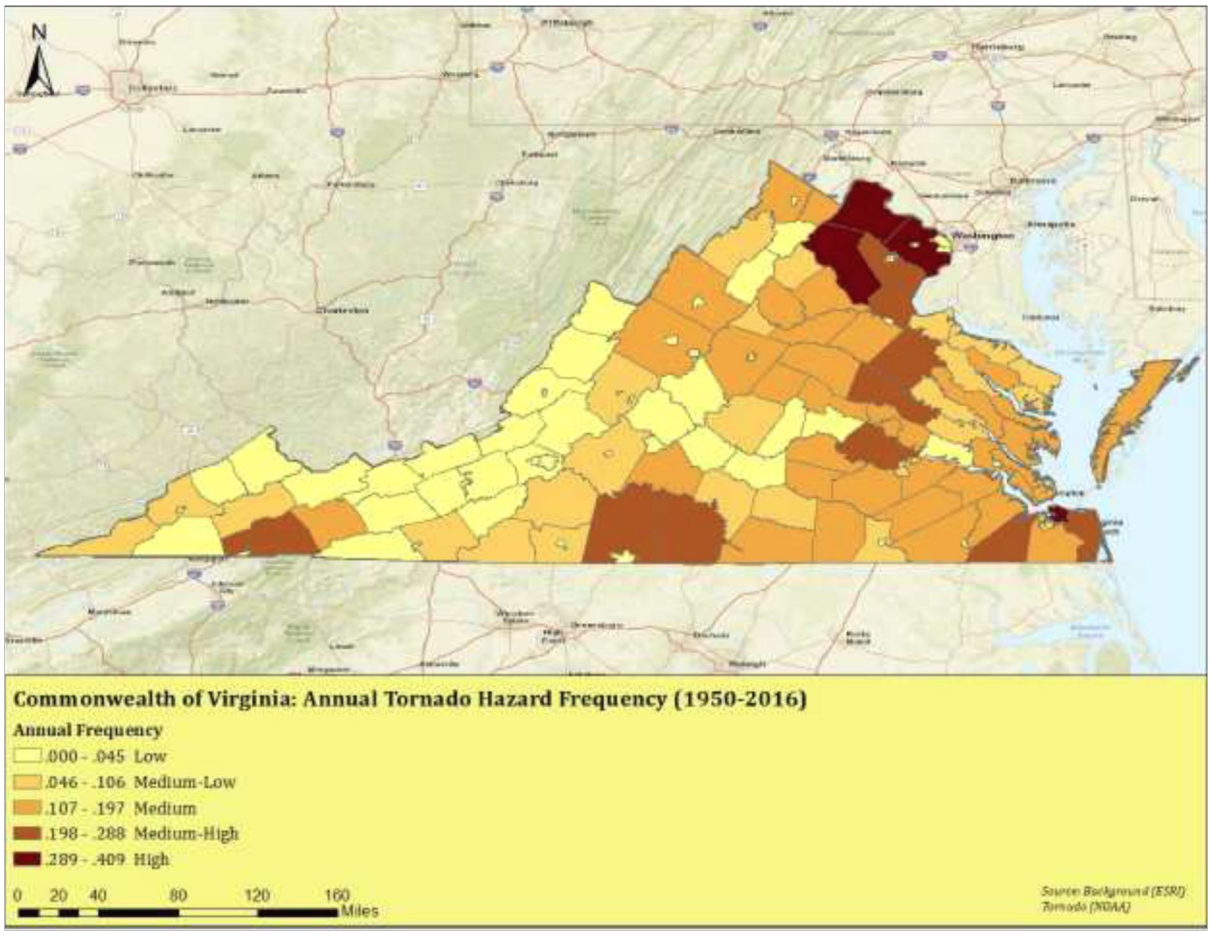
As pressures fell due to a low center developing along the front over southwest Virginia, an upper-level short-wave (disturbance) approached. Surface winds and winds aloft struggled against each other producing the ideal vertical wind shear needed for tornadic development that afternoon. The most devastating tornado of the day touched down one mile southwest of Petersburg at approximately 1:30 pm. This tornado rapidly grew in size and strength as it moved northeast into the commercial historic district of Petersburg. Numerous homes and businesses sustained major damage. Damage estimates for the area were $15 million. Forty people were injured.

Often called the “Tri-Cities Tornado”, the storm crossed the river into Colonial Heights and struck one of the area's shopping districts. It destroyed some buildings and did major damage to numerous other buildings including the Wal-Mart, where three people were killed and nearly 200 were injured. Total damage estimates in Colonial Heights were $29.5 million.

The tornado crossed the Appomattox River again into Prince George County where it struck a sand and gravel pit company. A block building collapsed, and numerous vehicles and other equipment were destroyed. One person was killed. Damage estimates were $750,000. It then moved into the northern section of Hopewell, where it ripped into the Riverside Park Apartment Complex, tearing the roofs off of several buildings. Minor damage was done to another 49 homes, major damage to 13 homes and destruction of 2 homes. The tornado weakened then dissipated near the confluence of the Appomattox and James Rivers. Final records indicate that the tornado caused 4 deaths, 246 injuries and approximately $50 million in damage. According to NCEI records, this tornado is one of only two F4 or greater tornadoes in Virginia history since 1950 and is by far the most destructive.

Figure 5.18 presents the results of a tornado frequency analysis performed as part of the *2018 Virginia State Hazard Mitigation Plan* update. The analysis suggests that relative to the entire Commonwealth of Virginia, the Richmond-Crater region is considered “Medium” to “Medium-High” in terms of tornado frequency. The State plan emphasizes that historical data may contain meteorological biases that should be considered when viewing the results of the probability analysis shown in **Figure 5.18**. Increased population and advanced technology have likely led to vastly higher numbers of low intensity tornadoes reported in recent decades, and more tornadoes are reported in areas of higher population because people are more likely to see and report the resultant damage. This map is also specific to Virginia, and “high frequency” in the Commonwealth is still relatively low frequency in parts of the Midwest and southern United States.

Figure 5.18: Historical Tornado Hazard Frequency Analysis



Source: 2018 Virginia State Hazard Mitigation Plan

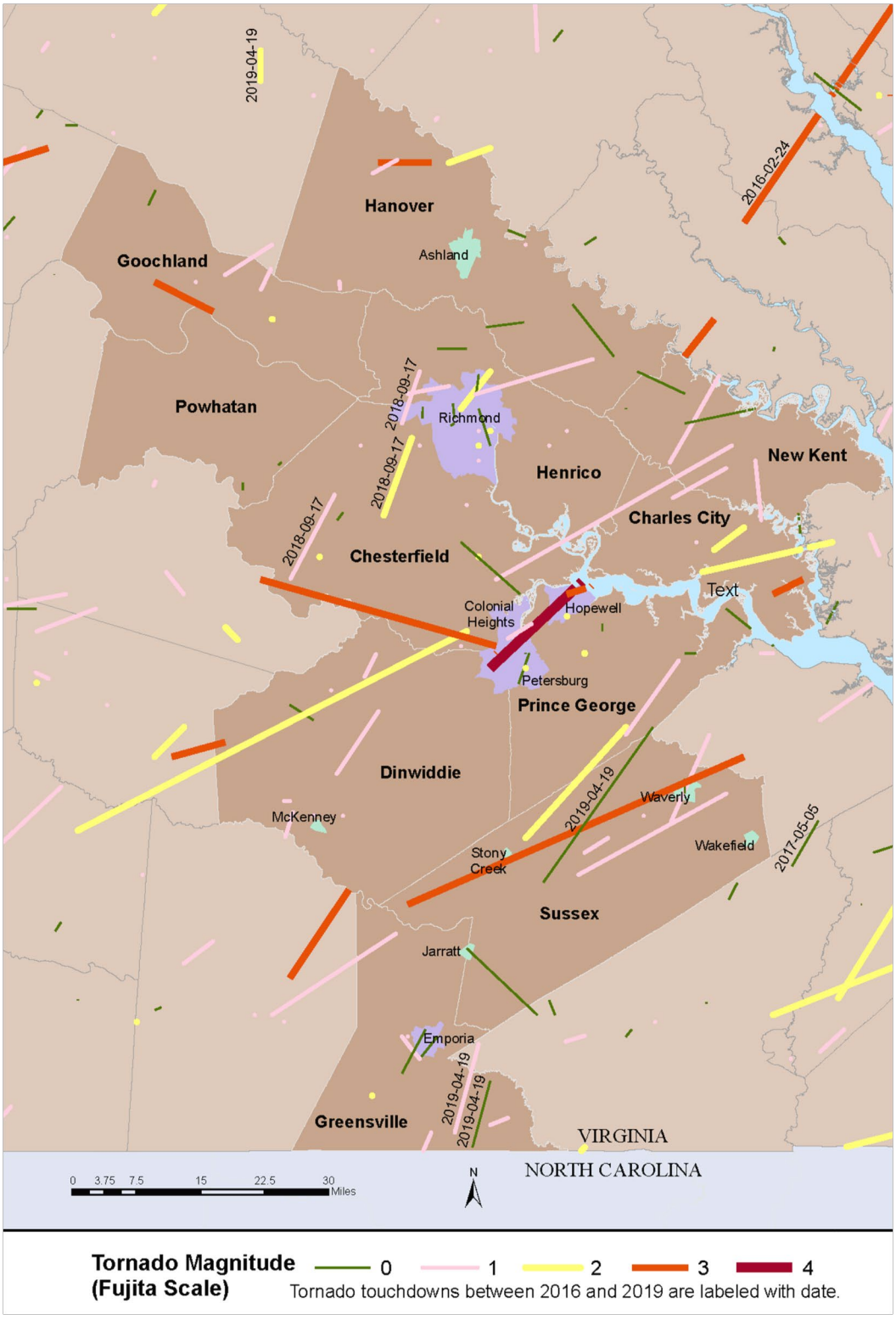
Table 5.20 presents summary data about the historical tornado events by jurisdiction and provides an estimate of annualized losses from tornadoes for each jurisdiction based on reports included in the NCEI database.

Table 5.20: Annualized Tornado Events and Losses, 1950 - 2020			
Jurisdiction	**Number of Events**	**Total Property Damages**	**Annualized Loss**
Charles City County	4	$700,000	$10,000
Chesterfield County	16	$7,073,250	$101,046
City of Colonial Heights	1	$2,000,000	$28,571
Dinwiddie County (inc. Town of McKenney)	11	$2,453,000	$35,043
City of Emporia	3	$125,000	$1,786
Goochland County	8	$553,500	$7,907
Greensville County (inc. Town of Jarratt)	8	$823,000	$11,757
Hanover County (inc. Town of Ashland)	16	$1,401,500	$20,021
Henrico County	11	$3,322,530	$47,465
City of Hopewell	2	$2,510,000	$35,857
New Kent County	6	$1,090,000	$15,571
City of Petersburg	7	$75,925,000	$1,084,643
Powhatan County	3	$103,000	$1,471
Prince George County	9	628000	$8,971
City of Richmond	14	$1,122,000	$16,029
Surry County (inc. Towns of Claremont (3), Dendron, Surry(2))	9	$696,000	$9,943
Sussex County (inc. Towns of Stony Creek, Wakefield, Waverly)	10	$3,692,000	$52,743
Total	**138**	**$104,217,780**	**$1,488,825**

Source: NOAA NCEI Database

Figure 5.19 graphically depicts tornado events in the region between 1950 and 2019, the latest year for which geographical data were available during the planning stage of this update. The thick burgundy swath across Petersburg and Hopewell represents the EF4 tornado from August 1993. The most recent events since the 2017 update to this plan are labeled with the date of occurrence.

Figure 5.19: Tornado Events, 1950 – 2019



Source: NOAA, 2021

Vulnerability Analysis

Human vulnerability to death or injury from tornado is based more on the availability, reception, and understanding of early warnings of tornadoes (e.g., tornado warnings issued by the NWS) and access to safe, substantial indoor shelter than it is on a person's location within the study area. While one might generalize that areas of high population are more vulnerable due to exposure of more people, property and infrastructure, Table 5.20 and Figure 5.19 demonstrate that tornadoes have struck both rural and urban jurisdictions of the study area. Access to technology (computers, radio, television, cell phones, outdoor sirens, etc.) that allows for receiving warnings, physical ability to relocate oneself safely to a tornado-safe space, and language comprehension that allows for suitable understanding of warnings are all factors affecting human vulnerability.

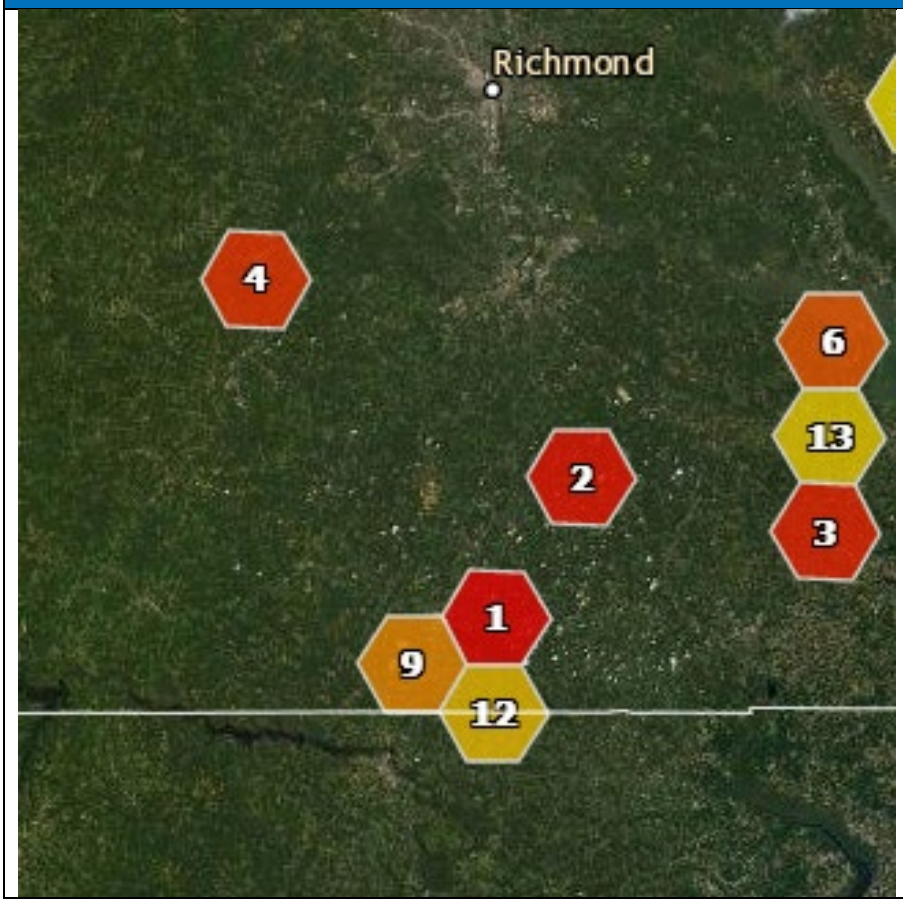
Low-intensity tornadoes may not completely destroy a well-constructed building, although even the most well-constructed buildings are vulnerable to the effects of a more intense (F2 or higher) tornado throughout the study area. A structure's tornado vulnerability is the same as that for other types of extreme wind events and is based in large part on building construction methods and design standards, as discussed in greater detail in Section 5.6 regarding Tropical Storm vulnerability. Other factors such as structure elevation, condition, and maintenance or location of trees and treelines also play a significant role in determining vulnerability to tornado damage. The statewide building code provides a reasonable level of protection for newly constructed buildings, while structures built before the code went into effect are most vulnerable to damage.

Although historical data indicate that there have been variations in the distribution of tornadoes across the region, the probability of experiencing a tornado is roughly equal for all of the jurisdictions. The vulnerability of critical facilities across the area is largely determined by construction type of each particular facility. Wood-framed structures are generally considered to be more vulnerable to tornado damage than steel, brick, or concrete structures. The population concentrations in the urbanized areas of Metropolitan Richmond and Petersburg may experience more damage as a result of a similar event than more rural areas of Greensville County or New Kent County, for example, but the vulnerability to tornado strike is characterized uniform throughout the study area.

Probably the most vulnerable type of structure with regard to tornado damage is a manufactured home. Proper anchoring of these structures can reduce damage exposure, but not entirely. Researchers at ODU have been documenting spatial variability and trends in tornado occurrence in the Commonwealth, and have overlaid areas of increased tornado activity with the highest percentage of manufactured homes in the state using data from the 2014-2018 American Community Survey.

Based on their analysis, there are several areas that have experienced an increased trend in number of tornadoes since 1950, and which have a high concentration of mobile homes, including the Richmond-Crater areas of: Emporia, Greensville County, Sussex County, and Surry County. **Figure 5.20** from the ODU study shows these areas in more detail.

Figure 5.20: Virginia Tornado Mobile Home Risk Index



#1 – (up trend since 1950 with 99% confidence), 23.52% mobile homes, Emporia, Greensville County, Sussex County, Southampton County

#2 – (up trend 95% confidence), 36.75% mobile homes, Sussex County

#6 – (up trend 95% confidence), 17.97% mobile homes, Surry County

#9 – (up trend 95% confidence), 15.25% mobile homes, Emporia, Greensville County

#12 – (up trend 95% confidence), 13.68% mobile homes, Greensville County

#13 – (up trend 95% confidence), 13.13% mobile homes, Isle of Wight County, Surry County

Source: Old Dominion University, accessed online at: https://odu-gis.maps.arcgis.com/apps/Cascade/index.html?appid=723e660c2c09447fa8a57d3186dc8d2a, 2021.

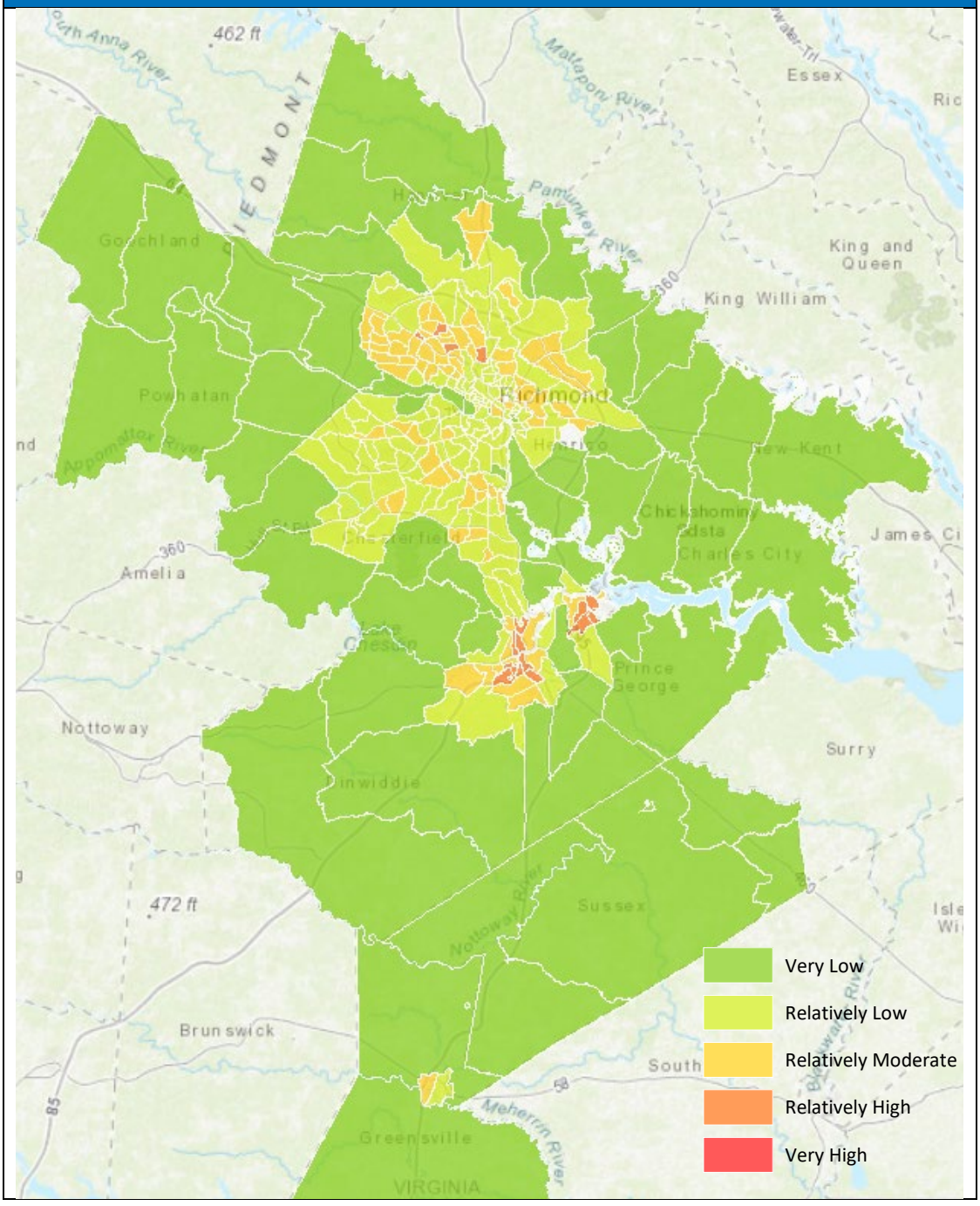
Because scientists and weather experts cannot predict exactly where a tornado may strike, there are no geographic boundaries for this hazard or methodology for modeling detailed loss estimates. Therefore, all buildings and contents within the region are considered to be exposed and could potentially be impacted on some level by the tornado hazard.

Based on historic property damages for the 70-year period of record between 1950 and 2020 as shown in Table 5.20, there were 138 tornado events with an annualized loss estimate of $1.48 million and a recurrence interval of .5 year, or frequency of 2.0 events per year.

Social Vulnerability

The NRI data for social vulnerability to tornadoes are shown in **Figure 5.21**. Despite the higher numbers of manufactured homes in the rural, southeastern portions of the study area, the damage history and built infrastructure exposure in the central part of the region result in higher social vulnerability in the Richmond and Petersburg regions.

Figure 5.21: National Risk Index, Tornado Risk Rating



Source: National Risk Index, FEMA 2021

Note: The Town of Surry has very low social vulnerability for tornado.

Future Vulnerability, Land Use and Climate Change

The link between changing climate and tornado severity and frequency is currently unclear. One problem is that long-term trends are difficult to determine, as records only go back to the 1950s. Another issue is that as population centers have grown and shifted over time, the reporting of tornadoes has been inconsistent. Also, improved observation technology (such a Doppler radar) allows for detection of events that was not possible in earlier years.

Researchers are working to better understand how the fundamental elements required for tornado formation – atmospheric instability and wind shear – interacts with changing climate conditions. It is likely that a warmer, wetter climate will allow for more frequent atmospheric instability. However, it is also likely that a warmer climate will dampen the probability of wind shear. Recent trends observed in the Midwest are inconclusive. It is also possible that climate change would shift the traditional timing or expected locations for tornadoes and have less impact on the total number of tornado occurrences.

Mass evacuations as a result of a tornado or tornado outbreak are unlikely. Evacuations of damaged areas or damaged communities may be required, but would be expected to be within the scope of responsibilities for local emergency management, the community and its partners.

5.8 Wildfires

Hazard Profile

A wildfire is any fire occurring in a wildland area (i.e., grassland, forest, brush land) except for fire under prescription.[12] Wildfires are part of the natural management of the Earth's ecosystems but may also be caused by natural or human factors. Over 80% of forest fires are started by negligent human behavior such as smoking in wooded areas or improperly extinguishing campfires. The second most common cause for wildfire is lightning.

There are three classes of wildland fires: surface fire, ground fire, and crown fire. A surface fire is the most common of these three classes and burns along the floor of a forest, moving slowly and killing or damaging trees. A ground fire (muck fire) is usually started by lightning or human carelessness and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildland fires are usually signaled by dense smoke that fills the area for miles around.

Fire probability depends on local weather conditions, outdoor activities such as camping, debris burning, and construction, and the degree of public cooperation with fire prevention measures. Drought conditions and other natural disasters (such as hurricanes, tornadoes and lightning) increase the probability of wildfires by producing fuel in both urban and rural settings. Forest damage from hurricanes and tornadoes may block interior access roads and fire breaks, pull down overhead power lines, or damage pavement and underground utilities.

[12] Prescription burning, or "controlled burn," undertaken by land management agencies is the process of igniting fires under selected conditions, in accordance with strict parameters.

The impacts of wildfire in the Richmond-Crater region are both economic and environmental. From an economic perspective, fires destroy most homes, businesses and infrastructure in their path. The population displacement and subsequent rebuilding consumes valuable resources of private and public entities. Communities in the region spend significant capital funds both fighting wildfires and training staff and preparing equipment and infrastructure to fight wildfire. Wildfire also endangers the lives and safety of firefighters and residents. Loss of life is a possible impact of severe wildfire in the region, especially where access roads are limited or impassable.

The region's air, water and soil environments are all altered by wildfire, and even wildfire in adjacent regions. Dense smoke and the fine particles and gases inside the smoke pose a risk to human health. Smoke irritates the eyes and respiratory system and can cause bronchitis or aggravate heart or lung disease even for residents hundreds of miles downwind. Wildfires raise the temperature of forest soils and potentially wipe away organic value of the soil. And although soils do eventually recover, the impact on watersheds in the interim can be detrimental to the region's water bodies. Burned organic matter in soils may negatively affect infiltration and percolation making soil surfaces water repellant. If water is unable to infiltrate, runoff quantity increases and infiltration to groundwater decreases. Both of these factors may negatively impact water quality downstream and could increase risk of flooding and landslides in the event of heavy rains.

Magnitude or Severity

A wildfire can range from a very localized and containable burn to an out-of-control blaze that can spread quickly and is capable of scorching thousands of acres of land over many days. The Virginia wildfire season is normally in the spring (March and April) and then again in the fall (October and November). During these months, relative humidity tends to be lower, and winds are higher. In addition, hardwood leaves are on the ground, providing more fuel and allowing the sunlight to directly reach the forest floor, warming and drying the surface fuels.

As fire activity fluctuates during the year from month to month, it also varies from year to year. Historically, extended periods of drought and hot weather can increase the risk of wildfires. Some years with adequate rain and snowfall amounts keep fire occurrences low; while other years with extended periods of warm, dry, and windy days exhibit increased fire activity.

Long-term climate trends as well as short-term weather patterns play a major role in the risk of wildfires occurring. For instance, short-term heat waves along with periods of low humidity can increase the risk of fire, while high winds directed toward a fire can cause it to spread rapidly.

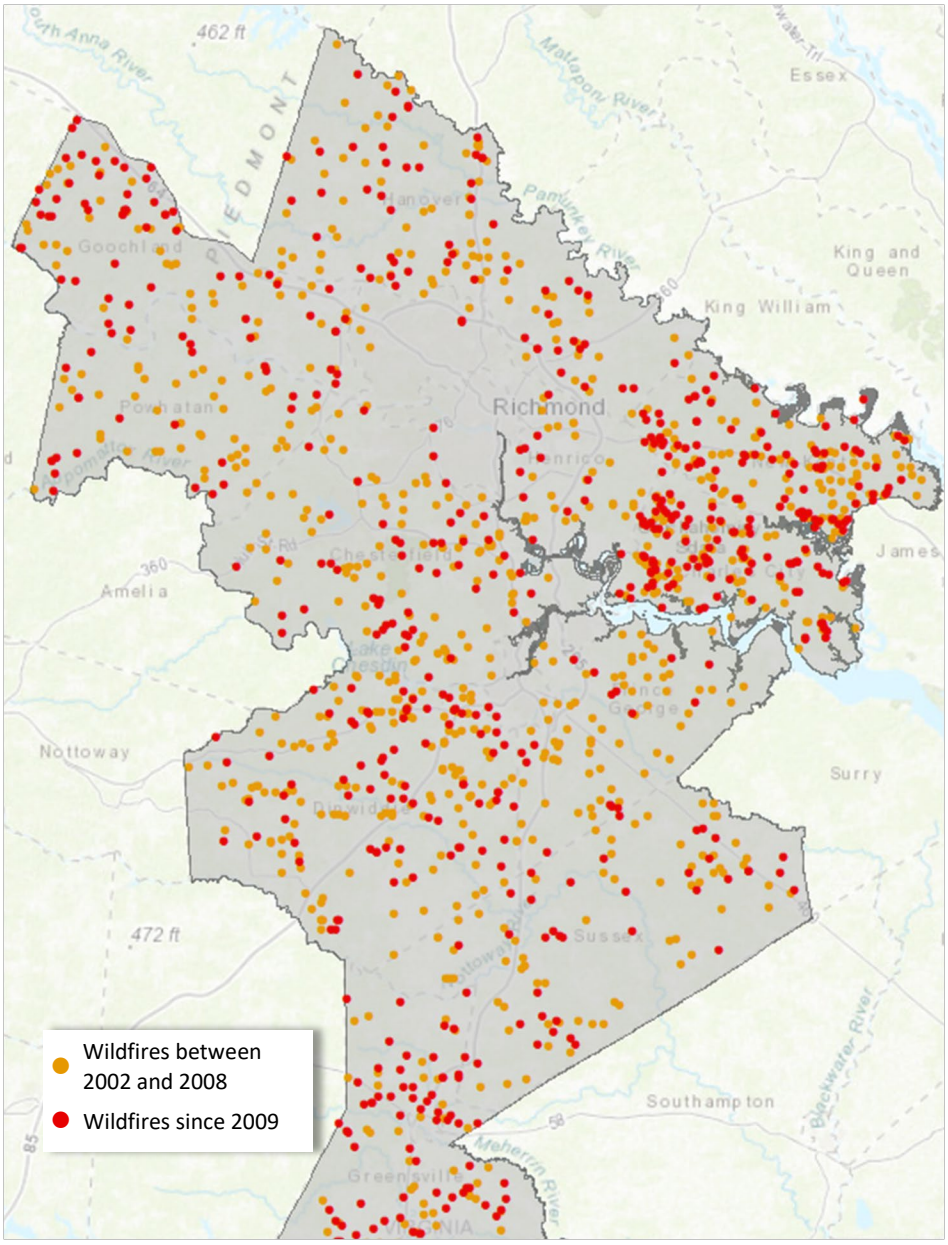
Hazard History

Due to the growth of the population of the commonwealth, there has been an increase in people living in the urban-wildland interface, as well as an increase in use of the forest for recreational purposes. Historical records of wildfire events specific to the study area are

limited, not all wildfires are reported, and the records appear to contain some duplicate entries. Nevertheless, the data provide useful information from a planning perspective.

VDOF provided fire incidence data for the period 1995 to 2020, with detailed data for the period between 2005 and 2020. The fire incidence data provided from 1995 to 2004 were originally included in the *2011 Richmond-Crater Hazard Mitigation Plan*. The data from VDOF are summarized in **Table 5.21** showing the number of wildfires per jurisdiction per year, with acres burned and total damages for the latter periods. **Figure 5.22** indicates the location of VDOF-reported fires since 2002.

Figure 5.22: Wildfire History, 2002 - 2019



Source: VDOF, 2021

According to VDOF records from 1995 to 2020, there were 2,468 wildfires that burned approximately 9,170 acres and caused nearly $3.5 million in damages in the region. The most recent 5-year period, between 2015 and 2020, shows a dramatic reduction in the number of reported fires; from 722 fires in the period 1995 to 1999 down to just 244 fires between 2015 and 2020. In the most recent period, Charles City County shows the highest number of wildfires, while Sussex County experienced the most acres burned by wildfire.

Hanover County suffered the most damages in the most recent period, while Dinwiddie County has the highest annualized damages for the region.

One of the most damaging events in the period between 2000 and 2020 was the February 19, 2011, fire in Goochland County that burned approximately 273 acres and caused a reported $110,000 in damage. High winds exacerbated the brush fire on Cardwell Road that was caused by a limb falling on a power line. An abandoned home burned, as well.

Debris burning was the cause of another notable fire in the region on April 3, 2011, that burned an estimated 545 forested acres in Dinwiddie County, near McKenney. The value of the timber damaged was estimated at $200,000. A NOAA climate report issued in January 2012, indicated that "the overall [weather] pattern during 2011 created ideal wildfire conditions across most of the southern U.S. during the year."[13]

[13] National Centers for Environmental Information, Wildfires – Annual 2011 report, accessed online at: https://www.ncdc.noaa.gov/sotc/fire/201113.

Table 5.21: Wildfire Data, 1995–2020												
Jurisdiction Name	# of Wildfires		2005-2009			2010-2014			2015-2020			Annualized Damages
	1995-1999	2000-2004	# OF FIRES	ACRES BURNED	TOTAL DAMAGES	# OF FIRES	ACRES BURNED	TOTAL DAMAGES	# OF FIRES	ACRES BURNED	TOTAL DAMAGES	
Charles City	49	62	43	171.7	$67,600	52	78.7	$190,600	40	227.8	$65,950	$21,610
Chesterfield	130	36	65	137.8	$6,750	28	264.9	$80,635	19	58.5	$142,650	$15,336
Colonial Heights	0	1	0	0	$0	0	0	$0	0	0	$0	$0
Dinwiddie	54	93	91	3063.6	$780,500	48	826.7	$288,502	29	80.5	$64,950	$75,597
McKenney	0	0	0	0	$0	0	0	$0	0	0	$0	$0
Emporia	1	1	1	1	$0	1	2	$0	0	0	$0	$0
Goochland	76	40	31	153.2	$10,018	34	349.5	$307,330	18	110.1	$6,700	$21,603
Greensville	30	20	36	408.9	$80,900	37	151.2	$68,400	30	183	$77,900	$15,147
Jarratt	0	1	0	0	0	0	0	0	0	0	0	$0
Hanover	56	35	67	151.2	$113,410	30	126.8	$170,250	26	103.8	$207,215	$32,725
Ashland	0	0	2	2	$100	0	0	$0	0	0	$0	$7
Henrico	39	31	16	93.2	$12,000	8	39.7	$373,600	3	21.2	$17,000	$26,840
Hopewell	0	1	0	0	$0	0	0	$0	0	0	$0	$0
New Kent	47	19	58	43.8	$9,800	56	119.9	$118,251	35	92.9	$700	$8,583
Petersburg	0	71	2	26	$0	1	1	$0	1	2.5	$0	$0
Powhatan	99	32	24	38.6	$0	10	44.7	$42,100	11	59.1	$82,985	$8,339
Prince George	40	23	56	90.2	$4,250	8	91.5	$8,850	7	41.5	$2,600	$1,047
Richmond	1	60	0	0	$0	1	7	$0	2	28	$100	$7
Surry	0	0	0	0	$0	0	0	$0	0	0	$0	$0
Sussex	67	43	51	368.3	$21,150	21	228.2	$26,150	17	283.6	$28,550	$5,057
Jarratt	0	1	0	0	$0	0	0	$0	0	0	$0	$0
Stony Creek	0	0	0	0	$0	0	0	$0	0	0	$0	$0
Wakefield	0	1	0	0	$0	0	0	$0	0	0	$0	$0
Waverly	1	1	0	0	$0	0	0	$0	1	1	$0	$0
Totals	**722**	**572**	**543**	**4,749.5**	**$1,106,478**	**335**	**2,331.8**	**$1,674,668**	**239**	**1,293.5**	**$697,300**	**$231,896**

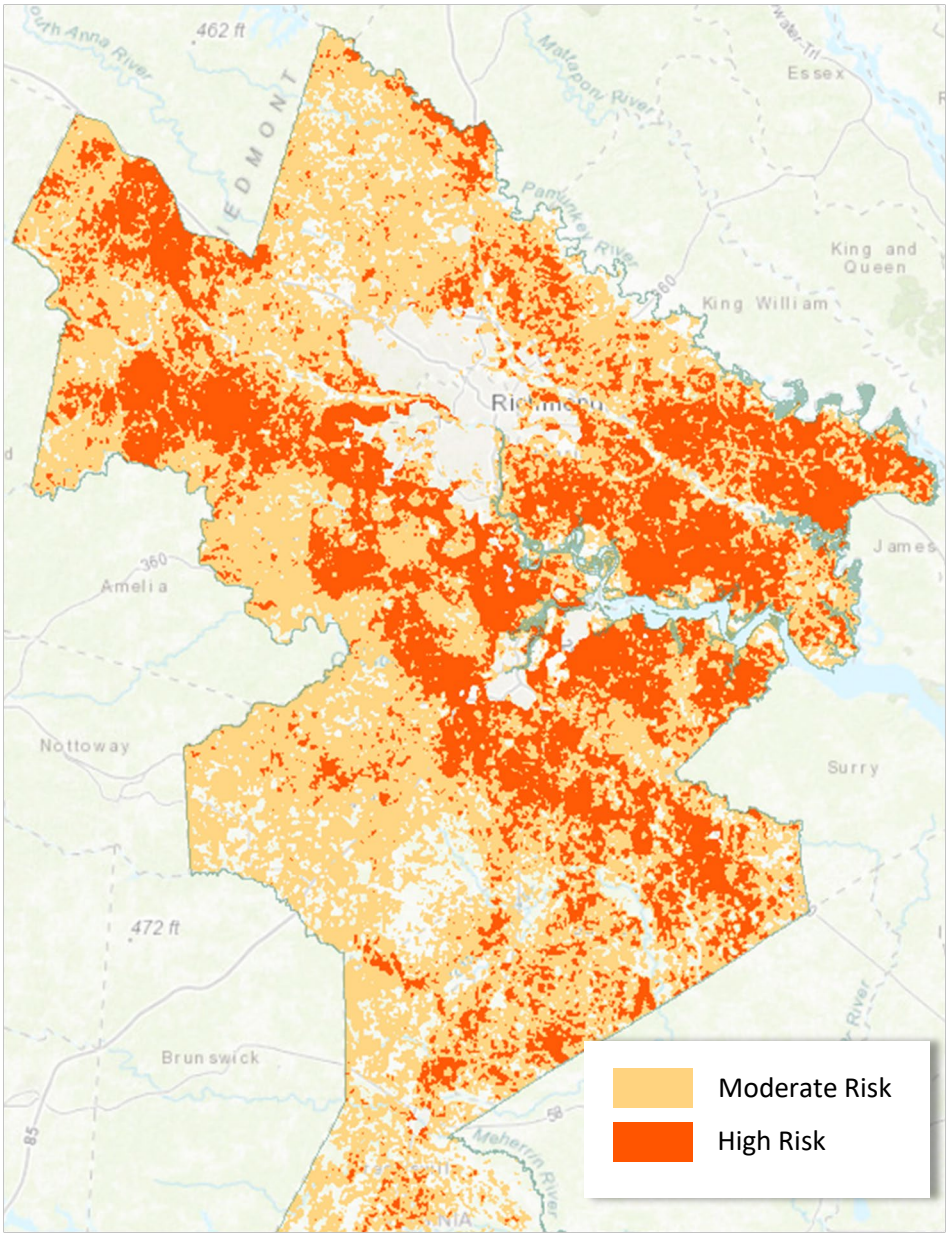
Vulnerability Analysis

The probability of wildfires is difficult to predict, constantly in flux over the short-term, and dependent on numerous factors, including the types of vegetative cover in a particular area, and weather conditions, including humidity, wind, and temperature. Analysis of VDOF data indicates that on an annual basis, approximately 99 wildfires impact the region.

In July 2003, VDOF developed and released a GIS-based wildfire risk assessment for the Commonwealth of Virginia. The data are now part of the Southern Foresters web site at www.southernwildfirerisk.com that serves as a portal for data from several southern states. While this assessment of wildfire risk is not recommended for site-specific determinations of wildfire vulnerability, the data were used in this plan as an indicator of general hazard exposure within the region, as shown in **Figure 5.23**. Risk assessment designation involved several inputs, including slope, aspect, land cover, distance to railroads, distance to roads, population density, and historical fire occurrence. Potential wildfire risk areas are graduated but presented in two overall categories indicating the relative level of threat to the area as high or moderate. Areas without a high or moderate designation are considered to be at low risk of wildfire.

Hurricanes Isabel and Irene downed thousands of trees in both New Kent and Charles City Counties in 2003 and 2011, respectively. While the counties removed the most hazardous trees from public facilities and many homeowners have removed trees from their property, thousands still remain. These trees provide an easy source of fuel for wildfires and create a high risk across these counties.

Figure 5.23: Wildfire Risk Assessment



Source: VDOF and www.southernwildfirerisk.com accessed online 2021

Certain groups of essential facilities were assessed to determine if their location was within a high risk area as determined by the Wildfire Risk Assessment. The analysis looked at facilities that could be particularly hazardous during a wildfire: electric power facilities, hazardous materials facilities, natural gas and oil facilities. All of the natural gas providers in the region have segments of their lines that traverse high wildfire risk areas. The

analysis for other facilities shows the following facilities are located in high wildfire risk areas:

Electric Power Facilities:	Boydton Plan Road Cogen Plant, Petersburg
	Correctional Solar, Barhamsville
	Scott Solar Farm, Powhatan
Hazardous Materials Facilities:	Van Waters & Rogers, Inc, Richmond
	Industrial Chemicals, Inc, Richmond
	Rehrig International, Richmond
	Honeywell Tech Center, Chesterfield
	Carter-Wallace, Colonial Heights
	Super Radiator Coils, Richmond
	Chaparral, Petersburg
	Graphic Packaging Corp. of Virginia, Richmond
	Borden Chemical Inc., Waverly
Oil Facilities:	Atlantic Industrial Services, Chester

VDOF defines woodland home communities as clusters of homes located along forested areas at the wildland-urban interface that could possibly be damaged during a nearby wildfire incident. **Table 5.22** illustrates the number of woodland communities in each jurisdiction, broken down by wildfire risk zone, while **Table 5.23** illustrates the number of homes in woodland communities, also broken down by wildfire risk zone. The data indicate that approximately 46% of woodland home communities in the region are located in a high-wildfire-risk area. Of the 132,218 homes in woodland home communities, approximately 33% are located in a high-fire-risk area.

Table 5.22: Number of Woodland Communities by Fire Risk

Jurisdiction Name	Low	Moderate	High	Total	% High Risk
Charles City County	0	6	36	42	86%
Chesterfield County	82	140	189	411	46%
City of Colonial Heights	0	0	1	1	100%
Dinwiddie County	1	5	4	10	40%
Town of McKenney	1	0	0	1	0%
City of Emporia	5	0	0	5	0%
Goochland County	4	93	79	176	45%
Greensville County	1	5	0	6	0%
Town of Jarratt	0	0	2	2	100%
Hanover County	10	184	79	273	29%
Town of Ashland	2	3	1	6	17%
Henrico County	54	67	74	195	38%
City of Hopewell	1	0	0	1	0%

Table 5.22: Number of Woodland Communities by Fire Risk					
Jurisdiction Name	**Low**	**Moderate**	**High**	**Total**	**% High Risk**
New Kent County	0	8	47	55	85%
City of Petersburg	5	2	4	11	36%
Powhatan County	0	31	73	104	70%
Prince George County	2	7	24	33	73%
City of Richmond	23	2	4	29	14%
Town of Surry	0	0	0	0	0%
Sussex County	0	0	1	1	100%
Town of Jarratt	0	0	2	2	100%
Town of Stony Creek	0	0	0	0	0%
Town of Wakefield	0	0	0	0	0%
Town of Waverly	0	0	0	0	0%
Totals	**191**	**553**	**622**	**1,366**	**46%**

Source: VDOF

Table 5.23: Number of Homes in Woodland Communities by Fire Risk					
Jurisdiction Name	**Low**	**Moderate**	**High**	**Total**	**% High Risk**
Charles City County	0	136	855	991	86%
Chesterfield County	20,697	27,146	25,142	72,985	34%
City of Colonial Heights	0	0	75	75	100%
Dinwiddie County	135	144	253	532	48%
Town of McKenney	31	0	0	31	0%
City of Emporia	240	0	0	240	0%
Goochland County	138	3,099	2,720	5,957	46%
Greensville County	85	149	0	234	0%
Town of Jarratt	0	0	76	76	100%
Hanover County	981	7,278	3,342	11,601	29%
Town of Ashland	255	312	14	581	2%
Henrico County	13,700	4,409	3,761	21,870	17%
City of Hopewell	65	0	0	65	0%
New Kent County	0	293	1,829	2,122	86%
City of Petersburg	555	104	271	930	29%
Powhatan County	0	713	3,204	3,917	82%

Table 5.23: Number of Homes in Woodland Communities by Fire Risk					
Jurisdiction Name	**Low**	**Moderate**	**High**	**Total**	**% High Risk**
Prince George County	415	199	1,397	2,011	69%
City of Richmond	7,595	65	185	7,845	2%
Town of Surry	0	0	0	0	0%
Sussex County	0	0	43	43	100%
Town of Jarratt	0	0	76	76	100%
Town of Stony Creek	0	0	0	0	0%
Town of Wakefield	0	0	0	0	0%
Town of Waverly	0	0	0	0	0%
Totals	**44,892**	**44,047**	**43,279**	**132,218**	**33%**

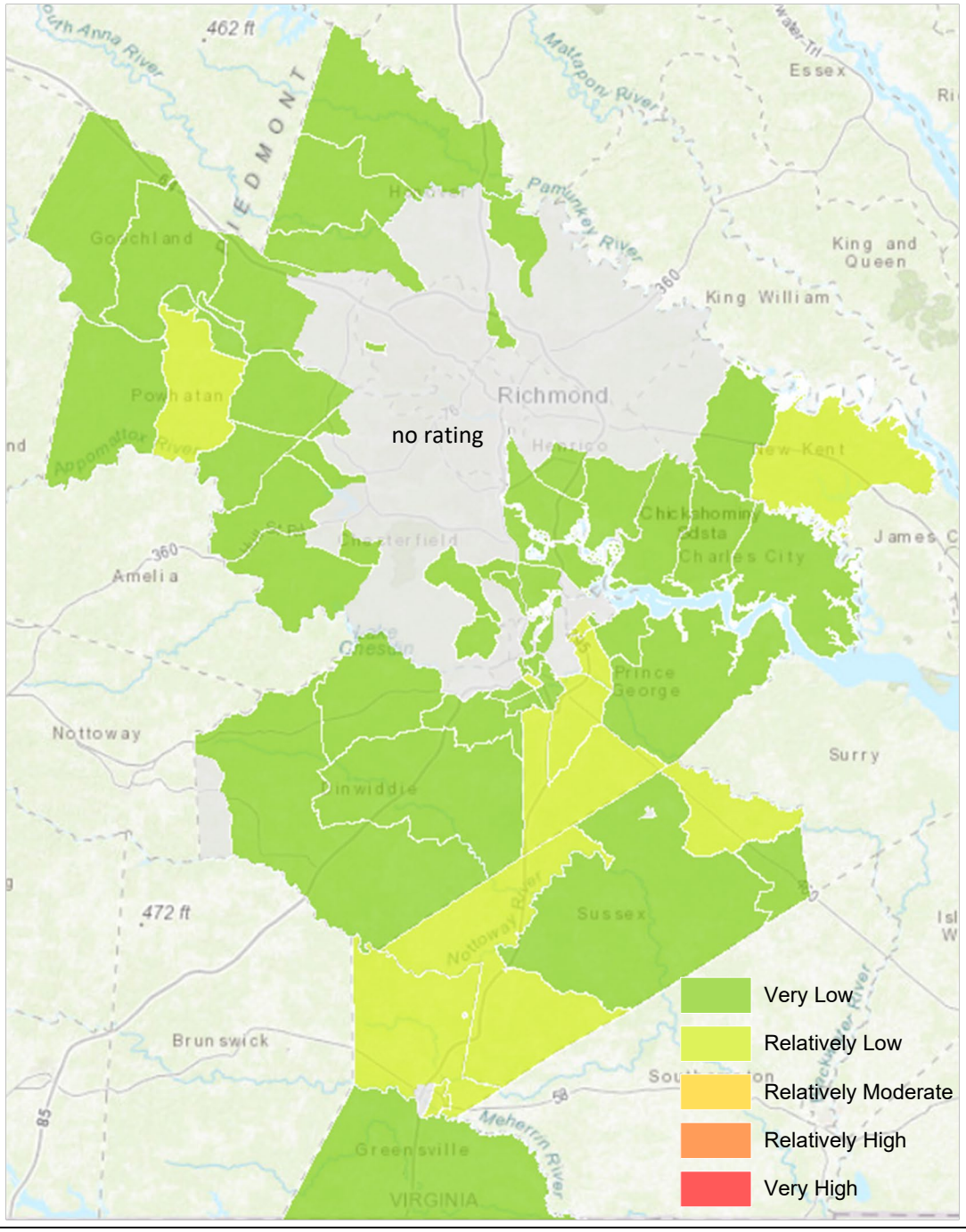
Source: Virginia Department of Forestry, 2010 dataset.

Based on the VDOF historical record from 1995 to 2020, the region experiences approximately 96 fires per year that result in approximately $231,896 in annualized damages.

Social Vulnerability

The NRI data for social vulnerability to wildfire are shown in **Figure 5.24**. Where data and historical events are sufficient to calculate a rating for wildfire, the risk is determined to be very low or relatively low throughout the study area.

Figure 5.24: National Risk Index Rating, Wildfire



Source: National Risk Index, FEMA 2021

Note: The Town of Surry has very low social vulnerability for wildfire south of Route 10 and relatively low social vulnerability for wildfire north of Route 10.

Future Vulnerability, Land Use and Climate Change

The region is expected to continue to incur wildfires, particularly during extended periods of dry and windy weather. The region's zoning ordinances do not generally guide new development away from the Wildland Urban Interface, but the wildfire threat is not as severe as in the western United States.

Climate change increases the risk of the hot, dry weather that is likely to fuel wildfires. Also, because climate change is also a factor in higher intensity windstorms, there is a likelihood of increased fuel for wildfire when downed trees from storms are not removed. For site specific information on historic wildfire ignition density, property owners and planners can visit: www.southernwildfirerisk.com.

While evacuations may be required as a result of wildfire in the Richmond-Crater region, these evacuations would likely be of a locality-manageable scale and are not expected to be considered "mass evacuations". Should larger-scale evacuations be required, adjacent jurisdictions can assist.

A VDOT snowplow plows I-64 East. (Photo by Tom Saunders, VDOT)

5.9 Severe Winter Weather

Hazard Profile

A winter storm can range from a moderate snow over a period of a few hours to blizzard conditions with blinding wind-driven snow that lasts for several days. Some winter storms may be large enough to affect several states, while others may affect only a single community. Many winter storms are accompanied by low temperatures and heavy and/or blowing snow, which can severely impair visibility.

In the Richmond-Crater region, winter storms typically include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Sleet—raindrops that freeze into ice pellets before reaching the ground—usually bounce when hitting a surface and do not stick to objects; however, sleet can accumulate like snow and cause a hazard to motorists. Freezing rain is rain that falls onto a surface with a temperature below freezing, forming a glaze of ice. Even small accumulations of ice can cause a significant hazard, especially on roads, power lines and trees. Ice storms have also occurred in the region, when freezing rain falls and freezes immediately upon impact.

Communications and power in the region can be disrupted for days, and even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Perhaps one of the most common impacts of winter storms in the region is vehicle accidents and stranded, disabled vehicles. Unaccustomed to driving in snow and ice much of the year, drivers attempt to drive at normal speeds despite deteriorated road conditions. Lacking the large fleets of snowplows of some counties and municipalities further north, the region's

secondary roads are not cleared as often or as quickly, and roads may remain unplowed or untreated for days. This impacts special needs populations and others who may become housebound by severe winter storms. Airports in the region also shut down for some time until the runways can be cleared.

Recent winter storms in the region have caused severe economic disruption with lengthy school and business closures, damage to vehicles and reduced community services for extended periods. In agricultural portions of the study area such as Greensville County, freezing temperatures may affect agricultural production, depending on when the event occurs relative to the growing periods of certain crops. Nor'easters can cause winter storms in the region, so the impacts of coastal flooding and shoreline erosion can also be associated with winter storm events, especially in New Kent and Charles City Counties.

The impacts of winter storms are usually minimal in terms of property damage and long-term effects. The most notable impact from winter storms is the damage to power distribution networks and utilities. Severe winter storms have the potential to inhibit normal functions of the community. Governmental costs for winter storms accumulate due to personnel and equipment needed for clearing streets. Private sector losses are attributed to lost work when employees are unable to travel. Occasionally, buildings may be damaged when snow loads exceed the design capacity of their roofs or when trees fall due to excessive ice accumulation on branches.

The water content of snow can vary significantly from one storm to another and can significantly impact the degree to which damage might occur. In snow events that occur at temperatures at or even above freezing, the water content of the snowfall is generally higher. Higher water content translates into a heavier, 'wet' snowfall that more readily adheres to power lines and trees, increasing the risk for their failure. Roof collapse is also more of a concern with wetter, heavier snowfall. On the other hand, clearing roadways and sidewalks is considerably easier for a drier, more powdery snow. A dry, fluffy snow is less likely to accumulate on power lines and trees. This type of snow generally occurs in temperatures below freezing with water content decreasing with temperature. The primary impact of excessive cold is increased potential for frostbite, and potentially death as a result of over-exposure to extreme cold.

Homes and businesses suffer damage when electric service is interrupted for long periods of time. Six utility companies provide service to the region, which can make power restoration complicated. Threats to personal health can intensify when frozen precipitation makes roadways and walkways slippery and when prolonged power outages and fuel supplies are combined.

Another challenge with winter weather in the region is the amount of ice that often accompanies the winter season. Even small accumulations of ice from sleet or freezing rain can cause significant hazards to people, especially to pedestrians and motorists, as well as to property. Ice from freezing rain can accumulate on trees, power lines, and communication towers causing damage and leading to power and communication outages that can last for days or weeks. Even small accumulations of ice can be severely dangerous

to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Some of the secondary effects presented by winter storms and extreme or excessive cold temperatures are threats to the health of livestock and pets, and frozen water pipes in homes and businesses that may burst and flood indoor areas. Debris created by the trees can also blocks roadways and impact emergency services. Clean-up of the debris is often complicated because responsibility is shared by the Virginia Department of Transportation (VDOT) and private utility companies.

Magnitude or Severity

NOAA's NCEI is now producing the Regional Snowfall Index (RSI) to evaluate significant snowstorms that impact the eastern two-thirds of the United States. The RSI is a regional snowfall impact scale that uses the area of snowfall, the amount of snowfall, and the number of people living within a snowstorm. Since the index uses population information, it attempts to quantify the societal impacts of a snowstorm. RSI has been calculated for large snowstorms back to 1900 and therefore the index puts a particular event into a century scale historical perspective (**Table 5.24**). A Category 5 snowstorm is a very rare event while Category 0 and 1 snowstorms are quite typical.

Table 5.24: Regional Snowfall Index (RSI)

Category	RSI Raw Score	Approximate Percent of Storms	Description
5	>18	1%	Extreme
4	10-18	2%	Crippling
3	6-10	5%	Major
2	3-6	13%	Significant
1	1-3	25%	Notable
0	0-1	54%	

Source: NOAA NCEI

RSI is calculated for specific regions. Only the snowfall within a particular region is used to calculate the index for that region. The Richmond-Crater study area is within the Southeast study region for the RSI. The RSI differs from other indices because it includes population, which ties the index to societal impacts. Currently, the index uses population based on the 2000 Census. Where available, the RSI value for specific storms is provided in the History section below.

Table 5.25 provides a summary of the most severe winter weather events to strike the Richmond-Crater region.

Table 5.25: History of Winter Storm Events and Damages, 2010–2021		
Date	**Damages**	**RSI Category**
December 25-28, 2010	A 4- to 10-inch snowfall blanketed the region with the heaviest amounts falling over the south and eastern sections. Amounts ranged from 4 inches northwest of the City of Richmond, 6 to 7 inches in the Cities of Petersburg and Emporia, and around a foot near the Town of Wakefield.	2
February 11-14, 2014	This was a major ice and snowstorm that affected the entire region and elsewhere in the Eastern United States. This event produced devastating amounts of freezing rain and snow along and east of Interstate 95 all the way down to the coast. Overall temperatures throughout the winter were much colder in 2014. A Presidential Disaster event was declared in Chesterfield. (Source: http://www.weather.gov/phi/02132014)	4
January 22-24, 2016	What transpired was reasonably close to what was forecast, with a major snowstorm for our entire region, which also included a mix of some sleet across portions of the area as well as small amounts of freezing rain. NOAA ranks Northeast U.S. storms according to overall impact, part of which is dependent on societal and economic factors, thus population density is a key component. This particular storm was ranked as a 4 on the "NESIS" scale of 1-5, or "crippling". It is now 4th on the list of historic storms that have been ranked on the NESIS scale, with only two storms ever ranked as a 5 ("extreme). Presidential Disasters for this study region were declared for Sussex and Henrico Counties. (Source: http://www.weather.gov/media/rnk/past_events/2017_01_2223_Winter.pdf)	4
January 5-8, 2017	Low pressure tracking northeast just off the Southeast and Mid Atlantic Coasts produced between three inches and twelve inches of snow across central, south central, and interior southeast Virginia. Laurel reported 2.5 inches of snow. Ginter Park and Glen Allen reported 2.0 inches of snow.	2
December 8-10, 2017	Low pressure tracking northeast just off the Southeast and Mid Atlantic Coasts produced between three inches and twelve inches of snow across central, south central, and interior southeast Virginia. Reports ranged from 7 to 12 inches across the study area.	2
January 3-5, 2018	Strong low pressure tracking northward just off the East Coast produced between one inch and four inches of snow across central and south central Virginia.	1

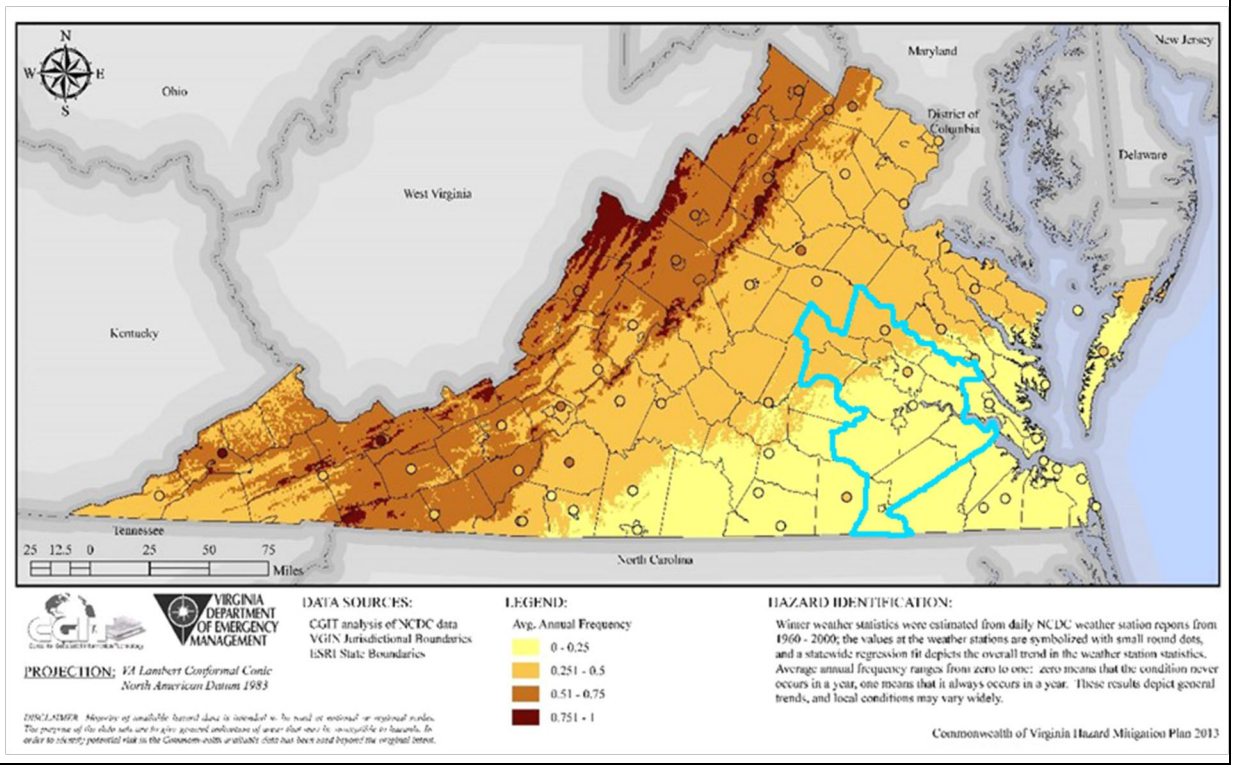
Table 5.25: History of Winter Storm Events and Damages, 2010–2021		
Date	**Damages**	**RSI Category**
March 11-15, 2018	Snowfall totals ranged from one to three inches across the Richmond-Crater region.	1
March 20-22, 2018	Low pressure tracking east northeast off the Mid Atlantic Coast produced between one inch and four inches of snow across portions of central and south central Virginia, and the Middle Peninsula. Snow totals ranged from 1 to five inches in the region.	1
December 7-10, 2018	An area of low pressure became centered over Florida Panhandle as a cold air damming regime set up across interior parts of Virginia and the Carolinas, with winds out of the NNE. A large area of precipitation was impacting the Carolinas and was approaching southern VA by sunrise on the 9th. By Sunday morning, there was snow in most areas except for coastal SE VA/NE NC, where NE winds ushered in milder air. Bands of heavy snow (rates of 1-2"/hour) set up over far southwestern portions of Wakefield area. Snow started changing to sleet then rain over SE VA/northern NC Sunday afternoon. Snow became heavy over Richmond metro area in afternoon, with temperatures slightly below freezing. Moderate to heavy snow continued through afternoon from Richmond metro to Virginia Piedmont, with widespread 9 to 14 inches of snow. Numerous flight cancellations at area airports. Interstates became snow covered and numerous accidents were reported. The 11.5 inches of snow at Richmond International Airport ranks as the 2nd largest December snowstorm on record.	3
January 30 – February 3, 2021	Powhatan County and Oilville in Goochland County had snow totals between 1 to 4 inches, but snow accumulation elsewhere in the region was between .5 inch to 3 inches.	1
February 18 – 19, 2021	Strong surface high pressure centered from the Midwest into New England helped to supply low level cold air into the area, as a prolonged Classic Cold Air Damming regime was in place throughout the duration of the event. With warmer air present aloft, precipitation fell in the form of freezing rain and sleet across central and south central Virginia, and the Virginia Northern Neck, as a couple of weak low pressure areas tracked northeast along and off the Southeast and Mid Atlantic Coasts. There were two distinct waves of precipitation that moved across the area. One that occurred during the early morning-midday on the 18th, and a second wave of light to moderate precipitation that moved across the region during the early to mid morning on the 19th. This resulted in significant ice accretion between 0.20 inch and 0.40 inch, along with sleet accumulations between 0.5 inch and 1.5 inches. Several trees and power lines were downed, with	3

Table 5.25: History of Winter Storm Events and Damages, 2010–2021		
Date	**Damages**	**RSI Category**
	numerous power outages reported. Ice accretions between 0.20 inch and 0.25 inch, along with sleet accumulations between 0.5 inch and 1.0 inch were reported. Damages estimated at $390,000 throughout the region.	

**History from 1940-2010 in Appendix F-6*
Source: NCEI

The Virginia Tech Center for Geospatial Information and Technology performed analyses of weather station daily snowfall data for the Commonwealth of Virginia's *2013 Hazard Mitigation Plan Update*. Station-specific statistics were used as the basis for a seamless statewide estimate based on multiple linear regressions between the weather statistics (dependent variable) and elevation and latitude (independent variables). **Figure 5.25** shows that the average number of days with at least 3 inches of snowfall ranges from 1.51 to 2 days over northwestern portions of the region, including portions of Hanover, Goochland, Powhatan, and Henrico Counties to 1.5 days or fewer over the remainder of the area. A similar analysis was not conducted in the most recent state hazard mitigation plan.

Figure 5.25: Average Annual Frequency of Days with at Least 3 Inches of Snowfall

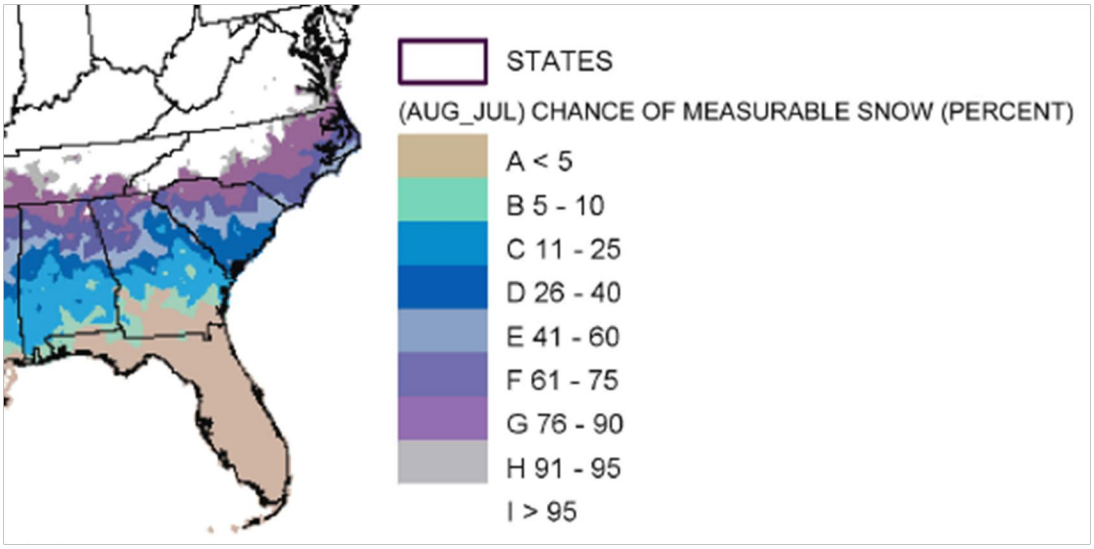


Source: 2013 Commonwealth of Virginia Hazard Mitigation Plan

Vulnerability Analysis

Historical evidence indicates that the region has been impacted by varying degrees of snowstorms and ice storms over the last century. **Figure 5.26** provides graphic evidence that the chance of snow annually is close to or equal to 100 percent in the study area.

Figure 5.26: Annual Percent Chance of Measurable Snow



Source: North Carolina State University, Climate Education web page: http://climate.ncsu.edu/edu/k12/.SEPrecip, undated

To determine the geographic distribution and frequency with which major snow or ice events impact the region, the Iowa Environmental Mesonet (IEM) obtains data from cooperating members that have observing networks. Watch, Warning, and Advisory events were collected and examined between 1986 and 2021 (see **Table 5.26**). The events were sorted into the following categories: Freeze, Freezing Fog, Freezing Rain, Frost, Heavy Snow, Snow, Winter Storm, and Winter Weather. (Data were collected from: http://mesonet.agron.iastate.edu/vtec/search.php)

The most alerts between 1986 and 2021 were for Dinwiddie County, followed by Goochland and Hanover Counties. The fewest alerts were issued for Charles City, Surry County, and Prince George Counties. The most common type of events for all counties were the Winter Weather, Winter Storm, Freeze, and Frost type events.

Table 5.26: National Weather Service Winter Alerts, 1986 - 2021

Jurisdiction	Watch Events	Warning Events	Advisory Events	Total Events	Annualized Events
Charles City County	20	36	59	115	3.3
Chesterfield County	21	38	63	122	3.5
City of Colonial Heights	-	-	-	-	
Dinwiddie County	31	48	88	167	4.8
City of Emporia	-	-	-	-	

Table 5.26: National Weather Service Winter Alerts, 1986 - 2021					
Jurisdiction	**Watch Events**	**Warning Events**	**Advisory Events**	**Total Events**	**Annualized Events**
Goochland County	33	45	73	151	4.3
Greensville County	21	37	62	120	3.4
Hanover County	26	41	77	144	4.1
Henrico County	22	38	64	124	3.5
City of Hopewell	-	-	-	-	
New Kent County	22	34	65	121	3.5
City of Petersburg	-	-	-	-	
Powhatan County	32	46	65	143	4.1
Prince George County	19	38	62	119	3.4
City of Richmond	-	-	-	-	
Surry County	22	34	62	118	3.4
Sussex County	22	37	65	124	3.5
Totals	**291**	**472**	**805**	**1,568**	

**county data includes towns*
Source: Iowa State University, Iowa Environmental Mesonet, accessed 2021 online at: https://mesonet.agron.iastate.edu/vtec/search.php

Winter storm vulnerability can be expressed by impacts to people, property, and societal function. For example, exposure of individuals to extreme cold, falls on ice-covered walkways, carbon monoxide poisoning from generators and automobile accidents is heightened during winter weather events. **Table 5.27** summarizes NCEI historical impacts of winter weather events since 1993. Based on this information, on average, the region experiences approximately one and a half winter weather events annually, of which some rare winter storms have historically included significant accumulations of ice (due to freezing rain). In terms of annualized damages, roughly $40,411 per year in losses is attributed to winter weather events.

Property damage due to winter storms includes damage done by and to trees, water pipe breakage, structural failure due to snow loads, and injury to livestock and other animals. The average amount of total damages due to winter events is $40,400 per year (1993-2017) for the region. The counties most affected from winter events are Prince George ($9,089/yr.), Henrico ($8,948/yr.), and Chesterfield ($7,962/yr.). Disruption of utilities and transportation systems, as well as lost business and decreased productivity represent societal vulnerability.

Table 5.27: NCEI Annualized Winter Weather Events, 1993 - 2020				
Jurisdiction	**Annualized Number of Winter Weather Events**	**Annualized Property Damages**	**Annualized Crop Damages**	**Annualized Total Losses**
Charles City County	2.4	$1,304	-	$1,444
Chesterfield County	5.5	$7,962	-	$7,962
City of Colonial Heights	-	-	-	-
City of Emporia	-	-	-	-
City of Hopewell	-	-	-	-
City of Petersburg	-	-	-	-
City of Richmond	-	-	-	-
Dinwiddie County	2.4	$2,600	-	$2,600
Goochland County	3.3	$3,004	-	$3,004
Greensville County	3.9	-	-	-
Hanover County	3.4	$3,030	-	$3,030
Henrico County	5.6	$8,948	-	$8,948
New Kent County	2.5	$1,444	-	$1,444
Powhatan County	2.9	$2,889	-	$2,889
Prince George County	7.0	$9,089	-	$9,089
Surry County	1.0	-	-	-
Sussex County	2.2	-	-	-
Total		**$40,411**	**$0**	**$40,411**

Source: NOAA NCEI

According to NCEI records dating back to 1993, one fatality was officially recorded resulting from a winter storm event in the area. NCEI storm event records typically do not contain traffic fatalities blamed on wintry weather, and although details were not provided, the fatality reportedly occurred during a severe snowstorm on January 25, 2000.

The number of reported events from the IEM (Table 5.26) and NCEI (Table 5.27) were slightly different. With the number of annual IEM events being 44.8 and the NCEI annual winter events being 46.9. Because of the difference in collection criteria, agencies, and time frames of the reported events, the difference between the two annualized events reported was not significant.

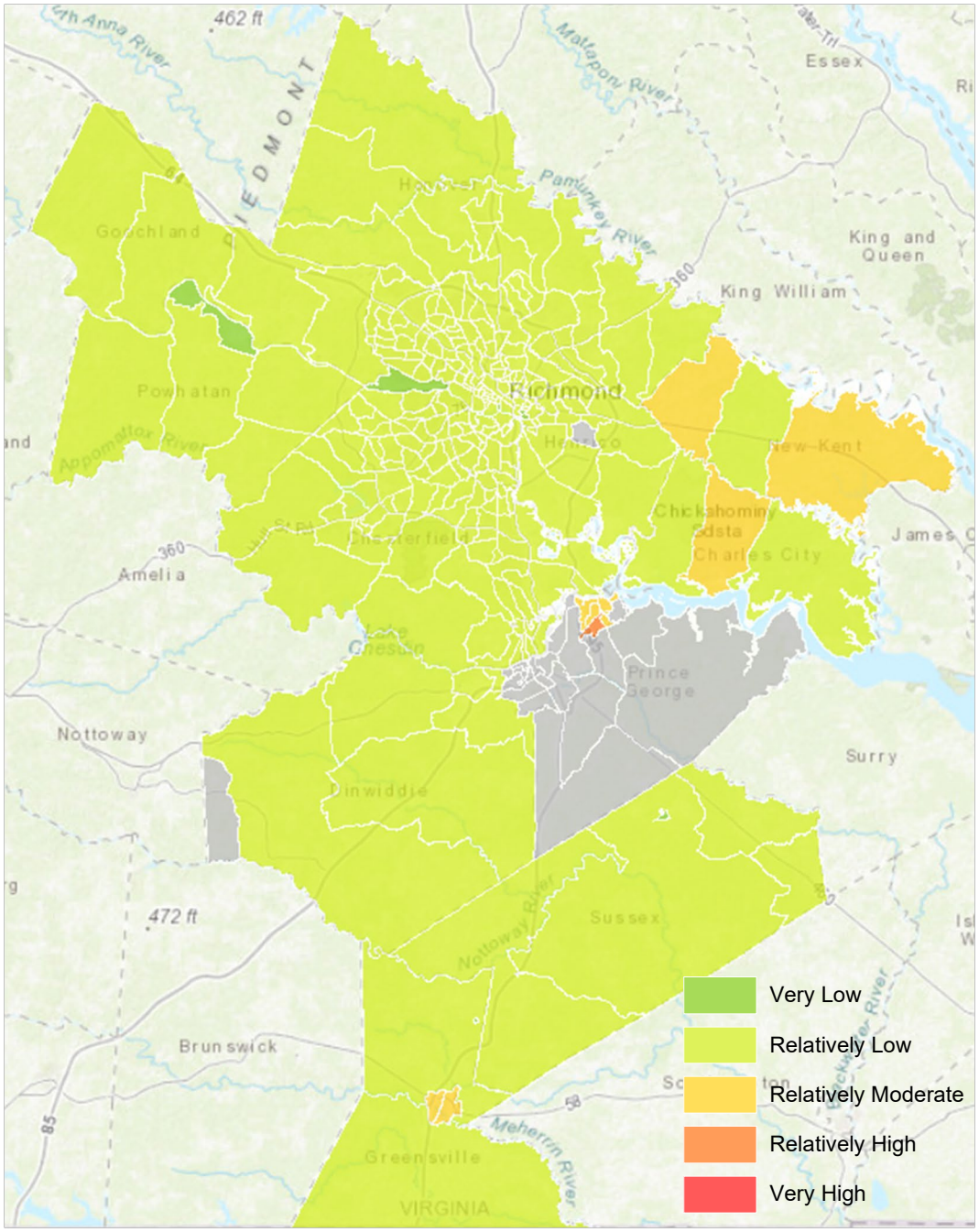
A quantitative assessment of critical facilities for winter storm risk was not feasible for this plan update. Transportation structures and natural gas transmission lines are at great risk from winter storms. In addition, building construction variables, particularly roof span and construction method, are factors that determine the ability of a building to perform under severe stress weights from snow. Finally, critical facilities do not always have

redundant power sources, and many are not wired to accept a generator for auxiliary power.

Social Vulnerability

The NRI data for social vulnerability to winter weather are shown in **Figure 5.27**. Most of the region is rated as Relatively Low, with some moderate areas found in New Kent and Charles City counties, and a Relatively High area in Petersburg. The social vulnerability map does not appear to reflect the disparity between the historically higher impacted areas of Henrico, Prince George and Chesterfield counties and the southern and eastern portions of the study area with fewer reported winter storms. Technical documentation for the NRI indicates that the Iowa Environmental Mesonet data were used for historical occurrences; however, the historic loss ratios were derived from NCEI data which show relatively low dollar value losses for the region. Total reported losses from winter storms for the 27-year period between 1993 and 2020 were just under $1 million.

Figure 5.27: National Risk Index Rating, Winter Weather



Source: National Risk Index, FEMA 2021

Note: The Town of Surry has relatively moderate social vulnerability for winter weather.

Notwithstanding the above, severe winter weather can be problematic for socially vulnerable populations, especially people living in substandard housing or without alternative arrangements when power goes down. Transportation impacts are especially

severe when vulnerable people rely on public transportation and those routes are interrupted by snow or ice accumulation.

Future Vulnerability, Land Use and Climate Change

Winter storms remain a likely occurrence for the region. While storms will be more likely to produce small amounts of snow, sleet or freezing rain, larger storms, though less frequent in occurrence, are also expected to impact the region. The *2018 Commonwealth of Virginia Hazard Mitigation Plan* suggests that the southern and southeastern portions of the state are likely to receive significant winter weather approximately once a decade. Local zoning and comprehensive plans are not focused on winter storm planning in the study area; however, the statewide building code does address snow loads and newer buildings are expected to better withstand roof snow loads, in particular.

As the earth's climate changes, heavy seasonal snow years have begun to occur with greater frequency. According to NOAA's NCEI, the frequency of extreme snowstorms in the eastern US has increased over the past century, with approximately twice as many extreme snowstorms occurring in the last half of the 20th century as in the first half. Conditions that influence snowstorm severity including warmer ocean surface temperatures in the Atlantic. These increased temperatures can lead to exceptionally high amounts of moisture feeding into a storm and contribute to storm intensification.

Global ocean surface temperatures have increased at a rate of +.18 degrees Fahrenheit each decade since 1950. Natural variability can affect surface ocean temperatures, but as global surface temperatures increase, the temperature is higher at any time than it would have been if the climate were not changing. Some research has shown that increasing ocean surface temperature and reductions in Arctic sea ice may produce atmospheric circulation patterns that are favorable for winter storm development in the eastern United States. Notably, a greater prevalence of high pressure blocking patterns over the North Atlantic that result in cold outbreaks in the eastern US, along with slow moving systems can further exacerbate the longevity and severity of a snowstorm.

Studies have shown that natural variability associated with El Niño conditions has a strong relationship and influence on the incidence of severe snowstorms in the eastern US. An analysis of 100 storms in six regions east of the Rocky Mountains found that severe snowstorms are approximately twice as likely to occur in the eastern US – north and south – during years when a moderate to strong El Niño is present as compared to years when more neutral conditions are present.

Mass evacuations are not expected in relation to severe winter weather, including evacuations into the Richmond-Crater region from other areas.

5.10 Thunderstorms (including Hail and Lightning)

Hazard Profile

Thunderstorms are caused when air masses of varying temperatures and moisture content meet. All thunderstorms produce lightning. Droplets of water in a thunderstorm may get picked up in the storm's updraft, a column of rising air. The updraft can carry the droplets to levels of the atmosphere where temperatures are below freezing. The frozen droplets,

now hail, may then fall due to gravity injuring people, property and animals. In Virginia, thunderstorms can occur at any time during any season, but are most common in the late afternoon and evening hours of the summer months.

Magnitude or Severity

A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning can remain in-cloud or can contact the ground or other surfaces. A cloud-to-ground bolt of lightning can sometimes strike locations 10 or more miles away from the parent thunderstorm, producing the effect that the lightning came from 'out of the blue' or without warning. Lightning kills an average of 49 people each year in the United States and hundreds more are injured. Some survivors suffer lifelong neurological damage.[14]

In addition to flooding rainfall, damaging winds, and sometimes tornadoes, thunderstorms might also produce large hail and deadly lightning. Hail can be smaller than a pea, or as large as a softball or grapefruit, and can be very destructive to automobiles, glass surfaces such as skylights and windows, roofs, siding, trees, and crops. The amount of damage to crops can be a factor of crop growth stage, amount of hail and how hard it falls, size of the hail (smaller does not necessarily lead to less damage), and concurrent wind speeds and temperatures.

Hazard History

Virginia averages 40 to 50 thunderstorm days per year.[15] Past occurrences of thunderstorm events that produced damage, injuries, or fatalities as a result of hail or lightning since 2010 are listed in **Table 5.28**. The NCEI database shows that at least two people in the region have been killed and three others injured as a result of lightning since 1993 (see **Appendix F-7**). The database did not indicate any deaths or injuries in the region during this period as a result of hail.

[14] https://www.weather.gov/safety/lightning, NWS, accessed September 16, 2021.

[15] Sammler, William. Personal interview, September 15, 2005. (National Weather Service, Warning Coordination Meteorologist, Wakefield, Virginia office.)

Table 5.28: History of Hail/Lightning Events and Damages, 2010–2020	
Date	**Damages**
August 12, 2010	**Hanover County:** Hail, two inches in diameter, damaged vehicles in the county east of Old Cold Harbor.
June 29, 2012	The June 2012 Mid-Atlantic and Midwest derecho was one of the most destructive and deadly fast-moving severe thunderstorm complexes in North American history. The progressive derecho tracked across a large section of the Midwestern United States and across the central Appalachians into the mid-Atlantic states on the afternoon and evening of June 29, 2012, and into the early morning of June 30, 2012. It resulted in 20 deaths, widespread damage and millions of power outages across the study region. (Source: https://en.wikipedia.org/wiki/June_2012_North_American_derecho)
June 13, 2013	On the morning of the 13, another linear complex of severe storms developed along a line near the southern border of Ohio. The storms eventually strengthened into a powerful derecho and raced to the south and east. Fatalities and injuries occurred as a result of falling trees and power lines as the storms ripped through Virginia, along with numerous reports of damaging winds and power outages. The derecho downed numerous tress and damaged structures winds up to 80 mph (130 km/h) in some areas. (Source: https://en.wikipedia.org/wiki/June_12%E2%80%9313,_2013_derecho_series)
May 22, 2014	A large Hail and Thunderstorm event came through the region. Some hail was reported to be as large as ping pong balls. Several areas were affected from fallen electric lines. The NCEI data reports that 12 direct deaths in the study region resulted from this event. (Source: NCEI data & http://www.nbcwashington.com/news/local/Severe-Thunderstorms-DC-Area-May-22-260300391.html)
February 24, 2016	This storm started in the northeastern states and traveled down through Virginia and south. During the thunderstorm, hail in some parts of the region were as large as 3 inches in diameter. (Source: http://www.weather.gov/akq/Feb24-2017TOR)
July 19, 2016	Scattered severe thunderstorms associated with a cold front produced damaging winds and large hail across portions of Henrico, Chesterfield, Sussex and Greensville Counties. Reports of hail size varied from quarter size to hen's egg size in Sussex County, where a corn field was stripped by the large hail on Beaverdam Road near Harrels Mill Pond causing $3000 crop damage.
February 25, 2017	Thunderstorms caused large hail and damaging winds of 50-60 mph throughout the study area. Hail was generally small or quarter size. Minor roof damage of $1000 reported in Bon Air section of Chesterfield County.
May 27, 2017	A low pressure system and warm front produced scattered thunderstorms, causing large hail and damaging winds in Hanover, Henrico, Dinwiddie and Chesterfield Counties. Hail was very large in the Beach area of Chesterfield County, reportedly as large as teacups, with $2000 damage reported.
July 19, 2017	Chesterfield County, Ampt Hill: A lightning strike associated with severe thunderstorms in advance of a cold front caused a small structural fire. There was

Table 5.28: History of Hail/Lightning Events and Damages, 2010–2020	
Date	**Damages**
	also lightning strike on utilities and an adjacent shed on Dulwich Lane. Damages reported at $15,000.
June 22, 2018	Lightning from a thunderstorm produced by a warm frontal boundary caused a house fire in the New Bohemia section of Prince George County. Damage was reported at $10,000.
August 15, 2019	Damaging lightning strikes caused damage in Chesterfield County and Henrico County. Lightning struck a house on Shepherds Drive in Chesterfield causing $5000 damage to the house. In Henrico County, lightning caused a house fire on Linstead Road, with $3000 reported.
August 23, 2019	A house was struck by lightning on Hunnicut Road in Dinwiddie causing $3000 damage.
June 19, 2020	Lightning strike caused a house fire on North Oaks Drive in Hanover with a reported $5000 in damage.

Source: NOAA NCEI

Vulnerability Analysis

Although most frequent in the Southeast and parts of the Midwest, thunderstorms are a relatively common occurrence across the region and have been known to occur in all calendar months. All of the central Virginia region is deemed equally likely to experience severe thunderstorms and associated damages from hail or lightning. **Table 5.29** indicates the annualized number of hail and damaging lightning events by jurisdiction based on NCEI data.

Table 5.29: Annualized Hail and Lightning Events and Losses, 1956 - 2020				
Jurisdiction	**Annualized Hail/Lightning Events**	**Annualized Property Losses**	**Annualized Crop Damages**	**Annualized Total Losses**
Charles City County	0.14	$78	-	$78
Chesterfield County	1.67	$1,773	-	$1,773
City of Colonial Heights	0.19	$31	-	$31
Dinwiddie County (inc. Town of McKenney)	0.36	$516	$1	$517
City of Emporia	0.08	$156	-	$156
Goochland County	0.45	$78	-	$78
Greensville County (inc. Town of Jarratt)	0.13	$0	-	$0
Hanover County (inc. Town of Ashland)	0.95	$2,046		$2,046
Henrico County	1.53	$11,781	-	$11,781

Table 5.29: Annualized Hail and Lightning Events and Losses, 1956 - 2020				
Jurisdiction	**Annualized Hail/Lightning Events**	**Annualized Property Losses**	**Annualized Crop Damages**	**Annualized Total Losses**
City of Hopewell	0.25	$78	-	$78
New Kent County	0.23	$78	-	$78
City of Petersburg	0.11	$187	-	$187
Powhatan County	0.45	$16	-	$16
Prince George County	0.63	$344	-	$344
City of Richmond	0.36	$78	-	$78
Surry County (inc. Town of Surry)	0.16	-	-	-
Sussex County (inc. Towns of Stony Creek, Wakefield, Waverly)	0.31	$313	$47	$360
Total	**0.31**	**$17,553**	**$48**	**$17,601**

Source: NOAA NCEI (events categorized as hail and lightning only)

Table 5.29 is based on NCEI historical data for the 64-year period of record between 1956 and 2020. On average, the region experiences approximately seven to eight hailstorms annually and one damaging lightning event every two years. In terms of damages, roughly $1,200 in losses is attributed to hail and about $16,400 to lightning annually.

Electrical utilities and communications infrastructure are vulnerable to lightning. Damage to power lines or communication towers from direct lightning strikes can cause power and communication outages for residents, businesses, and critical facilities. In addition to lost revenues, downed power lines present a threat to personal safety. Downed wires and lightning strikes have also sparked fires in the past.

A structure's thunderstorm vulnerability is based in large part on building construction and design standards. Other factors, such as location, condition, and maintenance of trees also plays a significant role in determining vulnerability. Windows, roofs, and siding are most vulnerable to the impacts of large hail.

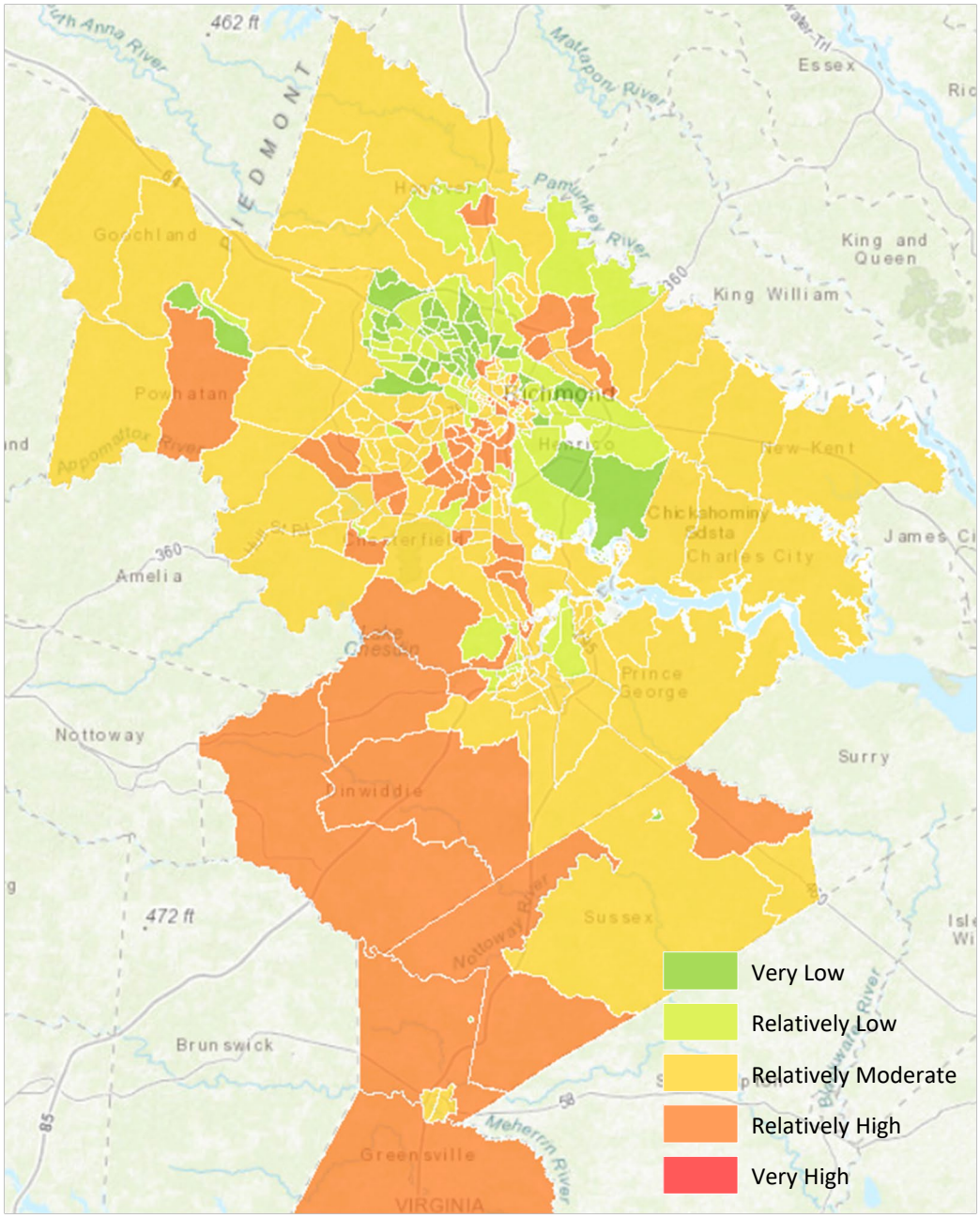
Human vulnerability is based on the availability and reception of early warnings of significant thunderstorm events (i.e., Severe Thunderstorm Warning issued by the NWS) and access to substantial indoor shelter. Seeking shelter indoors on the lowest floor of a substantial building away from windows is recommended as the best protection against thunderstorm-related hazards.

All critical facilities in the study area are at risk for hail and lightning damage, but recent history does not include mention of significant previous damage to these facilities. Critical facilities with generators for auxiliary power are better prepared in the event of power outages caused by thunderstorms and associated wind, hail and lightning.

Social Vulnerability

The NRI data for social vulnerability to lightning and hail are shown in **Figure 5.28** and **Figure 5.29, respectively**.

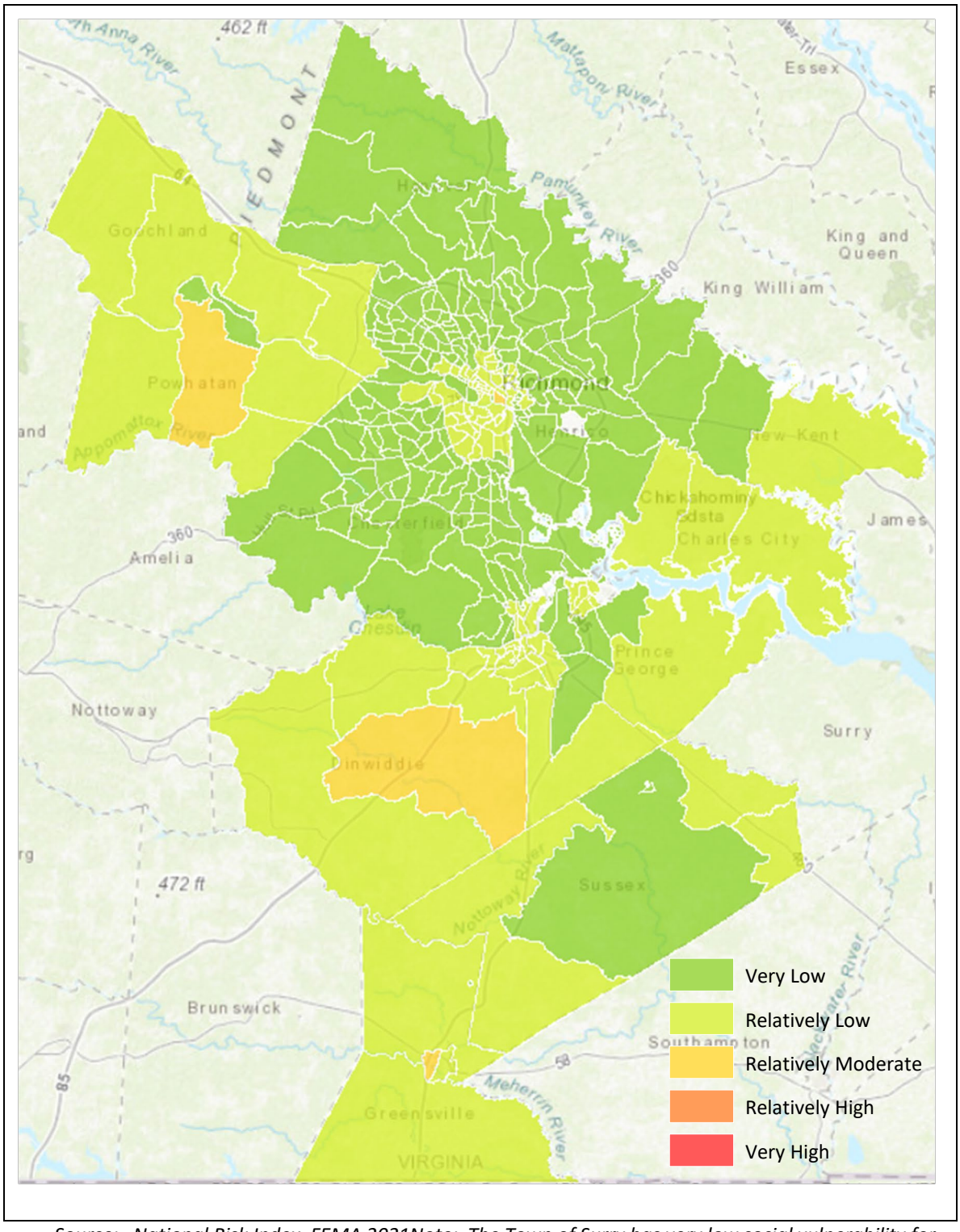
Figure 5.28: National Risk Index Rating, Lightning



Source: National Risk Index, FEMA 2021

Note: The Town of Surry has relatively moderate social vulnerability for lightning.

Figure 5.29: National Risk Index Rating, Hail



Source: National Risk Index, FEMA 2021Note: The Town of Surry has very low social vulnerability for lightning.

Future Vulnerability, Land Use and Climate Change

Future vulnerability to hail and lightning damage may change if the nature of the hazard changes as a result of climate change. If the frequency and severity of thunderstorms

increases as expected, with commensurate increases in lightning strikes and hail size and storm longevity, damage patterns could change, and human vulnerability may increase.

Mass evacuation is not expected in association with thunderstorms, lightning or hail.

5.11 Droughts and Extreme Heat

Hazard Profile

A drought can be characterized in several different ways depending on the nature of the impacts. The most common form of drought is agricultural. Agricultural droughts are characterized by unusually dry conditions during the growing season. Meteorological drought is an extended period of time (six or more months) with precipitation of less than 75% of normal precipitation. Severity of droughts often depends on the community's reliance on a specific water source. The probability of a drought is difficult to predict given the number of variables involved.

A heat wave is defined as a prolonged period of excessive heat, often combined with excessive humidity. Extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. A heat wave combined with a drought is particularly dangerous.

Magnitude or Severity

Many problems can arise at the onset of a drought, some of which include diminished water supplies and quality, undernourishment of livestock and wildlife, crop damage, and possible wildfires. Secondary impacts from droughts pose problems to farmers with reductions in income, while food prices and lumber prices could drastically increase.

High summer temperatures can exacerbate the severity of a drought. When soils are wet, a significant portion of the sun's energy goes toward evaporation of the ground moisture. However, when drought conditions eliminate soil moisture, the sun's energy heats the ground surface and temperatures can soar, further drying the soil.

Table 5.30 provides a summary of drought categories and impacts produced by the U.S. Drought Monitor. The U.S. Drought Monitor classification uses both science and subjectivity to create a drought severity classification table for each dryness level. Notice that water restrictions are usually initiated as "voluntary" and can evolve to "mandatory."

Table 5.30: Drought Severity Classification and Possible Impacts		
Category	**Description**	**Possible Impacts**
D0	Abnormally dry	Going into a drought: short-term dryness slows planting, growth of crops or pastures; fire risk above average. Coming out of a drought: some lingering water deficits; pastures or crops not fully recovered.
D1	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low; some water shortages develop or are imminent; voluntary water use restrictions requested.
D2	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.
D3	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions.

Source: U.S. Drought Monitor

The impact of excessive heat is most prevalent in urban areas, where urban heat-island effects prevent inner-city buildings from releasing heat built up during the daylight hours. Secondary impacts of excessive heat are severe strain on the electrical power system and potential brownouts or blackouts.

Extreme heat also impacts the human body. When combined with high relative humidity that slows evaporation, extreme heat limits the body's ability to efficiently cool itself. Overexposure may result in first dehydration and heat cramps, and then heat exhaustion or heat stroke, which could lead to death. Heat stroke is caused by prolonged exposure to high temperatures or by physical activity. Sweating usually stops and body temperature becomes too high.

For excessive heat, the NWS uses heat index thresholds as criteria for the issuance of heat advisories and excessive heat warnings. NWS heat advisory bulletins inform citizens of forecasted extreme heat conditions. The bulletins are based on projected or observed heat index values and include:

- Excessive Heat Outlook when there is a potential for an excessive heat event within three to seven days.
- Excessive Heat Watch when conditions are favorable for an excessive heat event within 12 to 48 hours, but some uncertainty exists regarding occurrence and timing.
- Excessive Heat Warning/Advisory when an excessive heat event is expected within 36 hours.

These products are usually issued when confidence is high that the event will occur. A warning implies that conditions could pose a threat to life or property, while an advisory is issued for less serious conditions that may cause discomfort or inconvenience but could still lead to threat to life and property if caution is not taken.

Hazard History

There have been a number of significant droughts recorded in Virginia since 1900. An extended period of abnormally dry weather occurred during a period of four years, from 1998 to 2002. This period saw rainfall levels well below normal and caused many communities throughout the state to institute water restrictions.

Table 5.31 includes descriptions of major droughts that have occurred in the Richmond-Crater region. Drought conditions generally occur over a region or larger area rather than in a single jurisdiction. The NCEI database lists no significant drought or extreme heat events since 2016.

Table 5.31 History of Drought Events and Damages, 1976–2020

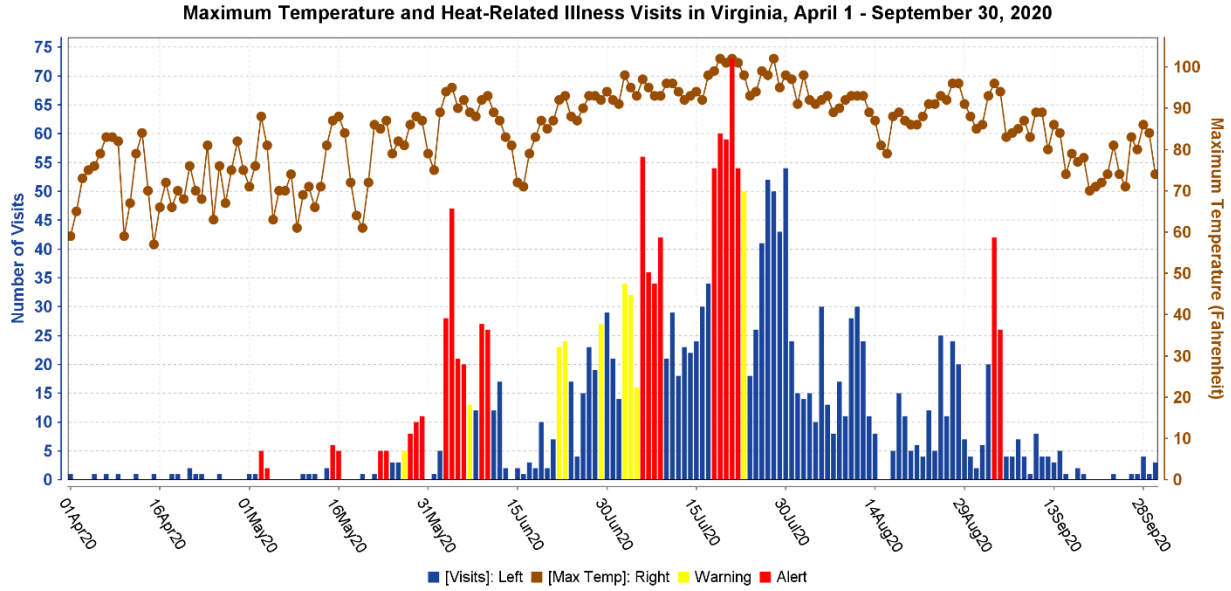
Date	Damages
November 1976 – September 1977	The region experienced ten months of below average precipitation. The drought began in November 1976 when rainfall totaled only 50% to 75% of normal. During the rest of the winter, storms tracked across the Gulf. During the spring and summer storms tracked across the Great Lakes. These weather patterns created significant droughts throughout most of Virginia.
1993	Hot, dry weather affected 23 counties and was responsible for an estimated $75 million in crop damages.
June – November 1998	A heat wave over the Southeast produced warm and dry conditions over much of Virginia. Unusually dry conditions persisted through much of the fall. The drought produced approximately $38.8 million in crop damages over portions of central and south-central Virginia.
December 2001 – November 2004	Beginning in the winter of 2001, the Mid-Atlantic began to show long-term drought conditions. The NWS issued reports of moisture-starved cold fronts that would continue throughout the winter. Stream levels were below normal with record lows observed at gauges for the York, James, and Roanoke River basins. By November 2002, the U.S. Secretary of Agriculture had approved 45 counties for primary disaster designation, while 36 requests remained pending.
2007	Unusually dry conditions persisted through a significant portion of the year through much of southern and central Virginia. Virginia as a whole experienced its tenth driest year on record.
2010	The summer of 2010 was hot and dry. Most of the state suffered from moderate to severe drought conditions, and some jurisdictions were placed under water restrictions.
July 21, 2011	This was one of the hottest July's in the last 75 years, breaking multiple records. According to the NCEI data, all counties were recorded as having excessive heat waves and drought throughout the entire month.
2012-2013	La Nina conditions produced extreme and exceptional drought conditions throughout much of the US, Canada, and Mexico. Peak drought conditions in July resulted in more than 80% of the country with at least abnormally dry conditions. For this event, much of Virginia was classified as either abnormally dry or as experiencing moderate to severe drought conditions.

The NCEI database contains only one extreme heat event for the study area. Between July 21 and July 23, 2011, high temperatures ranged from 96 to 103 degrees during the afternoons, with heat index values ranging from 110 to 119. Overnight lows only fell into the lower 70s to lower 80s. Zero fatalities or injuries and no damages were noted. In an online blog note from July 2021, the Virginia Department of Health (VDH) wrote that, "According to the Office of the Chief Medical Examiner, between 2018 and 2020 there were 28 heat-related deaths in Virginia."[16] Although the geographic location is not provided, these data do not match up with the NCEI data for the state, so NCDI-reported data should not be considered complete.

The VDH receives data on visits to emergency departments and urgent care centers in Virginia for purposes of public health surveillance. These data are analyzed through a syndromic surveillance system, known as ESSENCE, to monitor the health of the community and identify emerging trends of public health concern. In response to extreme heat, the Office of Epidemiology, Division of Surveillance and Investigation conducts surveillance for heat-related illness. While the data depicted in **Figure 5.30** are not readily available by jurisdiction, the statewide data provide insights about significant extreme heat dates, the maximum temperatures and the number of hospital visits for heat-related illness.

[16] https://www.vdh.virginia.gov/blog/2021/07/02/virginia-department-of-health-reminds-residents-to-be-aware-of-the-risks-of-heat-related-illness-enjoy-the-outdoors-this-holiday-weekend-but-make-sure-to-stay-hydrated-use-sunscreen-and-take/

Figure 5.30: Maximum Temperatures and Heat-Related Illness Visits in Virginia, 2016-2020



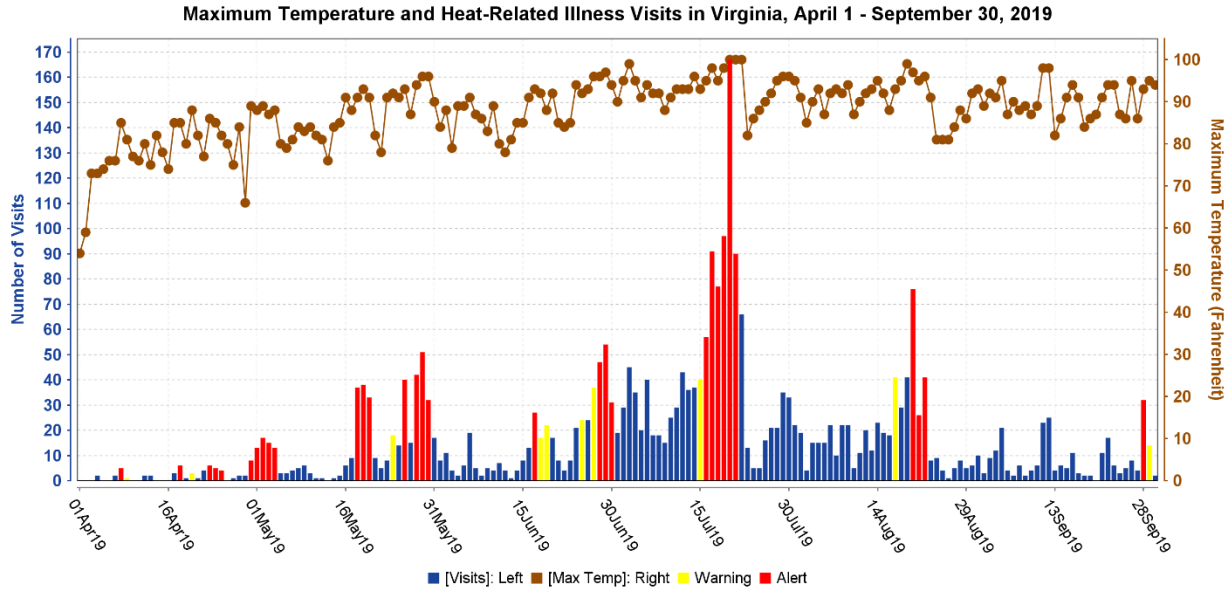
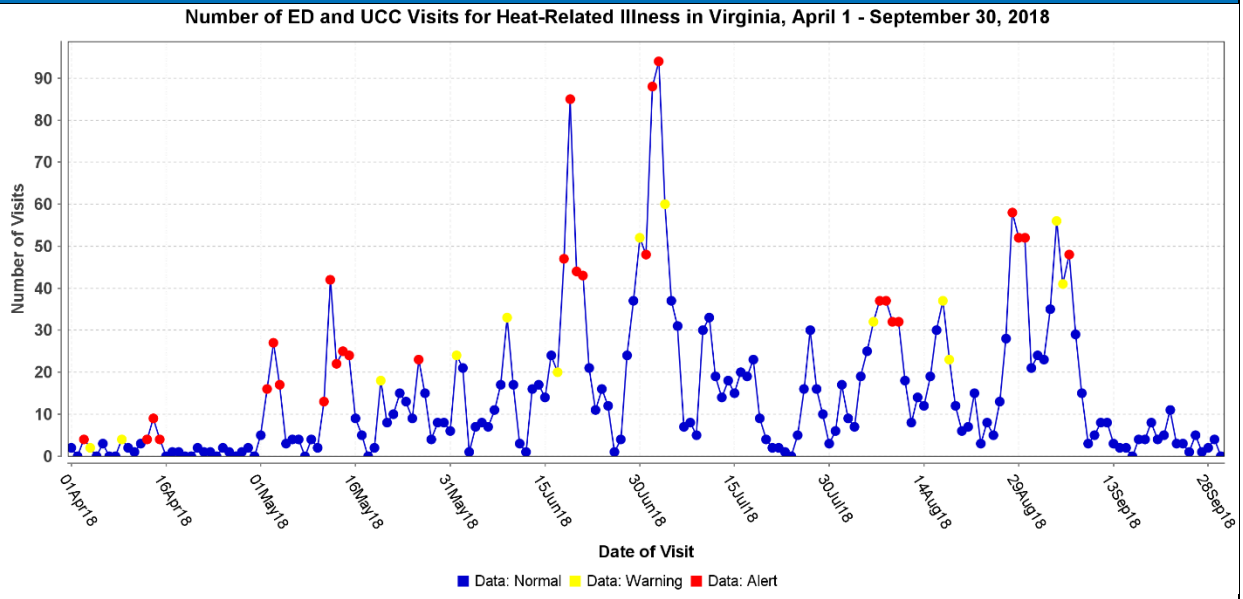


Figure 5.30: Maximum Temperatures and Heat-Related Illness Visits in Virginia, 2016-2020



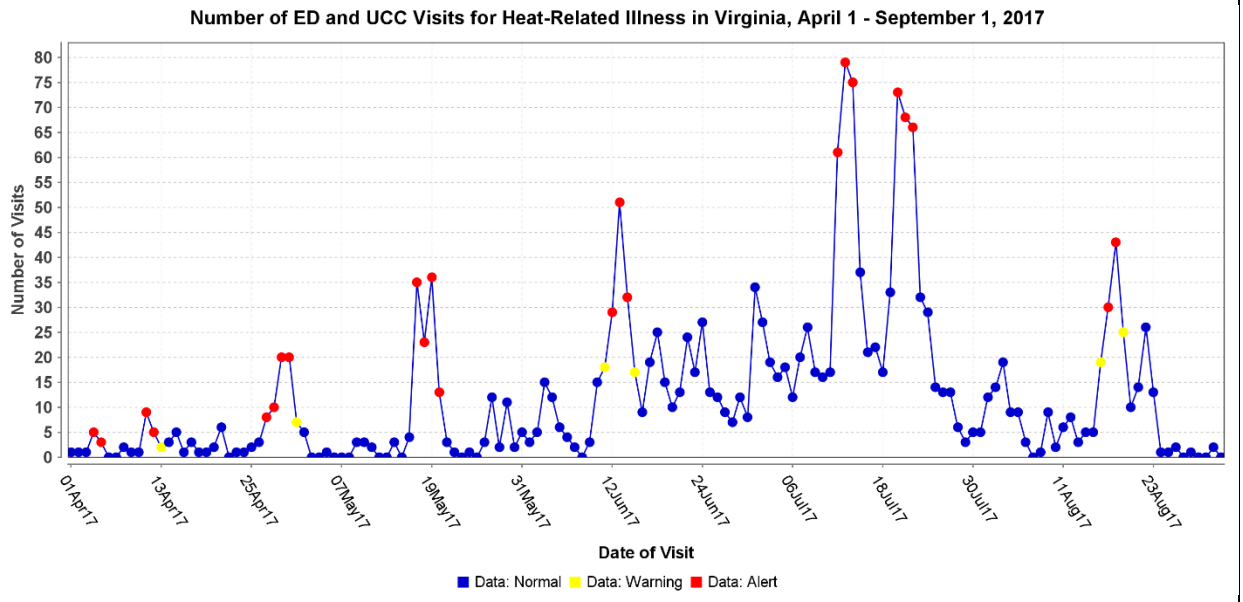
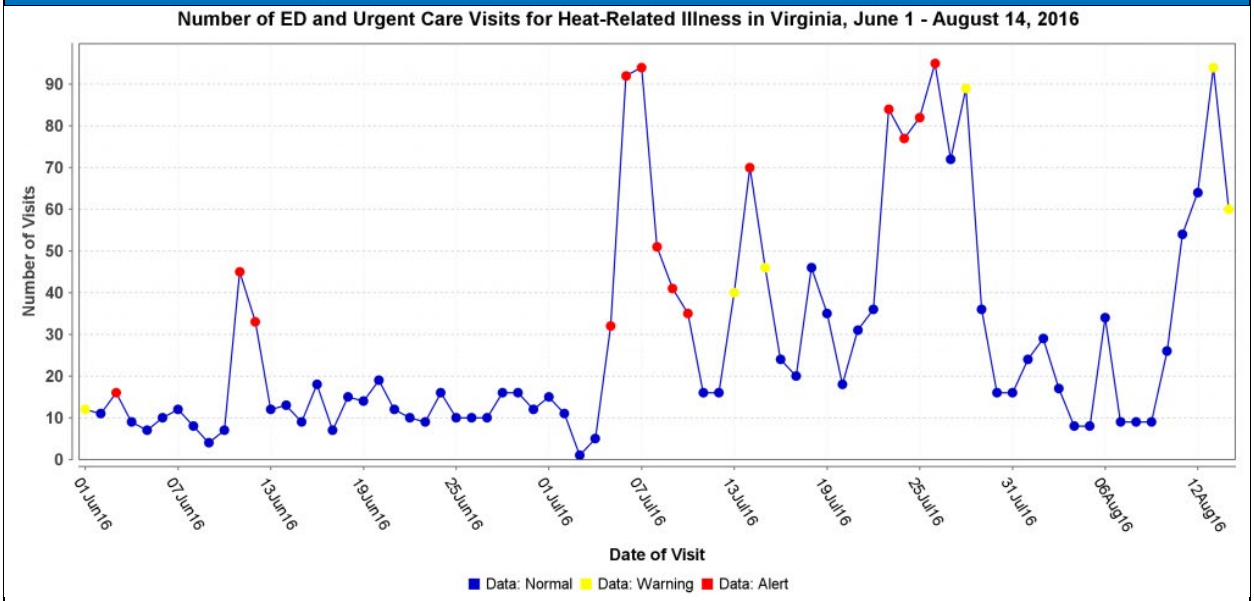


Figure 5.30: Maximum Temperatures and Heat-Related Illness Visits in Virginia, 2016-2020



Source: Virginia Department of Health, accessed online https://www.vdh.virginia.gov/surveillance-and-investigation/syndromic-surveillance/weather-surveillance/.

Vulnerability Analysis

Based on historical frequency of occurrence using NCEI, an annual determination of drought events can be made. **Table 5.32** indicates that drought events of some significance affect jurisdictions in the region. The annualized event occurrence and damages are shown for the study area.

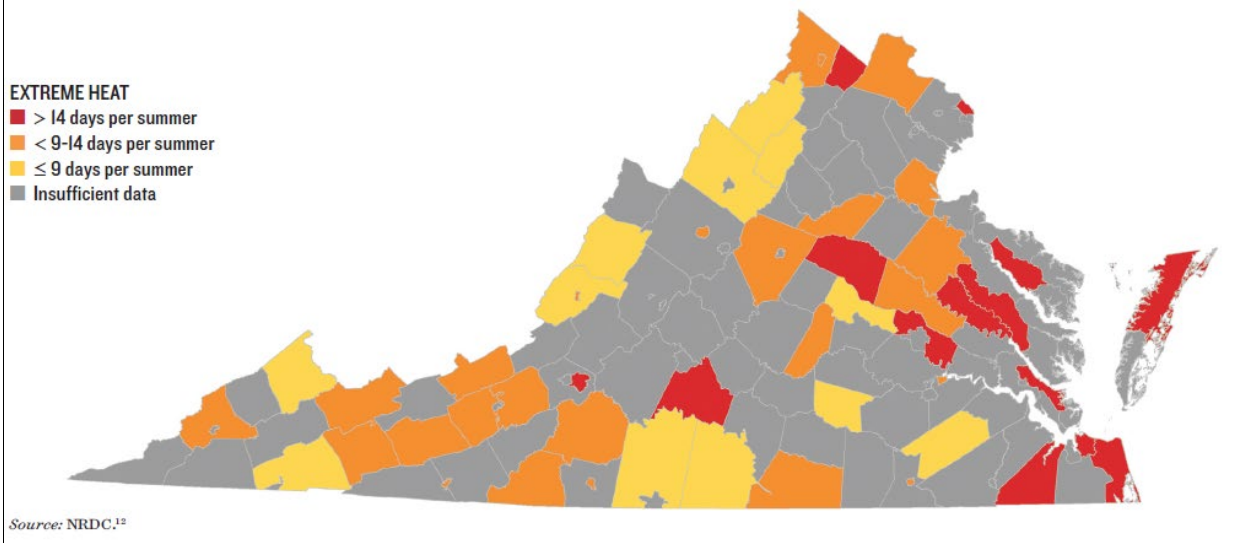
Table 5.32: Annualized Drought Events and Losses, 1993 – 2020

Jurisdiction	Annualized Number of Events	Annualized Property Losses	Annualized Crop Losses
Charles City County	0.14	-	$111,948
Chesterfield County	0.21	-	-
City of Colonial Heights	-	-	-
Dinwiddie County (inc. Town of McKenney)	-	-	$342,918
City of Emporia	-	-	-
Goochland County	-	-	$103,992
Greensville County (inc. Town of Jarratt)	-	-	-

Table 5.32: Annualized Drought Events and Losses, 1993 – 2020			
Jurisdiction	**Annualized Number of Events**	**Annualized Property Losses**	**Annualized Crop Losses**
Hanover County (inc. Town of Ashland)	0.21	-	$426,633
Henrico County	0.18	-	$207,982
City of Hopewell	0.21	-	-
New Kent County	0.21	-	$59,142
City of Petersburg	0.43	-	-
Powhatan County	0.11	-	$ 322,325
Prince George County	0.21	-	$190,100
City of Richmond	0.43	-	-
Surry County (inc. Town of Surry)	-	-	-
Sussex County (inc. Towns of Stony Creek, Wakefield, Waverly)	0.11	-	-
Totals	**0.40**	**$0**	**$1,765,040**

An examination of vulnerability to extreme heat by jurisdiction necessitates the use of data other than NCEI data, which are incomplete. **Figure 5.31** shows the average number of extreme summer heat days per year in Virginia, by county, between 2007 and 2016, from an NRDC report on Climate Change and Health in Virginia. While the data are insufficient in much of the study area, a definite urban heat island effect for metro Richmond is evident.

Figure 5.31: Average Number of Extreme Summer Heat Days per Year in Virginia



Source: NRDC, Climate Change and Health in Virginia, Issue Brief, April 2018. Accessed online: https://www.nrdc.org/sites/default/files/climate-change-health-impacts-virginia-ib.pdf

If a significant drought event were to occur, it could bring economic, social, and environmental impacts to the study area. Commonly, one of the most significant economic effects to a community is agricultural impact. Other economic effects could be felt by businesses that rely on adequate water levels for their day-to-day business, such as carwashes and Laundromats.

Droughts can also create conditions that lead to occurrence or worsening of other natural hazard events such as wildfires. The likelihood of flash flooding and sinkholes is increased if a period of severe drought is followed by a period of extreme precipitation. Low-flow conditions also decrease the quantity and pressure of water available to fight fires, while the dry conditions increase the likelihood that fires will occur.

Environmental drought impacts include those on both human and animal habitats and hydrologic units. During periods of drought, the amount of available water decreases in lakes, streams, aquifers, soil, wetlands, springs, and other surface and subsurface water sources. This decrease in water availability can affect water quality such as oxygen levels, bacteria, turbidity, temperature increase, and pH changes. Changes in any of these levels can have a significant effect on the aquatic habitat of numerous plants and animals found throughout the study area.

Low water flow can result in decreased sewage flows and subsequent increases in contaminants in the water supply. Decrease in the availability of water also decreases

drinking water supply and the food supply as food sources become scarcer. This disruption can work its way up the food chain within a habitat. Loss of biodiversity and increases in mortality can lead to increases in disease in endangered species.

Precipitation at reliable, predictable times in the growing cycle of any crop is essential for the success of that crop, as every crop has a predictable growing season. During dry periods, including droughts, evapotranspiration from plant leaves can contribute to the loss of moisture in the soil, further impacting vegetation and crops. **Table 5.33** provides an overview of the agricultural products that could be affected by a drought. These numbers are based on the 2017 Census of Agriculture conducted by the U.S. Department of Agriculture. The numbers show all of the counties with significant agricultural sectors that could be impacted by droughts. Hanover County, in particular, has almost $50 million in products sold, most of which were crops.

Table 5.33: Value of Agricultural Products Potentially Affected by Drought

Jurisdiction	Number of Farms 2017 (% Change from 2012)	Total Value of Agricultural Products Sold	Total Acres Operated in Farms
Charles City County	77 (-2.0%)	$16,186,000	31,392
Chesterfield County	210 (13.0%)	$4,511,000	18,013
Dinwiddie County	358 (-25.0%)	$25,705,000	92,841
Goochland County	355 (40.0%)	$11,740,000	56,739
Greensville County	150 (-1.0%)	$19,448,000	54,544
Hanover County	567 (-33.0%)	$49,254,000	89,186
Henrico County	99 (-18.0%)	$7,286,000	9,820
New Kent County	138 (1.0%)	$5,128,000	18,335
Powhatan County	263 (13.0%)	$11,249,000	34,585
Prince George County	164 (-3.0%)	$9,284,000	39,630
Surry County	111 (-16.0%)	$23,899,000	42,062
Sussex County	124 (1.0%)	$42,178,000	66,257
Total	**2,616 (-30.0%)**	**$225,868,000**	**553,404**

Source: United States Department of Agriculture, Virginia Agricultural Statistics Service. 2017 Census of Agriculture

Except for potential water supply issues associated with a prolonged drought, droughts have little impact on critical facilities.

The data show recurrence of drought conditions, of varying magnitude, on a relatively regular basis. With records dating back to 1993, the NCEI database indicates that drought events of some significance occur regularly in the region. Based on historical data, it is reasonable to assume that drought events will continue to impact the region with some regularity. Annual regional crop losses associated with drought events just slightly exceeds $2 million.

Social Vulnerability

The main concern in periods of extreme heat is the potential public health impact, such as heat exhaustion or heat stroke. Individuals of concern include those living in residences without air conditioning, or in areas where electric service is unavailable due to system-wide blackouts. The elderly, small children, the chronically ill, livestock and pets are most vulnerable to extreme heat. **Figure 5.32** shows the relative social vulnerability to heat waves based on the National Risk Index data.

The NRI data for social vulnerability to drought are shown in **Figure 5.33**. Historical occurrence data were taken from the University of Nebraska-Lincoln National Drought Mitigation Center, U.S. Drought Monitor. The period of record was January 2000 to December 2017. Portions of Dinwiddie County and Hanover County appear to be the most socially vulnerable communities to the impacts of drought.

Future Vulnerability, Land Use and Climate Change

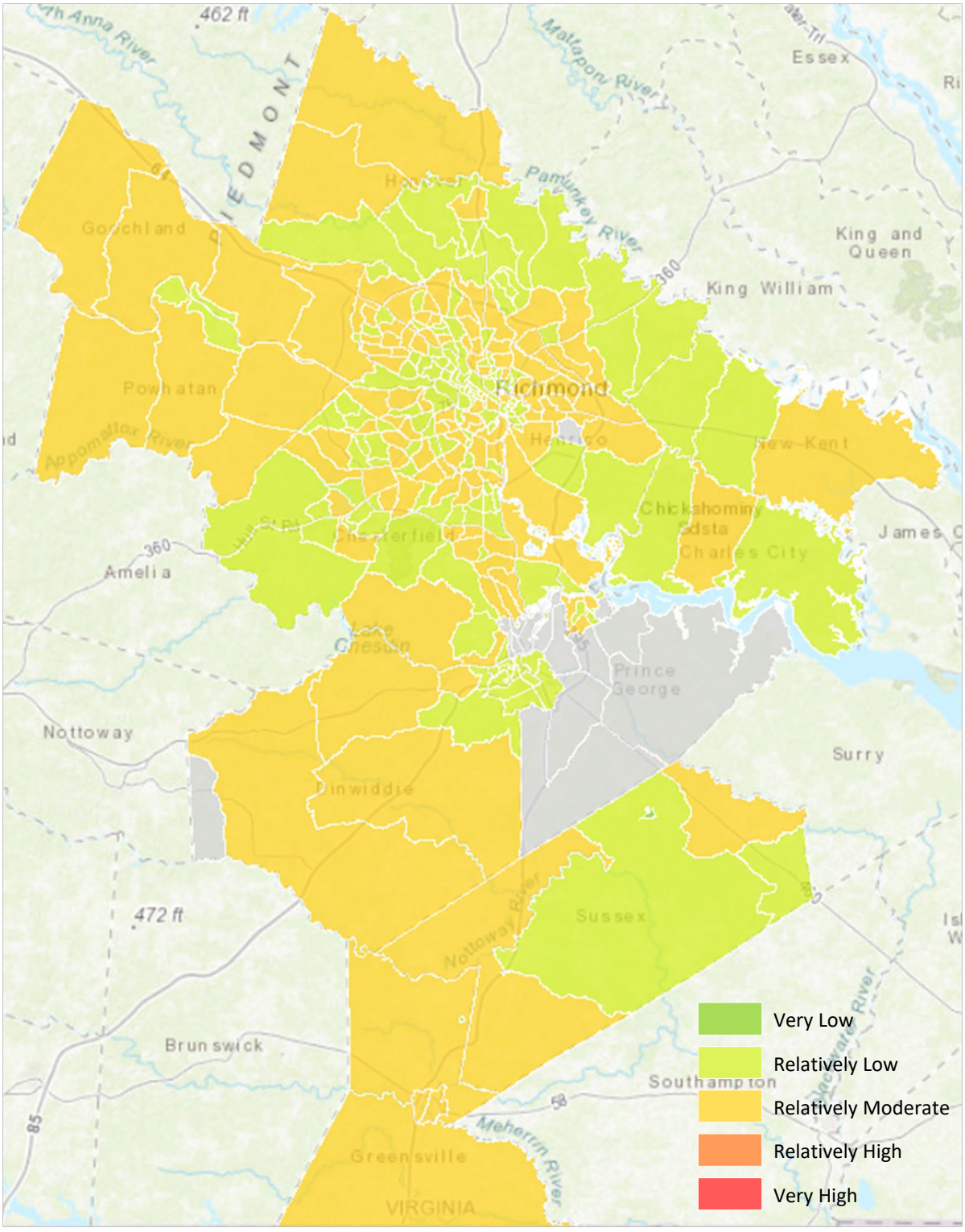
The VASEM 2021 report predicts that as this century comes to a close, agriculture will be impacted by more intense precipitation but also longer periods of drought. The cumulative effect will particularly be bad for crops near the warm end of their geographic range.

The risk of heat-related illnesses and deaths in Virginia will grow as climate change fuels more intense and frequent heat waves. NRDC analysis indicates that daily summer highs at Richmond International Airport averaged 88.6 degrees Fahrenheit in the past decade, compared with 85.6 degrees Fahrenheit in the 1960s.[17]

Neither droughts nor extreme heat are expected to cause mass evacuations.

[17] NRDC: *Climate Change and Health in Virginia*, Issue Brief, April 2018. Accessed online: https://www.nrdc.org/sites/default/files/climate-change-health-impacts-virginia-ib.pdf

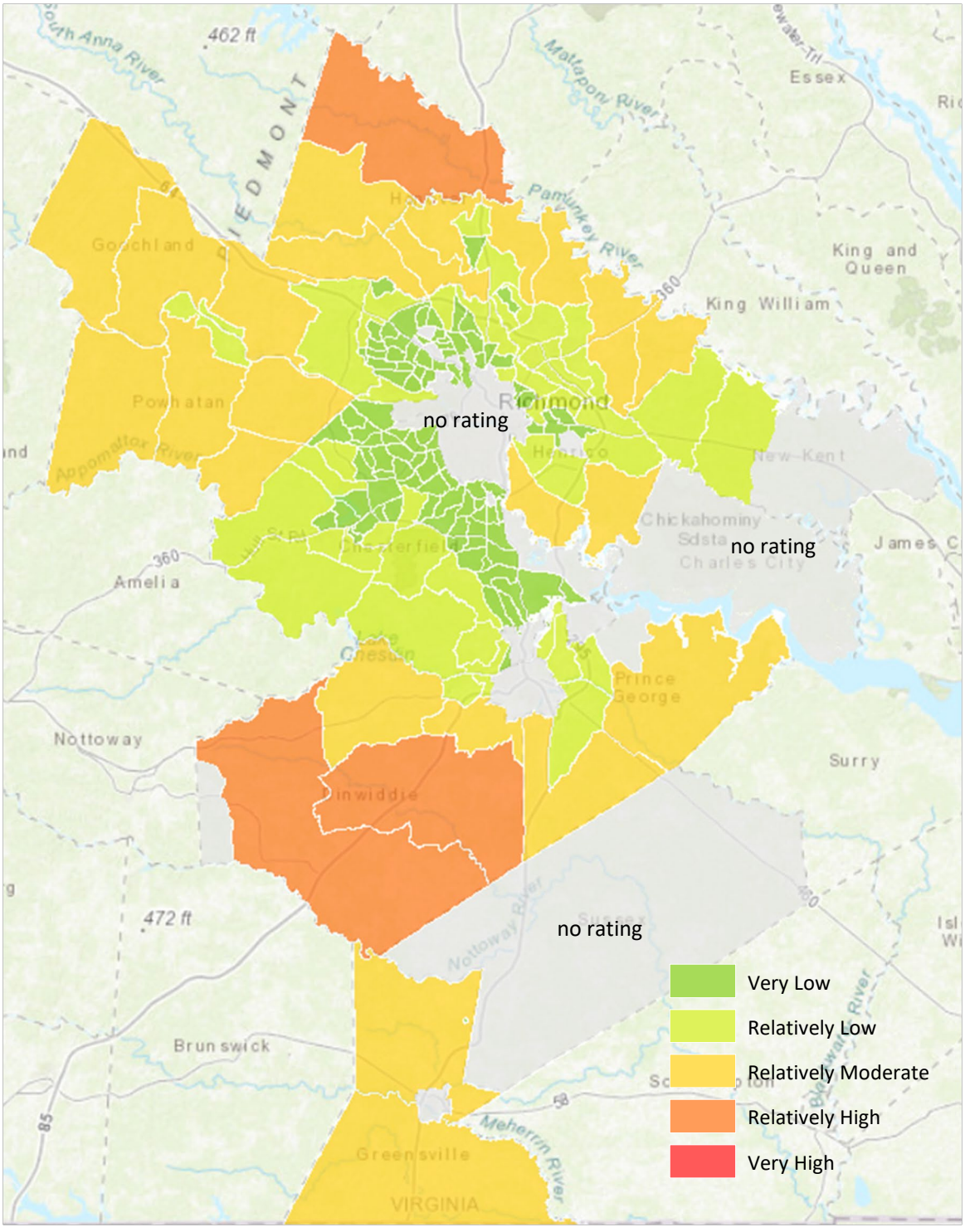
Figure 5.32: National Risk Index Rating, Heat Wave



Source: National Risk Index, FEMA 2021

Note: The Town of Surry has relatively moderate social vulnerability for heat wave.

Figure 5.33: National Risk Index Rating, Drought



Source: National Risk Index, FEMA 2021

Note: The Town of Surry has no NRI social vulnerability rating for drought.

5.12 Earthquakes

Hazard Profile

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock in the Earth's crust. Naturally occurring earthquakes result from crustal strain, volcanism, landslides or the collapse of caverns but can also be triggered by mine blasts or collapse or nuclear testing. Earthquakes can affect hundreds of thousands of square miles; cause damage to property measured in the tens of billions of dollars; result in loss of life and injury to hundreds of thousands of persons; and disrupt the social and economic functioning of the affected area.

Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site and regional geology and soil.

Earthquakes are caused by the sudden release of accumulated energy, resulting in the rupture of rocks along fault planes in the Earth's lithosphere. The areas of greatest tectonic activity occur at the boundaries of the Earth's slowly moving tectonic plates, as these locations are subjected to the greatest strain from plates traveling in various directions and speeds. Deformation along plate boundaries causes strain in the rock and the consequent buildup of stored energy. When the built-up stress exceeds the rocks' strength, a rupture occurs. The rock on both sides of the fracture is snapped, releasing the stored energy and producing seismic waves, generating an earthquake.

Impacts from earthquakes can be severe and cause significant damage. Ground shaking can lead to the collapse of buildings and bridges, and disrupt utilities. Death, injuries, and extensive property damage are possible from earthquakes. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, avalanches, tsunamis, and dam failure.

Magnitude or Severity

Smaller earthquakes occur much more frequently than larger earthquakes. These smaller earthquakes are generally not felt by people and cause little or no damage. Very large earthquakes can cause tremendous damage and may be followed by a series of aftershocks occurring in the region for weeks after the event. Aftershocks generally have a smaller magnitude than the main shock, but may still be powerful enough to cause additional damage.

Earthquakes can be measured in terms of their magnitude or intensity. Magnitude is the amount of energy that is released by an earthquake. There are a number of ways that magnitude can be measured but probably the most familiar is the Richter Scale (**Table 5.34**). The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology, as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of seismic waves recorded by seismographs. Adjustments are included for

variation in the distance between the various seismographs and the epicenter of the earthquakes.[18] On the Richter Scale, magnitude is expressed as a dimensionless number from 0.0 to 10.0. For example, a magnitude 5.3 quake might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Even though the original calculations developed by Richter to estimate earthquake magnitude have gone out of favor, newer formulae still retain the familiar Richter reporting methodology as shown in Table 5.34. Currently, the moment magnitude scale (MMS) is the primary reporting method used by the U.S. Geological Survey.[19]

Table 5.34: The Richter Scale

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally not felt but recorded.
3.5–5.4	Often felt, but rarely causes damage.
Under 6.0	At most, slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1–6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0–7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

The effect of an earthquake on people and structures on the Earth's surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and finally, total destruction. Although numerous intensity scales have been developed in the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli Intensity Scale (**Table 5.35**). It was developed in 1931 by American seismologists Harry Wood and Frank Neumann. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals as shown in Table 5.35. The scale does not have a mathematical basis; instead, it is an arbitrary ranking based on observed effects.[20]

[18] USGS, accessed online at: https://earthquake.usgs.gov/learn/glossary/?term%3Drichter%2520scale&sa=D&source=docs&ust=1645377818946701&usg=AOvVaw08xBaSg2rM9bLm1i43j_D5

[19] Virginia Department of Energy, accessed online at: https://energy.virginia.gov/geology/Earthquakes.shtml

[20] USGS, accessed online at: https://www.usgs.gov/natural-hazards/earthquake-hazards/science/modified-mercalli-intensity-scale?qt-science_center_objects=0#qt-science_center_objects

The lower numbers of the intensity scale deal indicate the manner in which people perceive the earthquake. The higher numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above.

Table 5.35: Modified Mercalli Intensity Scale for Earthquakes

Scale	Intensity	Earthquake Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	
II	Feeble	Some people feel it	<4.2
III	Slight	Felt by people resting; like a truck rumbling by	
IV	Moderate	Felt by people walking	
V	Slightly Strong	Sleepers awake; church bells ring	<4.8
VI	Strong	Trees sway; suspended objects swing; objects fall off shelves	<5.4
VII	Very Strong	Mild alarm; walls crack; plaster falls	<6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures; poorly constructed buildings damaged	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	<6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	<7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards	<8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	>8.1

Earthquakes in the central and eastern U.S., although less frequent than in the western U.S., are typically felt over a much broader region. East of the Rockies, an earthquake can be felt over an area as much as ten times larger than a similar magnitude earthquake on the west coast. A magnitude 4.0 eastern U.S. earthquake typically can be felt at many places as far as 60 miles from where it occurred, and it infrequently causes damage near its source.[21] A magnitude 5.5 eastern U.S. earthquake usually can be felt as far as 300 miles from where it occurred, and sometimes causes damage out to 25 miles.

Hazard History

Earthquakes everywhere occur on faults within bedrock, usually several miles deep. Most bedrock beneath central Virginia was assembled as continents collided to form a supercontinent about 500-300 million years ago, raising the Appalachian Mountains. Most

[21] Virginia Tech Global Seismological Lab, accessed online at: http://www.magma.geos.vt.edu/vtso/cvsz.html

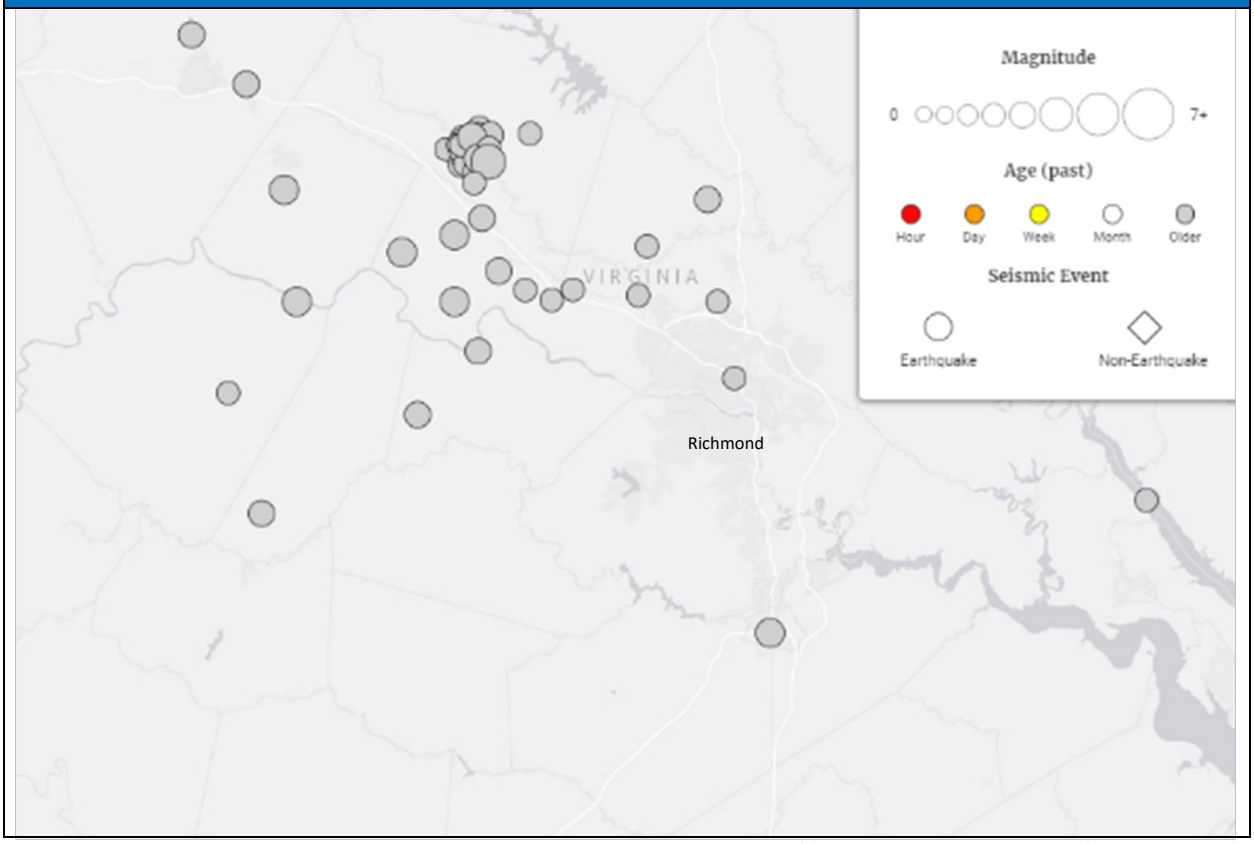
of the rest of the bedrock formed when the supercontinent rifted apart about 200 million years ago to form what are now the northeastern U.S., the Atlantic Ocean, and Europe.[22]

At well-studied plate boundaries like the San Andreas fault system in California, scientists can often determine the name of the specific fault that is responsible for an earthquake. In contrast, east of the Rocky Mountains this is rarely the case. The Central Virginia Seismic Zone is far from the nearest plate boundary, which are in the center of the Atlantic Ocean. The seismic zone is laced with known faults, but numerous smaller or deeply buried faults remain undetected. Even the known faults are poorly located at earthquake depths. Accordingly, few, if any, earthquakes in the seismic zone can be linked to named faults. It is difficult to determine if a known fault is still active and could slip and cause an earthquake. As in most other areas east of the Rockies, the best guide to earthquake hazards in the seismic zone is the earthquakes themselves.[23]

Earthquake activity in Virginia has generally been, with a few exceptions, low-magnitude but persistent. The first documented earthquake in Virginia took place in 1774 near Petersburg.[24] Virginia has had more than 160 earthquakes since 1977, of which 16% were felt. This averages to approximately one earthquake every month, with two felt each year.[25] **Figure 5.34** shows the significant earthquakes (magnitude greater than 2.5) that have impacted Virginia from 1774 to 2020. There have been eight noteworthy earthquakes centered in the region; however, surface faulting that generated these earthquakes remain unidentified.

[22] Virginia Tech Global Seismology Lab, accessed online at: http://www.magma.geos.vt.edu/vtso/cvsz.html
[23] Virginia Tech Global Seismology Lab, accessed online at: http://www.magma.geos.vt.edu/vtso/cvsz.html
[24] Virginia Department of Energy, accessed online at: https://energy.virginia.gov/geology/Earthquakes.shtml
[25] Virginia Tech Global Seismology Lab, accessed online at: http://www.geol.vt.edu/outreach/vtso/quake.html

Figure 5.34: Earthquake History in the Greater Richmond-Crater Region, 1774 - 2020



Source: USGS Earthquake Mapping Tool, accessed online 2021 at: https://earthquake.usgs177.gov/earthquakes/

Of the eight noteworthy earthquakes that have been recorded in the region, one was centered near the City of Petersburg, two near Goochland County, and one near Powhatan County. Historical earthquake occurrences, which have affected the region and are summarized in the following paragraphs, are based on available records from the Virginia Tech Seismological Observatory, Seismicity of the United States (USGS Paper 1527), the U.S. Geological Survey Earthquakes in Virginia and Vicinity 1774 – 2004 (USGS Open File Report 2006-1017), and the Virginia Department of Energy (DGMR Publication 185).[26]

The first major historical record for an earthquake (estimated Magnitude 4.5) occurred on February 21, 1774, near the City of Petersburg and Prince George County. The earthquake was felt in much of Virginia and southward into North Carolina. Many houses were moved considerably off their foundations in the cities of Petersburg and Blandford. The shock was described as "severe" in Richmond and terrified residents about 50 miles north in the City

[26] Virginia Department of Energy, accessed online at: https://energy.virginia.gov/geology/documents/FEMAHistoryReport.zip

of Fredericksburg but caused no damage in those areas. The total felt area covered about 57,900 square miles.

On August 27, 1833, an earthquake near Goochland County (estimated Magnitude 4.5) was felt from Norfolk to Lexington and from Baltimore, Maryland, to Raleigh, North Carolina – about 52,110 square miles. In Charlottesville, Fredericksburg, Lynchburg, and Norfolk, windows rattled violently, loose objects shook, and walls of buildings were visibly agitated.

Although it did not occur within the region, an earthquake (estimated Magnitude 4.3) was observed on November 2, 1852, with the epicenter in Buckingham County, Virginia. Chimney damage was reported in Buckingham and the earthquake was reported to be the strongest in Fredericksburg and Richmond, and the Town of Scottsville.

Centered near Goochland County, a series of shocks (estimated Magnitude 4.8) in quick succession were felt throughout the eastern two-thirds of Virginia and a portion of North Carolina on December 23, 1875. The highest intensities from this earthquake occurred mainly in towns near the James River shoreline in Goochland and Powhatan Counties, and in Louisa County. In Richmond and Henrico Counties, the most severe damage was sustained in the downtown business and residential areas adjacent to the James River. Damage included bricks knocked from chimneys, fallen plaster, an overturned stove, and several broken windows. Waves "suddenly rose several feet" at the James River dock in Richmond, causing boats to "part their cables" and drift below the wharf. At Manakin, about 20 kilometers west of Richmond, shingles were shaken from a roof and many lamps and chimneys were broken. The total felt area was about 50,180 square miles.

On February 11, 1907, an earthquake reaching magnitude 4.0 on the Richter Scale affected the community of Arvonia in Buckingham County. The earthquake was also felt strongly from Powhatan to Albemarle Counties.

The December 9, 2003, an earthquake occurred in Powhatan County (estimated Magnitude 4.5). The quake was a complex event consisting of two sub-events occurring 12 seconds apart and causing slight damage nearest the epicenter. The quakes were felt in much of Maryland and Virginia; in north-central North Carolina; and in a few areas of Delaware, New Jersey, New York, Pennsylvania, and West Virginia.

A 5.8 magnitude quake centered near Mineral, Virginia (Louisa County) occurred at 1:51 pm EDT on August 23, 2011. The earthquake was reportedly felt as far north as Canada, as far south as Georgia and as far west as Chicago. Effects of the earthquake were reported to the USGS through its online survey[27] from over 8,434 zip codes and ranged from weak intensity to very strong. In terms of damage, particularly hard-hit were brick and unreinforced structures and infrastructure near the quake's epicenter. In addition to cracks and buckling, some buildings were knocked off of their foundations. Minor injuries were reported as a result of the damage and debris. The earthquake forced the North Anna Power Station nuclear power plant offline pending an all-clear from a Nuclear Regulatory Commission review. Aftershocks of a lesser magnitude continued to plague the area for

[27] USGS, accessed online at: https://earthquake.usgs.gov/data/dyfi/

several weeks after the event. The strongest aftershock measured 4.5 and occurred on August 25 at 1:08 am EDT. Louisa County received over $6.6 million in individual assistance as well as $1.6 million in low-interest loans to individuals and businesses through the Small Business Administration (source: *2018 Commonwealth of Virginia Hazard Mitigation Plan*).

A magnitude 3.1 quake occurred May 22, 2014, 3.1 to 15 kilometers east-northeast of Cumberland, in Powhatan County. Reports of the quake were received by over 2,000 people in the central Virginia area. The earthquake depth was 9.0 kilometers.

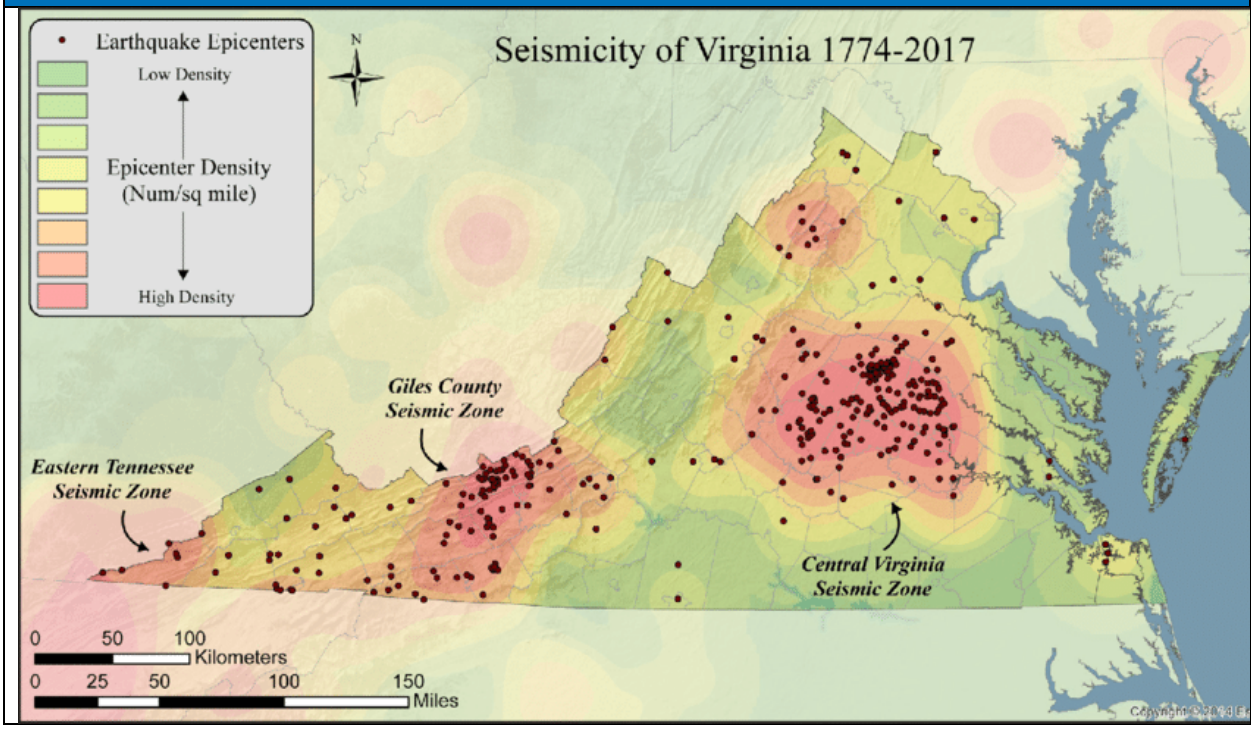
Vulnerability Analysis

Earthquakes are high-impact, low-probability events. With the few historical incidents throughout the region and limited data, the probability is low. **Figure 5.36** show the relative seismic hazard throughout the study area, highlighting the Central Virginia Seismic Zone.

Since the 2011 earthquake in Louisa County, Virginia, scientists have worked to create an all-inclusive database of the state's fault lines based on all data available, particularly earthquake epicenters. The Central Virginia Seismic Zone coincides with much of the northern region of the Richmond-Crater study area. The 2011 earthquake is the largest historical earthquake within the Central Virginia Seismic Zone and the largest earthquake to have occurred in Virginia in historical time. [28]

[28] Kelly, Wendy; A. Witt; M. Heller; and M. Chapman. August 2017. Virginia Division of Geology and Mineral Resources Publication 185 - Seismic History Of Virginia, August 2017.

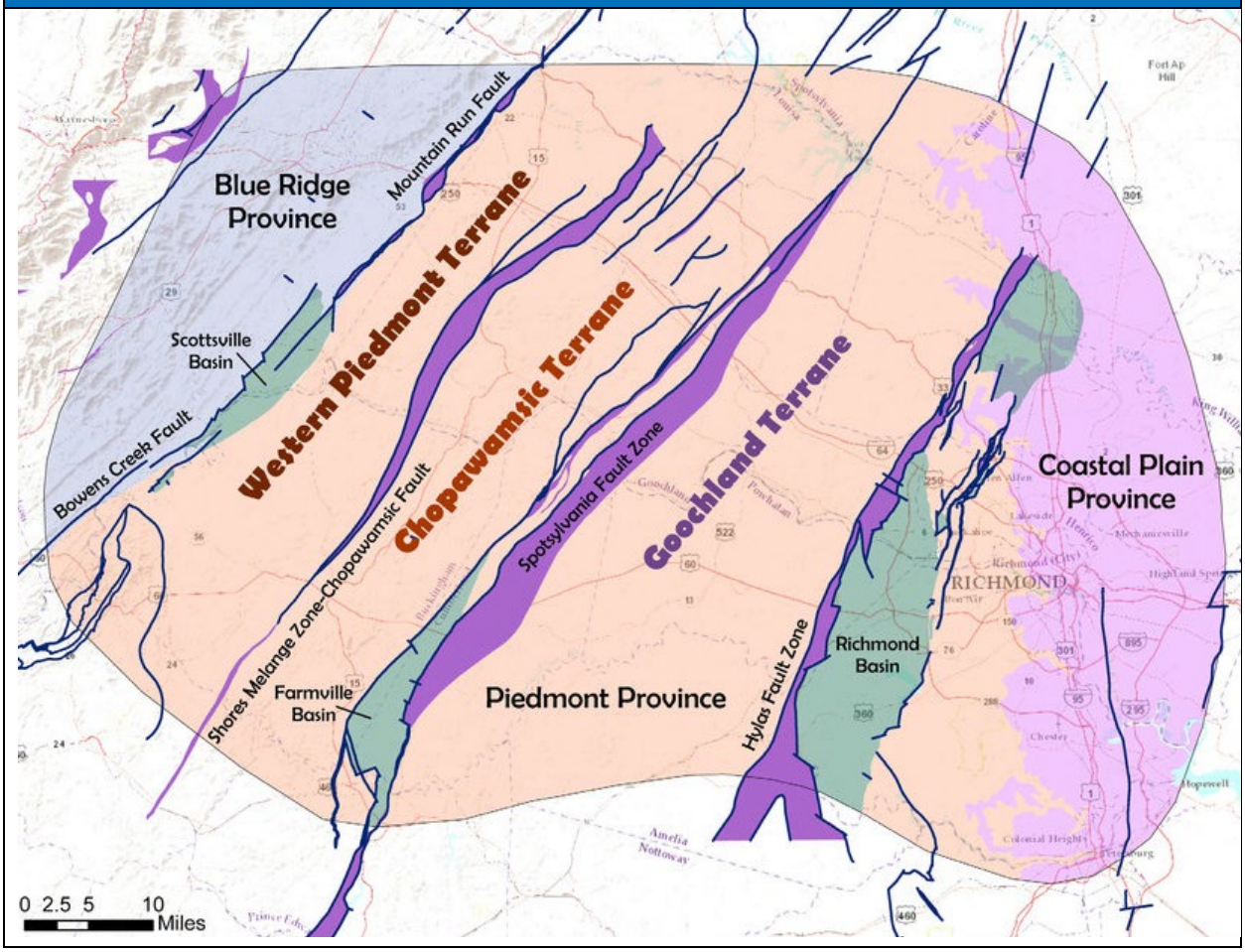
Figure 5.36: Seismicity of Virginia, 1774-2017



Source: Kelly, Wendy; A. Witt; M. Heller; and M. Chapman. August 2017. Virginia Division of Geology and Mineral Resources Publication 185 - Seismic History Of Virginia, August 2017.

Fault lines and zones in the study area are delineated in **Figure 5.37**, which shows the major faults (navy blue lines running southwest to northeast) and tectonic terranes within the Central Virginia Seismic Zone. Note the fault lines southwest and southeast of Richmond.

Figure 5.37: Major Faults and Tectonic Terranes within the Central Virginia Seismic Zone



Source: Kelly, Wendy; A. Witt; M. Heller; and M. Chapman. August 2017. Virginia Division of Geology and Mineral Resources Publication 185 - Seismic History Of Virginia, August 2017.

The Hazus earthquake model estimates damages and loss to buildings, lifelines, and essential facilities from customized-scenario and probabilistic earthquakes. Hazus was used to generate damage and loss estimates for the probabilistic ground motions associated with each of eight return periods (100-, 250-, 500-, 750-, 1,000-, 2,000-, and 2,500-year return periods), and then annualized to show the relative risk to each community in the study area.

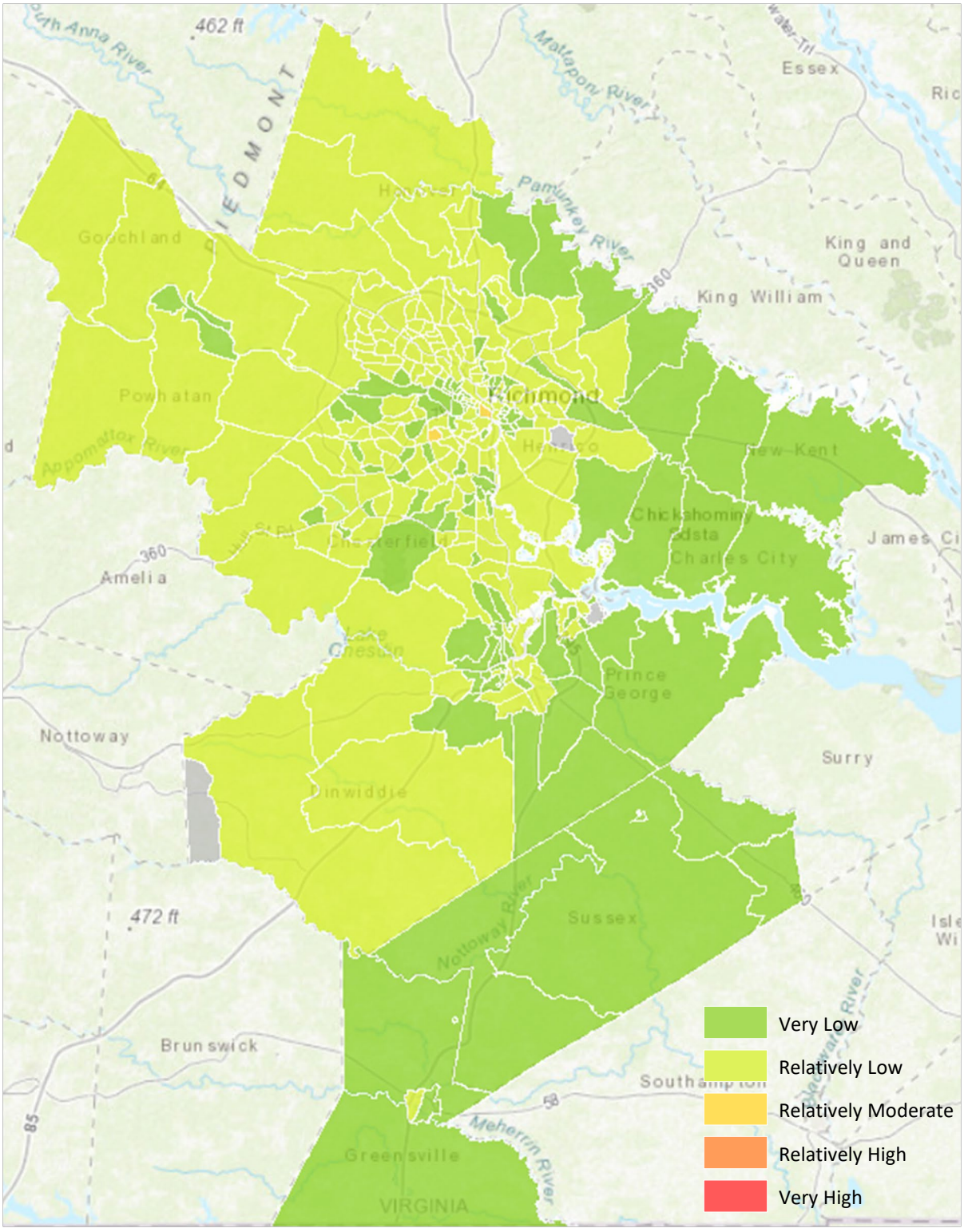
Table 5.36 shows results from the Hazus analysis for the jurisdictions in the region. These figures include direct economic losses for buildings, including non-structural damage, contents/inventory, and income losses from relocation, lost wages and lost rental income. Based on this analysis, Henrico County experiences the greatest losses on an annualized basis in the region, followed closely by Chesterfield County and the City of Richmond.

Table 5.36: Annualized Earthquake Losses	
Jurisdiction	**Annualized Total Damages**
Charles City County	$10,000
Chesterfield County	$1,032,000
City of Colonial Heights	$32,000
Dinwiddie County (inc. Town of McKenney)	$45,000
City of Emporia	$8,000
Goochland County	$132,000
Greensville County (inc. Town of Jarratt)	$9,000
Hanover County (inc. Town of Ashland)	$415,000
Henrico County	$1,384,000
City of Hopewell	$37,000
New Kent County	$27,000
City of Petersburg	$74,000
Powhatan County	$136,000
Prince George County	$46,000
City of Richmond	$763,000
Surry County (inc. Town of Surry)	$6,000
Sussex County (inc. Towns of Stony Creek, Wakefield, Waverly)	$11,000
Total	**$4,167,000**

Social Vulnerability

The NRI data for social vulnerability to earthquake are shown in **Figure 5.38**. The map reflects the history of earthquakes in Virginia, with few damages and slightly higher overall vulnerability near the Central Virginia Seismic Zone. There are two areas of relatively moderate social vulnerability in Richmond: the first is the downtown area where 195 and 95 converge; and the other is centered on Carnation Street, north of Midlothian Park and south of Jahnke Road.

Figure 5.38: National Risk Index Rating, Earthquake



Source: National Risk Index, FEMA 2021

Note: The Town of Surry has very low social vulnerability for earthquake.

Future Vulnerability, Land Use and Climate Change

While scientists have observed some correlation between climate change on rising temperatures, melting glaciers and isostatic rebound, a causal connection to subsequent earthquakes is less documented, especially for the eastern United States. Earthquakes and weather have a few *possible* correlations that are still under investigation and should be considered more theoretical than scientific:

1. glacier melt and isostatic rebound causing earthquakes;

2. changing surface stress loads from increased surface water causing microseismicity or tiny earthquakes with magnitudes less than zero, and changes in water quantity stored in large dams inducing seismicity;

3. longer duration droughts and/or groundwater withdrawals that change stress loads on the Earth's crust causing earthquakes; and,

4. injection wells that lubricate faults and induce seismicity.[29]

While it is conceivable that a massive earthquake in the study area or in a large metropolitan area nearby, such as Hampton Roads or northern Virginia, could cause a mass evacuation if damage is severe, this likelihood is not supported by the history of earthquake damage in these regions of Virginia.

5.13 Landslides

Hazard Profile

A landslide is the downslope transport of a mass of soil and rock material and refers to a number of different varieties of ground movement landforms and processes. The primary driving force for a landslide is gravity, but other factors may contribute to the failure of a slope. Landslides are usually triggered by heavy rainfall, rapid snow melt, oversteepening of slopes by stream incision, or earthquakes, while certain man-made changes to the land, such as slope modification or drainage alteration, can greatly increase the likelihood of landslides. Sometimes a landslide may move slowly down a slope, but often the movement can occur without warning and be extremely fast. Soil creep and slumping cause property damage gradually, whereas rockslides and debris flows can sweep away people and property instantaneously. In the United States, landslides annually cause up to $2 billion in damages and take between twenty-five and fifty lives.[30]

Landslides occur in many manifestations and are usually classified according to the type of material involved and the mode of downslope movement. The material can range from loose

[29] Buis, Alan. NASA: Global Climate Change: Vital Signs of the Planet. *Can Climate Affect Earthquakes, or are the Connections Shaky?* Feature dated October 29, 2019, accessed online at: https://climate.nasa.gov/news/2926/can-climate-affect-earthquakes-or-are-the-connections-shaky/

[30] Virginia Department of Energy, accessed online at: https://energy.virginia.gov/geology/Landslides.shtml&sa=D&source=docs&ust=1645377818936537&usg=AOvVaw2DI9rmYtgmQSFtoaok6Sgl

earth to blocks of solid rock. These materials may then move downslope by falling, sliding or flowing. The following are some of the more important types of mass movement:

Rockfalls entail large blocks of bedrock breaking off a cliff face and tumbling downslope;

Rockslides occur when a detached section of bedrock slides down an inclined surface, frequently along a bedding plane;

Earthslides involve masses of soil moving down a slip face, usually on top of the bedrock;

Creep is the slow, continuous, imperceptible downslope movement of soil and rock particles;

Rotational Slides or Slumps result from the rotation of a cohesive unit of soil or rock down a slip surface, leaving a curved scarp; and

Debris flows develop on steep slopes as a result of heavy rainfall that saturates the soil, which under the extra weight and lubrication breaks loose and becomes a slurry that takes everything with it, including large trees and houses. Channeled debris flows can reach speeds approaching a hundred miles an hour and strike without warning.

Landslides are most common in the mountainous terrain of Virginia because of the presence of steep slopes and highly fractured bedrock over shallow soils. The lower-relief areas of the Piedmont and Coastal Plain also have landslides, but they are often smaller and generated by human disturbance, such as making an oversteepened road cut. The most disastrous landslide events have been associated with heavy rainfall along the steep slopes of the Blue Ridge Mountains and the Appalachians. Areas that are prone to mass movement include areas where landslides have occurred in the past; steep slopes with an angle greater than 30 degrees; and oversteepened cuts and fills, particularly due to home and road building. Research in North Carolina has revealed that about fifty-six percent of recent landslides happened on slopes that had been altered in some way by development.

Landslides are capable of destroying buildings, rupturing gas, water, and sewer mains, and knocking out power and telephone lines while blocking transportation routes. Urban development can increase the damages caused by a landslide. Damages sustained by roads and highways during a landslide can result in long-term loss of use of certain transportation routes and contribute to increased traffic and emergency response times in the affected region. The soil movement that occurs during a landslide can destabilize structural supports for pipelines potentially resulting in pipeline ruptures and decreased or loss of service in a region.

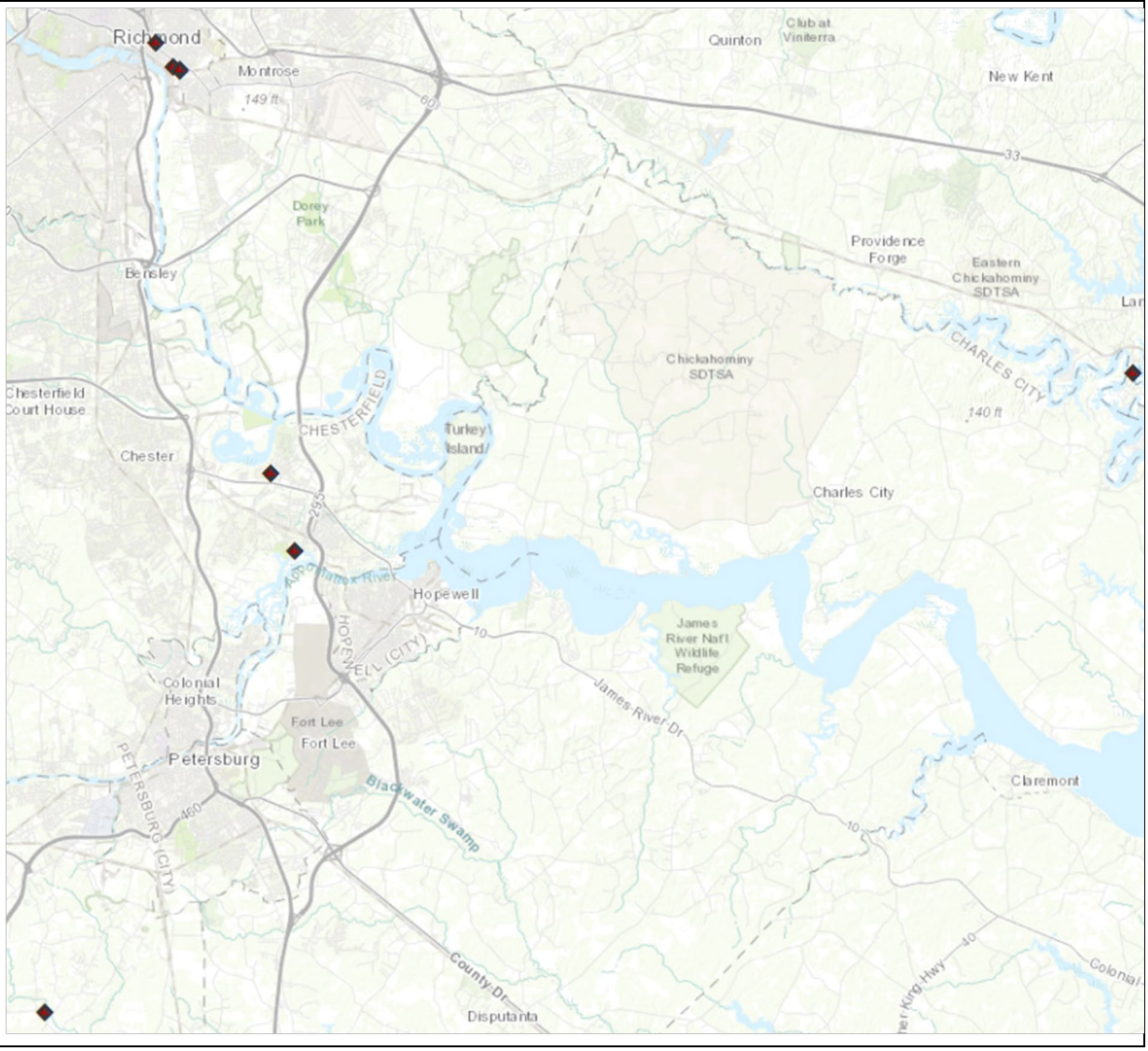
Magnitude or Severity

The severity of a landslide is dependent on many factors including the slope and width of the area involved, the speed of the earth movement, and any structures or infrastructure directly in the path of the slide. Impacts of a landslide can range from a minor inconvenience to a life-threatening situation when automobiles and buildings are involved.

Hazard History

Analysis of the hazards in the Richmond-Crater study area is limited by the availability of data and reporting of incidents; however, scientists at the Virginia Department of Energy maintain a statewide database of landslide locations. **Figure 5.39** shows the locations of landslides since 2004 on a map of the southeastern part of the region where the landslides occurred.

Figure 5.39: Locations of Recorded Landslides, 2004 – 2021



Source: Virginia Department of Energy, 2021

Table 5.37 provides additional detail on the landslides shown above. While details are preliminary, State geologists suggest that evidence shows in the Richmond-Crater and Virginia Peninsula regions, there is a higher incidence of landslide initiation near the

contact between two geological formations, the Eastover and the Yorktown Formations, to pervasive geological units in the Virginia Coastal Plain. Slopes can be further destabilized due to excess runoff from development, including storm water drains and gutters.

Table 5.37: Landslides in Richmond-Crater Area, 2004 - 2021

Jurisdiction	Notes	Movement Date	Noted Impacts, If Any
City of Richmond	Chimborazo Hill Landslide – Translational debris slide was active and very rapid (>3 meters/minute) when observed. May have been active as early as the 1900's; more tension cracks evident in 2011 photography. Groundwater was present soil & bedrock seep.	8/30/2004	Home condemned, park and road severely damaged.
	Chimborazo Hill Landslide photograph, *Virginia Minerals,* VA DMME, Vol. 48, November 2005.		
	This debris flow was rapid (>1.8 meters/hour).	8/30/2004	None reported.
	This debris slide was rapid (>1.8 meters/hour).	8/30/2004	None reported.
	Jefferson Park Landslide	8/30/2004	Covered Marshall Street
Chesterfield County	Homes were built on sand fill used to level a steep bluff that was once the edge of an open cut mine. Landslide is currently inactive. Debris slide was rotational on a cut slope.	1998 and 2016	Landslide is undermining foundations of houses.
	Large rotational slide in sandy sediment. Lower portions have scarping of up to 6 feet. Back rotated trees in slide. Slide likely undermined by stream. Sliding surface may be 1-3 foot thick clay lens within Cretaceous. Across from slide, clay lens is exposed in bank and groundwater noted at base of clay.	Not available	Damaged a walking trail.
Dinwiddie County	This debris slide was rotational.	Not available	Unverified

New Kent County	Claytor Landslide - homeowner says movement started during Hurricane Irene (2011). Headscarp is 5 feet from porch steps, two 10-foot sections of seawall at base of slope have been either toppled or covered by sediment from previous landslides. This is a series of concave erosional scarps along the riverbank.	2011 and March 5, 2019	Most recent scarp is threatening house.
	Translational debris slide in New Kent County, VA DMME, 2021.		

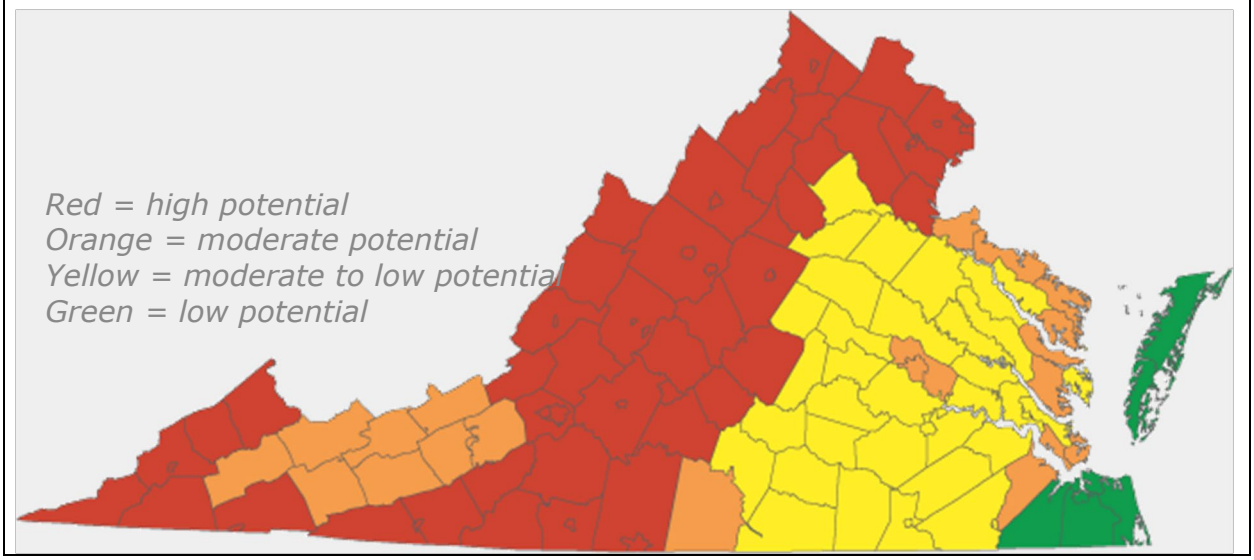
Source: Virginia Department of Energy, 2021

Local officials from the City of Richmond reported that a number of areas in the city were affected by landslides triggered by the rains of Tropical Storm Gaston in August 2004. The Church Hill and Riverside Drive sections of Richmond experienced 14 inches of rain in eight hours. Church Hill features unstable geologic formations which were destabilized by the heavy rainfall. One home in Church Hill was severely impacted by the Chimborazo Hill Landslide and was ultimately condemned and purchased by the City. Nearby tennis courts were also impacted. The Riverside Drive area features steep embankments along the south shore of the James River and abandoned granite quarries. During Gaston localized landslides also occurred near Forest Hill Park.

Vulnerability Analysis

Landslide events in the region are considered a low-probability event, with very localized impacts when and where they occur. The Virginia Department of Energy provided the map in **Figure 5.40** that shows counties in Virginia and related susceptibility to landslides. Because damages are rarely quantified or are extremely limited in nature, average annual damages from landslides are not very useful. Occurrence intervals are similarly flawed because of the short period of record. The Commonwealth's highest regional vulnerability is in the mountainous region west of this plan's study area. With the exception of the City of Richmond and Henrico County, the Richmond-Crater region is classified as having moderate to low potential for landslide. Richmond and Henrico County are classified as having moderate potential.

Figure 5.40: Susceptibility to Landslides by Virginia County/City

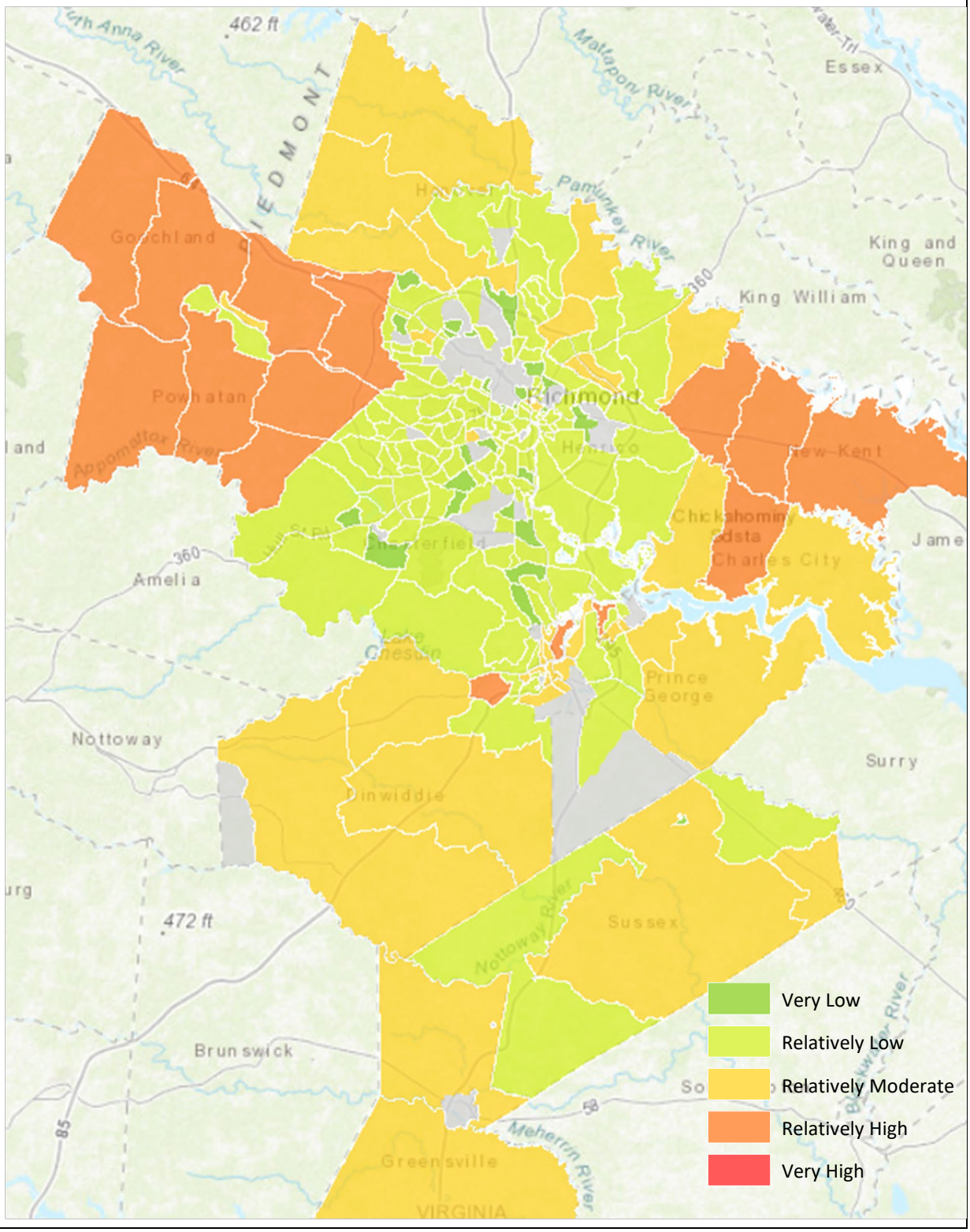


Source: Virginia Department of Energy, provided 2021

Social Vulnerability

The NRI data for social vulnerability to landslides are shown in **Figure 5.41**. The USGS Landslide Hazard Map was used as an input for hazard susceptibility, creating a raster that classified all of the conterminous United States as having either "some" or "negligible" landslide susceptibility based on slope and relief. This method may not adequately capture the unique geological conditions that are suspected as contributors to landslides in the study region. Nevertheless, the social vulnerability shown in Figure 5.41 is a starting point for discussions regarding factors that could affect a household's vulnerability to landslide.

Figure 5.41: National Risk Index for Landslide



Source: National Risk Index, FEMA 2021

Note: The Town of Surry has relatively moderate social vulnerability for landslide south of Route 10, and relatively high social vulnerability for landslide north of Route 10.

Future Vulnerability, Land Use and Climate Change

As noted in the previous section, landslides have occurred in the City of Richmond following periods of heavy precipitation but have generally been limited in geographic scope and/or damage extent. The primary area of concern noted by city officials is Government Road.

Current building code requirements restrict fill materials used to fill a building site prior to new construction; however, homes built on debris fill, or on oversteepened slopes (such as along a river bluff) may be more vulnerable to landslides in the future, especially on or near slopes near the contact between the Yorktown and Eastover convergence. The Virginia Department of Energy is interested in identifying and mapping at-risk areas in the region.

Climate change has the potential to worsen the risk associated with landslides in the study area. Precipitation patterns are expected to become more intense, prolonged and frequent as a result of a warming climate. There is a risk that these precipitation events could destabilize fragile slopes in the region, leading to more frequent and damaging landslides.

Based on the hazard's history in the region, mass evacuations caused by landslides are not expected.

5.14 Shoreline Erosion

Hazard Profile

Shoreline or coastal erosion is a process whereby large storms, flooding, strong wave action, sea level rise, and human activities, such as inappropriate land use, alterations, and shore protection structures, wear away beaches, banks and bluffs. Erosion undermines banks and can destroys homes, businesses, and public infrastructure.

Magnitude or Severity

The extent or severity of erosion may vary from year to year and is related to a number of factors: composition of the shoreline (rock, sand, clay, marsh, or human-made structures), fetch, orientation to prevailing wind direction, and relative sea level rise. The degree of recession at a particular site may also be dependent upon intensity of the wave action and exposure to tidal currents, character of the sediments and degree of vegetative cover, supply of sand moving along the shoreline, gradient or slope from fastland to shoreline to nearshore bottom.

While coastal erosion can destroy infrastructure like roads, septic tanks, and even structures such as homes and businesses, the most common damage in the Richmond-Crater region is loss of trees, denuded shores, wetland loss and sediment introduced into the Chesapeake Bay system.

While tidal surge events can cause nominal increases in the rate of erosion, large-scale storm events generating an extensive surge will cause a rapid acceleration in coastal erosion rates. Accelerated erosion in areas with no natural or man-made protective features

is more likely to increase severe impacts to infrastructure. Through loss of land and undercutting, infrastructure such as pipelines, piers, roadways, and other structures can be significantly damaged or destroyed.

Hazard History

The shoreline areas of the region are consistently undergoing coastal erosion. However, severe storms that increase wave activity (hurricanes, tropical storms, and nor'easters), sea level rise, and shoreline development can increase both short-term and long-term erosion along the region's shorelines. The banks of the James River have historically experienced varying rates of shoreline erosion from storm events and that change has been studied over time, particularly for Prince George, Charles City and Surry Counties.

The *Prince George County Shoreline Management Plan*[31], prepared by the Virginia Institute of Marine Science (VIMS) at the College of William & Mary in November 2016, breaks the county's portion of the James River into four reaches. Researchers calculated End Point Rate (EPR) by determining the distance between the oldest and most recent shoreline in the data and dividing it by the number of years between them. This method provides an accurate net rate of change over the long term and is relatively easy to apply to most shorelines since it only requires two dates. This method does not, however, use the intervening shorelines so it may not account for changes in accretion or erosion rates that may occur through time. The study documented very low erosion to very low accretion for the four reaches in Prince George County as shown in **Table 5.38**. The shoreline management plan concluded that "nearly 75% of the shoreline in Prince George County can be managed simply by enhancing the riparian buffer or the marsh if present."

The *Charles City County Shoreline Management Plan*[32], similarly prepared by VIMS in February 2015, concluded that "nearly 85% of the county's shoreline could be managed by enhancing the riparian buffer or marsh if present."

VIMS prepared *Shoreline Evolution: Surry County, Virginia James River Shorelines Data Summary Report*[33] in September 2011, which provides rates of shoreline change for the reaches shown in Table 5.38. Hog Island shoreline has the highest rates of documented change in the study area.

While VIMS has collected data regarding shoreline condition for other counties in the study area, they have not calculated rates of shoreline change or prepared shoreline management plans. **Figure 5.42** graphically shows shoreline change data compiled by VIMS for the 1937/38 shoreline, the 2009 shoreline and the 2017 shoreline. Areas showing a significant difference between the shorelines of the past and the present indicate areas of historic erosion. The map viewer online can be used to zoom in on areas of interest at:

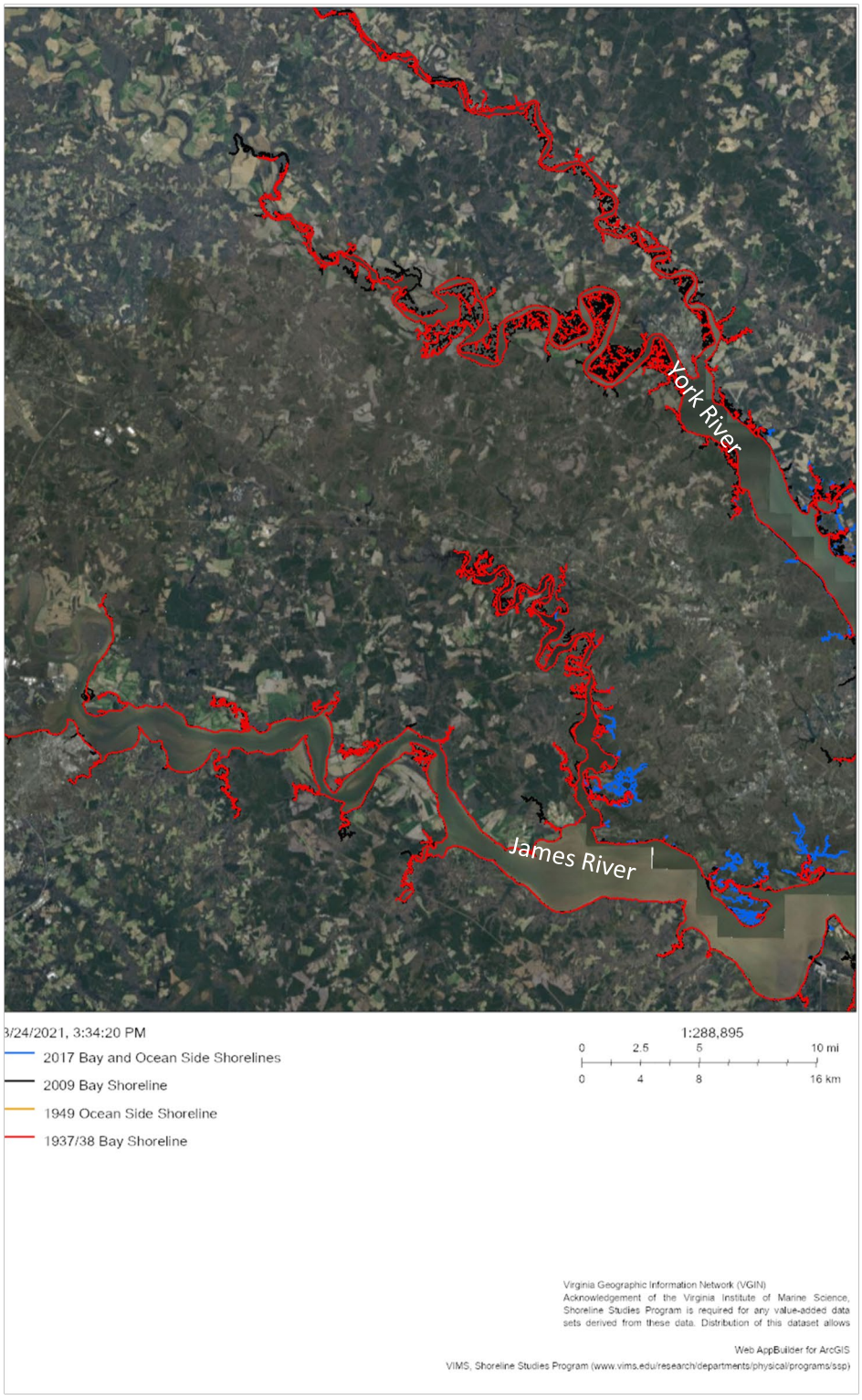
[31] Accessible online at: https://www.vims.edu/research/departments/physical/programs/ssp/_docs/PrinceGeorge_Shore%20Man_2016-lr.pdf
[32] Accessible online at: https://scholarworks.wm.edu/cgi/viewcontent.cgi?article=1255&context=reports
[33] https://scholarworks.wm.edu/cgi/viewcontent.cgi?article=1575&context=reports

https://www.vims.edu/research/departments/physical/programs/ssp/shoreline_evolution/gis_maps/index.php.

Table 5.38: Rates of Shoreline Change in the Richmond-Crater Region (1937 – 2009)			
Jurisdiction	**Reach Name**	**Average End Point Rate of Change (Ft/Yr)**	**Category**
Prince George County	Reach 1: Appomattox River – Harrison Creek to James River	-0.4	Very Low Erosion
	Reach 2: James River – City Point to Coggins Point	0.0	Very Low Accretion
	Reach 3: James River – Coggins Point to Windmill Point	-0.1	Very Low Erosion
	Reach 4: James River – Windmill Point to Kennon Marsh	-0.4	Very Low Erosion
	Reach 5: James River – Kennon Marsh to Upper Chippokes Creek	-0.4	Very Low Erosion
	Reach 6: Upper Chippokes Creek	-0.8	Very Low Erosion
Charles City County	James River Turkey Island Creek to Epps Island	-0.1	Very Low Erosion
	James River Epps Island to Herring Creek	-0.3	Very Low Erosion
	Herring Creek	-0.4	Very Low Erosion
	James River Herring Creek to Queens Creek	-0.5	Very Low Erosion
	Queens Creek	-0.3	Very Low Erosion
	James River Queens Creek to Kennon Creek	-0.4	Very Low Erosion
	James River Kennon Creek to Tomahund Creek	-0.1	Very Low Erosion
	Chickahominy River	-0.6	Very Low Erosion
Surry County	A - Upper Chippokes Creek	-1.4	Not classified
	B - James River	0.0	
	C – James River	-0.1	
	D – James River	-0.6	
	E – Swanns Point	-0.6	
	F – Grays Creek	-0.7	
	G - James River	-0.1	
	H – James River	0.2	

Table 5.38: Rates of Shoreline Change in the Richmond-Crater Region (1937 – 2009)			
Jurisdiction	**Reach Name**	**Average End Point Rate of Change (Ft/Yr)**	**Category**
	I – James River, Cobham Bay	0.0	
	J – James River	-0.4	
	K – James River, Hog Island	-1.8	
	L – James River, Hog Island	-1.2	
	M – James River	-1.1	
	N – Lawnes Creek	-0.7	
Source: VIMS, Center for Coastal Resources Management, Virginia's Coastal Zone Locality Portals and individual Shoreline Management Plans, accessed online at: https://www.vims.edu/ccrm/ccrmp/portals/index.php			

Figure 5.42: Regional Shoreline Change, 1937/38 - 2017



Source: VIMS, 2021

Vulnerability Analysis

Shoreline erosion is likely to continue along some of the region's shorelines, especially in areas that have experienced historic erosion as shown in the figure above. In addition, the condition of the shoreline, wave climate, tide range, storm surge occurrence and rates of sea level rise are all factors in determining vulnerability of shoreline reaches to future erosion. Shorelines without best management practices (BMPs) for protection such as groin fields, healthy marshes, living shorelines or revetments may be more vulnerable, and shorelines with nearby buildings are of highest importance for mitigation. VIMS provides a Shoreline Assessment Mapper that displays site-specific coastal resource data across the coastal plain portion of the study area: http://cmap2.vims.edu/SAM/ShorelineAssessmentMapper.html

VIMS provides a site-specific set of BMPs throughout the study region, specifically for property owners interested in improving their shoreline's resistance to the damaging effects of erosion. The self-guided decision tools are interactive and lead users through questions about shoreline conditions to help choose the most effective erosion control strategies based on surrounding shoreline conditions. Access the main tool online at: https://cmap2.vims.edu/LivingShoreline/DecisionSupportTool/ShorelineDST.html

Social Vulnerability

Any measurement of social vulnerability to shoreline or coastal erosion requires considerably more knowledge about the location of vulnerable structures in each locality. Mitigation Action MH-4 in the 2018 Commonwealth of Virginia Hazard Mitigation Plan proposes VDEM involvement in assisting localities, state agencies, and PDCs with identification of vulnerable structures and application for funding to implement soil stabilization projects to reduce risk to structures or infrastructure from erosion. Future revisions to the plan may be able to more precisely define socially vulnerable areas of the study region for shoreline or coastal erosion using information developed under this or a similar effort.

Future Vulnerability, Land Use and Climate Change

The Commonwealth's Stormwater Management program and enabling statutes help to manage future land use, and reduce stream channel erosion, water pollution, depletion of groundwater resources and more frequent localized flooding to protect property value and natural resources throughout the region.

While waves are the primary force in determining the prevailing shoreline processes in the short-term of months or individual storms, sea level rise is the primary driver of shoreline change over the long-term. Documented sea level rise in the study area is expected to accelerate and will continue to impact shoreline morphology in the future. Shoreline management plans cited above contain recommended projects and conceptual designs for erosion mitigation.

Shoreline or coastal erosion are not expected to contribute to a mass evacuation for the study area or surrounding areas.

5.15 Sinkholes

Hazard Profile

Sinkholes are basin-like, funnel-shaped, or vertical-sided depressions in the land surface. In Virginia, the formation and modification of sinkholes is a natural process in areas underlain by limestone and other soluble rock. In general, sinkholes form by the subsidence of unconsolidated materials or soils into voids created by the dissolution of the underlying soluble bedrock. The rock exposed in a collapsed sinkhole is usually weathered and rounded, but some sinkholes contain freshly broken rock along their steep sides. Freshly broken rock may indicate that the sinkhole has formed by the collapse of a cave (naturally occurring) or a mine (man-made). Where sinkholes and caves have formed by the dissolution of soluble rock, such as limestone, dolomite, and gypsum, surface water is uncommon, and streams may sink into the ground. This type of topography is referred to as karst terrain. In karst terrain, sinkholes are input points where surface water enters the groundwater system. Signs of karst-related sinkhole formation may include:

- Slumping or falling fence posts;
- Wilting vegetation;
- Discolored well water;
- Structural cracks in walls, floors or foundations; and
- Cracks in soil/subsidence.

There are three types of potential problems associated with the existence or formation of sinkholes: subsidence (including catastrophic collapse and damage to infrastructure), flooding, and pollution. Sinkholes are the result of differential subsidence of the land surface. The term subsidence is commonly used to imply a gradual sinking, but it also can refer to an instantaneous or catastrophic collapse.

The location and rate at which sinkholes form can be affected by human activities. Sinkholes result from various mechanisms, including consolidation from loading, consolidation from dewatering, hydraulic compaction, settling as materials are removed by groundwater flow, raveling of materials into a void, and instantaneous collapse into a void. Although the formation of sinkholes is a natural process in karst terrains, man-made modifications to the hydrology of these areas commonly results in the acceleration of this process. The lowering of the water table in unconsolidated materials or soils, especially near the soil-bedrock interface, can result in the draining of voids caused by the dissolution of bedrock or the removal of soil by groundwater flow.

Patterns of pumping from high-yield wells over extended periods of time can result in large, rapid drawdowns of the water table. Where such drawdowns occur in unconsolidated materials, sinkhole collapse can be catastrophic, and subsidence can be extensive over the area subject to the drawdown. Disposal of stormwater in sinkholes or shallow dry wells can induce subsidence. The collapse of soil or rock above a void created by underground mining activities is another mode of sinkhole formation.

Sinkhole flooding can develop from a number of natural conditions, but two man-made conditions are the most common causes in Virginia: the plugging of natural sinkhole drains by sediment, and the overwhelming of natural sinkhole drains by increases in runoff from impermeable surfaces. Inadequate erosion control during construction can result in the plugging of natural sinkhole drains by sediment-laden runoff. The accompanying restriction of subsurface drainage causes an increase in ponding or flooding. Increased runoff from roads, parking lots, and structures is the most significant cause of sinkhole flooding. Much of the precipitation that would have percolated through a vegetated soil cover is introduced rapidly into surface and subsurface (input through sinkholes) drainage networks.

The potential impacts of land subsidence depend on the type of subsidence that occurs (regional or localized, gradual or sudden) and the location in which the subsidence occurs. The impacts of subsidence occurring in non-urban areas are likely to be less damaging than subsidence that occurs in heavily populated locations. The amount of structural damage depends on the type of construction, the structure location and orientation with respect to the subsidence location, and the characteristics of the subsidence event (sag or pit).

Potential impacts from land subsidence could include damage to residential, commercial, and industrial structures; damage to underground and above-ground utilities; damage to transportation infrastructure, including roads, bridges, and railroad tracks; as well as damage to or loss of crops.

Magnitude or Severity

Depending on size, sinkholes can cause damage to bridges, roads, railroads, storm drains, sanitary sewers, canals, levees, and private and public buildings. Karst topography can impact aquifers, introducing the potential for groundwater contamination. The greatest impact occurs when polluted surface waters enter karst aquifers. This problem is universal among all populated areas located in karst terrain. The groundwater problems associated with karst can be accelerated by: (1) expanding urbanization, (2) misuse and improper disposal of environmentally hazardous chemicals, (3) shortage of suitable repositories for toxic waste (both household and industrial), and (4) ineffective public education on waste disposal and the sensitivity of the karstic groundwater system.

Mine collapses have resulted in losses of homes, roadways, utilities, and other infrastructure. Subsidence is often exacerbated by the extensive pumping of groundwater associated with underground mining. Abandoned coal mines occur in Henrico, Chesterfield, and Goochland Counties in the Richmond coal basin.[34]

In addition to areas of karst and underground or abandoned mine sites, aging or crumbling infrastructure is another potential source of sudden sinkholes. This can occur anywhere, and magnitude and severity are difficult to predict because each case is unique and based on the site-specific conditions of the soil, groundwater, infrastructure and other factors.

[34] For additional information, see: https://energy.virginia.gov/coal/mined-land-repurposing/Abandoned-Mine-Land.shtml&sa=D&source=docs&ust=1645377818936136&usg=AOvVaw1d-de58AG4LD6i_gLTSbss

Hazard History

Dramatic collapses of land that swallow homes or persons have happened in Virginia but are generally rare. According to the *2018 Virginia State Hazard Mitigation Plan*, there have been no Federally-declared disasters or NCEI recorded events for karst-related events in the Commonwealth. Land subsidence is very site-specific. A comprehensive long-term record of past events in Virginia is not available; however, several documented occurrences are included in **Table 5.39**.

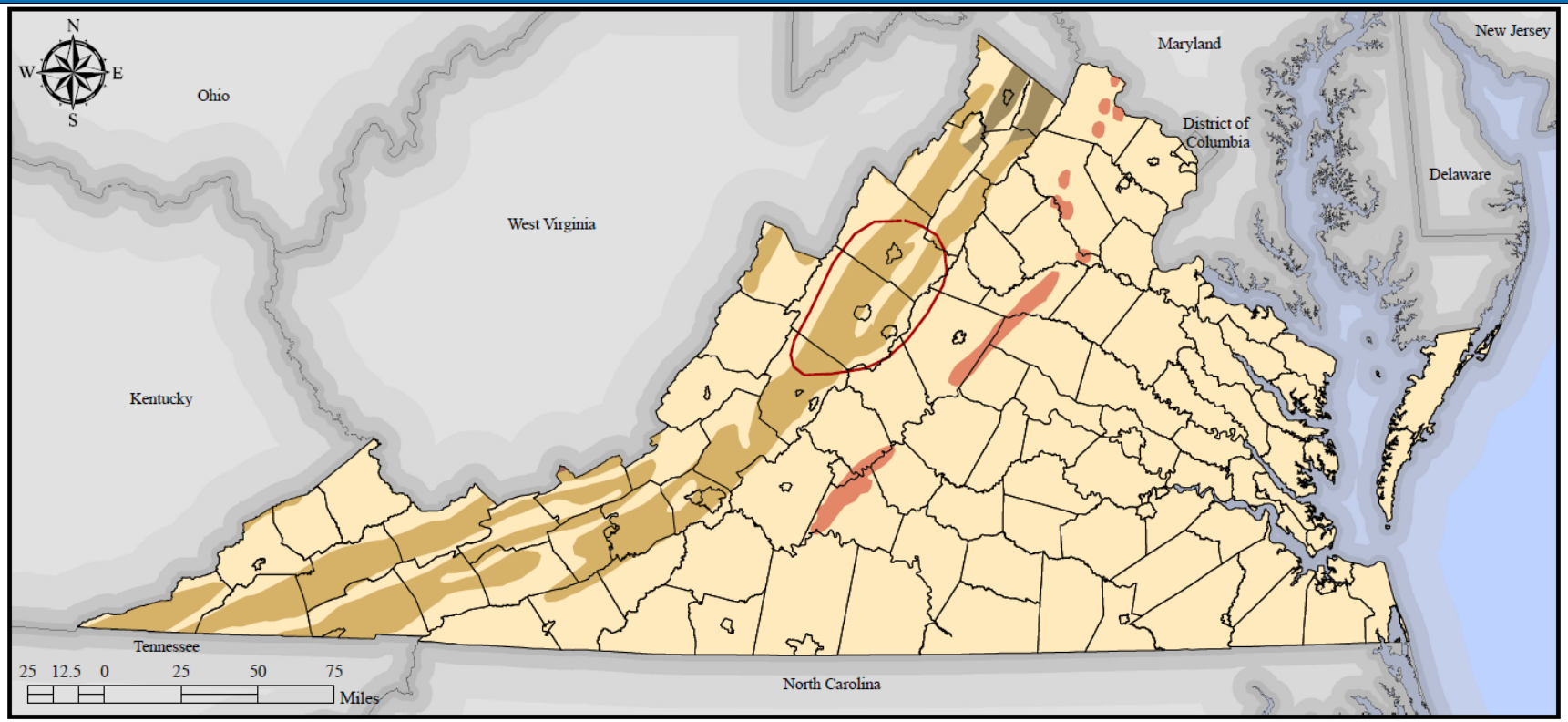
Table 5.39: Notable Sinkholes, 2010 – 2020

Date	Damages
December 2008	**Chesterfield County:** Sinkholes discovered at a home off Coalboro Road were declared an emergency by DMME and suspected to be part of the Richmond Coalfield Mine. Source: NBC12 On Your Side online.
January 4, 2010	**City of Richmond:** The ramp from I-95 North to Broad Street in downtown Richmond was closed because of a sinkhole. Reports say that what started as a pothole quickly became a gaping hole in which the ground collapsed, with about 5 feet of earth underneath it washed away. Source: WWBT-TV NBC 12
August 2010	**Chesterfield County:** Sinkholes in the Scottingham neighborhood were reported around storm drain infrastructure. Source: WWBT-TV NBC 12
March 2011	**City of Richmond:** A sinkhole closed the intersection of Grove and Stafford Avenues in Richmond. Source: *Richmond Times-Dispatch*
September 5, 2012	**Chesterfield County:** VDOT closed part of State Route 10 near Rivers Bend for an extended period because of a sinkhole. Source: *Richmond Times-Dispatch* online
April 17, 2017	**Henrico County:** A sinkhole on a baseball field near Holman Middle School in Glen Allen caused the field to be closed for repairs for a short time. Source: WRIC 8News online
~ January 2018	**Henrico County:** Sinkhole opened up and slowly increased in size, behind a new residential structure. Sinkhole had standing water after precipitation. Source: WTVR Ch 6 online.
June 2018	**Richmond:** Sinkholes reported at Hull & 19th St, 35th & East Marshall St, and North 22nd St (utility issue). Source: WRIC news online.
May 7, 2019	**Henrico County:** A deep sinkhole opened in a residential backyard, threatening the oil tank and structure. Water could be heard at the bottom of the hole. County speculated it could be an abandoned septic system. Source: WTVR CBS 6 online.
September 2019	**Henrico County:** A family was forced to move out of their condo when a sinkhole opened up and threatened to collapse the building's foundation. Source: https://independentamericancommunities.com/2019/09/17/no-word-on-what-caused-hole-beneath-henrico-county-condo/
October 21, 2019	**Henrico County:** A water main break caused a sinkhole to form that covered an entire lane of unspecified roadway. Source: WBAL TV11 online.

Vulnerability Analysis

In Virginia, the principal area affected by sinkholes is the Valley and Ridge province, an extensive karst terrain underlain by limestone and dolomite, but the narrow marble belts in the Piedmont and some shelly beds in the Coastal Plain are also pocked with sinkholes. A majority of the karst regions in Virginia follow Interstate-81, as seen in **Figure 5.43**.

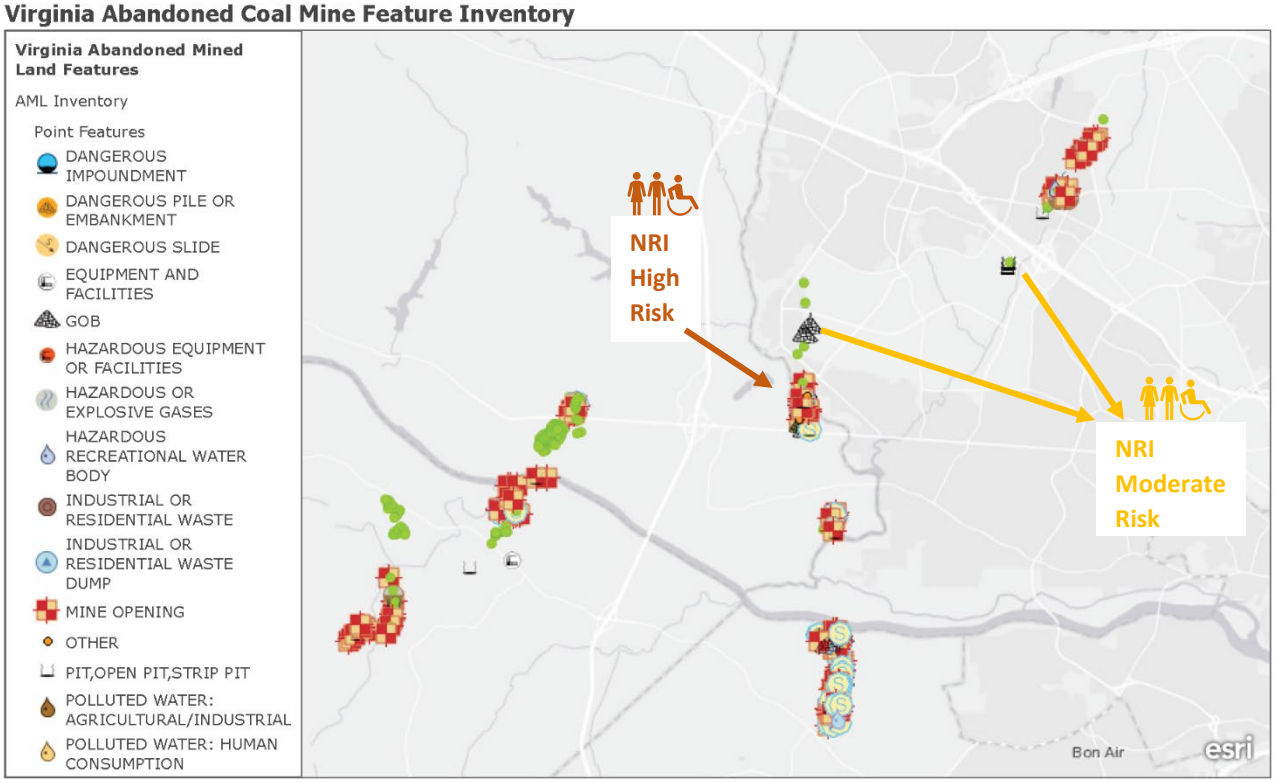
Figure 5.43: Karst Areas in the Commonwealth of Virginia



Source: 2013 Virginia State Hazard Mitigation Plan

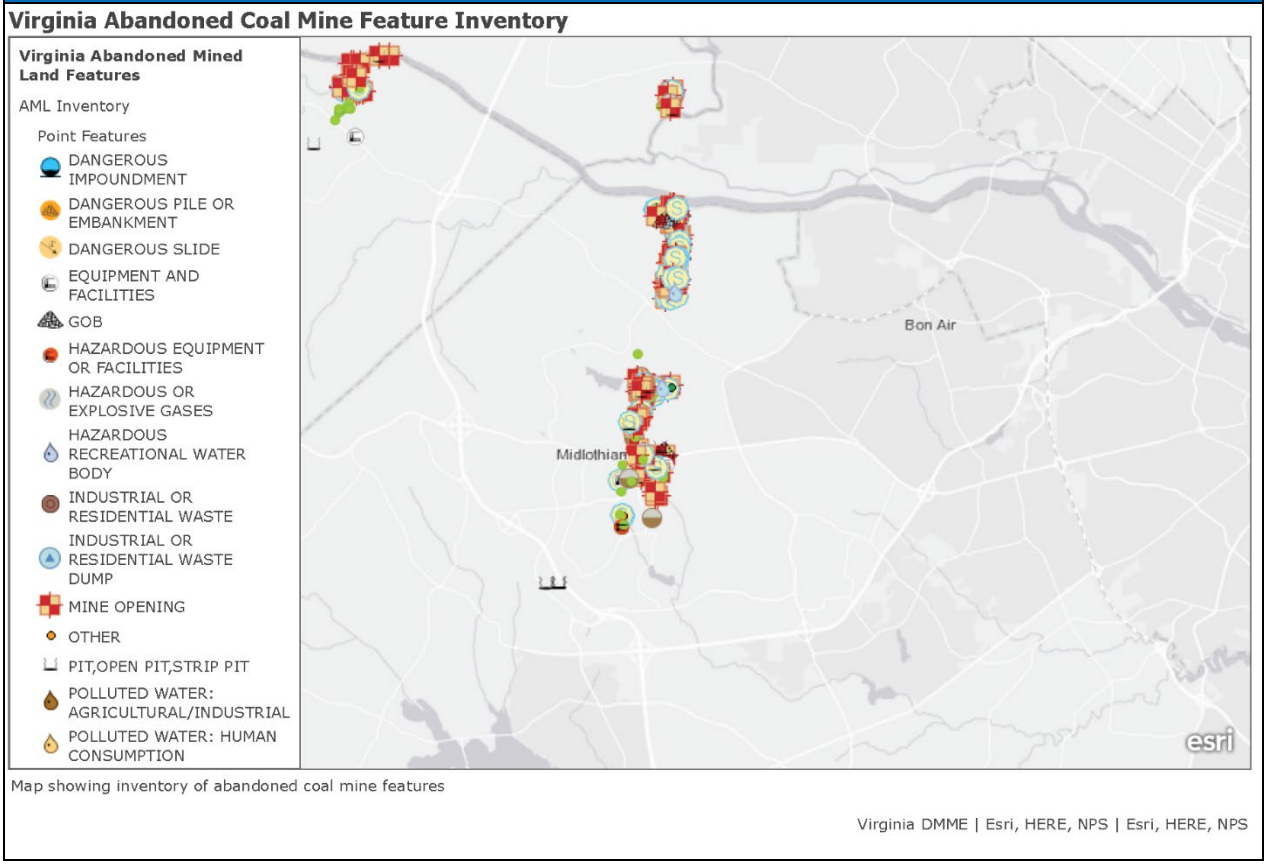
Abandoned coal mines are present in the Richmond-Crater region and, as stated previously, areas over underground mine workings are susceptible to sinkhole formation. Maps of abandoned coal mine features in the region are shown in **Figures 5.44a through 5.44c,** courtesy of the Virginia Department of Energy. For site specific information, go to: https://vadmme.maps.arcgis.com/home/index.html.

Figure 5.44a: Abandoned Coal Mine Features, James River Northwest of Richmond



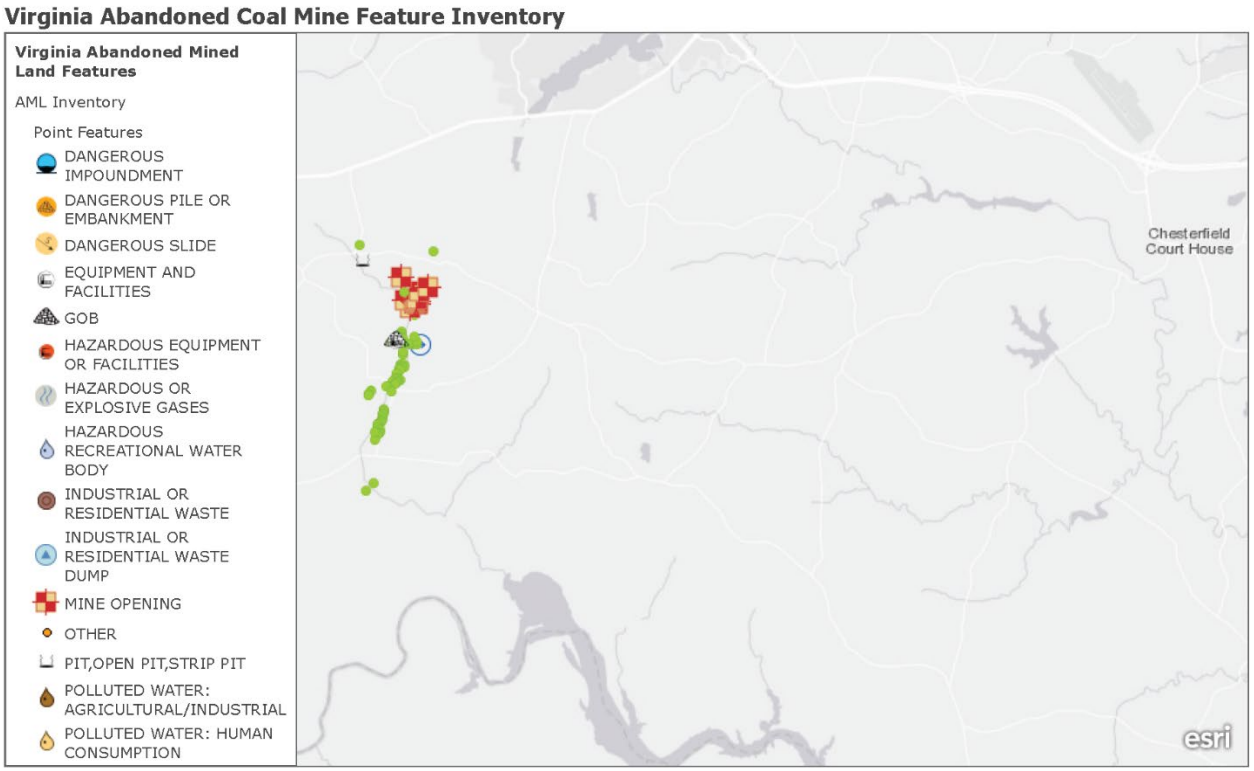
Source: Virginia Department of Energy, 2021

Figure 5.44b: Abandoned Coal Mine Features, James River, West of Richmond



Source: Virginia Department of Energy, 2021

Figure 5.44c: Abandoned Coal Mine Features, Chesterfield County



Source: Virginia Department of Energy, 2021

Existing soil types in the region are not generally conducive to creating natural sinkholes. There are no known sources of data for determining relative sinkhole probability within the region, except for the maps in Figures 5.44a through 5.44c above. Based on previous instances, likely the result of aging infrastructure, and the fact that abandoned mines exist, there is at least a low probability of future sinkhole occurrences in the region.

Limited data prevent a detailed vulnerability analysis at the jurisdictional level. Those jurisdictions with underground infrastructure in need of replacement or repair and those sitting on top of abandoned mine locations are at an elevated risk from sinkholes as compared to those without such risk factors. Potential damage and loss due to sinkholes or land subsidence is nearly impossible to assess because the nature of the damage is site- and event-specific.

Social Vulnerability

Locations of abandoned coal mine features in the study area were compared to the NRI baseline social vulnerability map to determine if any areas of moderate or high social vulnerability coincided with areas at risk of sinkholes. Figure 5.44a above shows the only areas identified as having elevated vulnerability. The areas with moderate and high social

vulnerability that correlate with mine features are all in or near retirement, independent or assisted living facilities in Henrico County: Hermitage at Cedarfield, Gayton Terrace Assisted Living, Lynmoore, and Lakewood Manor Independent Living.

Future Vulnerability, Land Use and Climate Change

As noted in the previous section, sinkholes have occurred in the Richmond-Crater region, often following periods of heavy precipitation. The phenomena are generally limited in geographic scope and/or damage extent.

Climate change has the potential to worsen the risk associated with sinkholes in the study area. Precipitation patterns are expected to become more intense, prolonged and frequent as a result of a warming climate. More severe precipitation events may accelerate the relevant factors in sinkhole formation for the region (*e.g.,* dissolution of overlying sediments or rock, differential subsidence, vulnerability of aging infrastructure), possibly leading to more frequent and damaging sinkholes.

Based on the hazard's history in the region, mass evacuations caused by sinkholes are not expected.

5.16 Radon Exposure

Hazard Profile

Radon is a colorless, odorless naturally occurring gas that forms by the radioactive decay of uranium, thorium, or radium, found in certain types of rocks, soil, and groundwater. Radon is found naturally in the atmosphere in trace amounts, where it disperses rapidly and is generally not a health issue. Radon exposure becomes dangerous in confined areas, where the gas can accumulate, and the inert gas can be inhaled into the lungs where it adheres to lung tissue.

Under the earth's surface, radon may be transported as a soil gas or dissolved in ground water. It can enter a building via cracks in solid floors, construction joints, cracks in walls, gaps in suspended floors, gaps around service pipes and drains, cavities inside walls or through the water supply. Well water used for bathing or washing can potentially carry radon, especially if faucets are aerated. Due to less ventilation, radon concentrations in buildings are typically higher in the winter. Any home, school or workplace may have a radon problem, whether it is new or old, well-sealed or drafty, or with or without a basement. The EPA estimates that nearly one out of every 15 homes in the U.S. has elevated annual average levels of indoor radon,[35] and that nearly one in five schoolrooms has a short-term radon level above the actionable level.[36]

The concentration of radon in buildings is highly variable and is based on the underlying rocks or sediments, weather and construction methods. The amount of radon emitted by a particular soil is controlled by the underlying rock type, the concentration of uranium,

[35] *US EPA's Map of Radon Zones, Virginia.* Radon Division, Office of Radiation and Indoor Air, September 1993.
[36] US EPA Radon in Schools, accessed 4/23/21 online at: https://www.epa.gov/radon/radon-schools

thorium, or radium in the rock or sediment, and the permeability of the rock, sediment and soil. [37]

Magnitude or Severity

The EPA recommends taking action to reduce radon in homes, schools or other buildings that have a radon level at or above 4 picocuries per liter (pCi/L) of air (a "picocurie" is a common unit for measuring the amount of radioactivity). That level of risk is more than 10 times the average outdoor level, more than receiving the equivalent radiation of 200 chest x-rays per year, and almost five times the average non-smoker's risk. A radon level of 40 pCi/L is more than the risk of a 2 pack-a-day smoker.

The EPA indicates that radon is estimated to cause about 21,000 lung cancer deaths per year in the United States.[38] When a person breathes in radon, radioactive particles from radon gas can get trapped in the lungs, emitting radiation. Over time, these radioactive particles increase the risk of lung cancer. People who smoke and are exposed to radon are at a greater risk of developing lung cancer. Damage may be undetected for years before health problems appear.

The chances of getting lung cancer from radon depend primarily on:

- How much radon is in one's home–the location where you spend most of your time (e.g., the main living and sleeping areas);
- The amount of time spent in the home;
- Whether one is a smoker or has ever smoked;
- Whether one burns wood, coal, or other substances that add particles to the indoor air; and
- Combinations of these factors that multiply the impacts.

Lung cancer may start with a nagging cough, shortness of breath or wheezing. Other symptoms such as coughing up blood, chest pain or weight loss may also present. There are no medical tests to test the body for radon exposure, but doctors can check for signs of lung cancer and homes can be easily tested for radon levels.

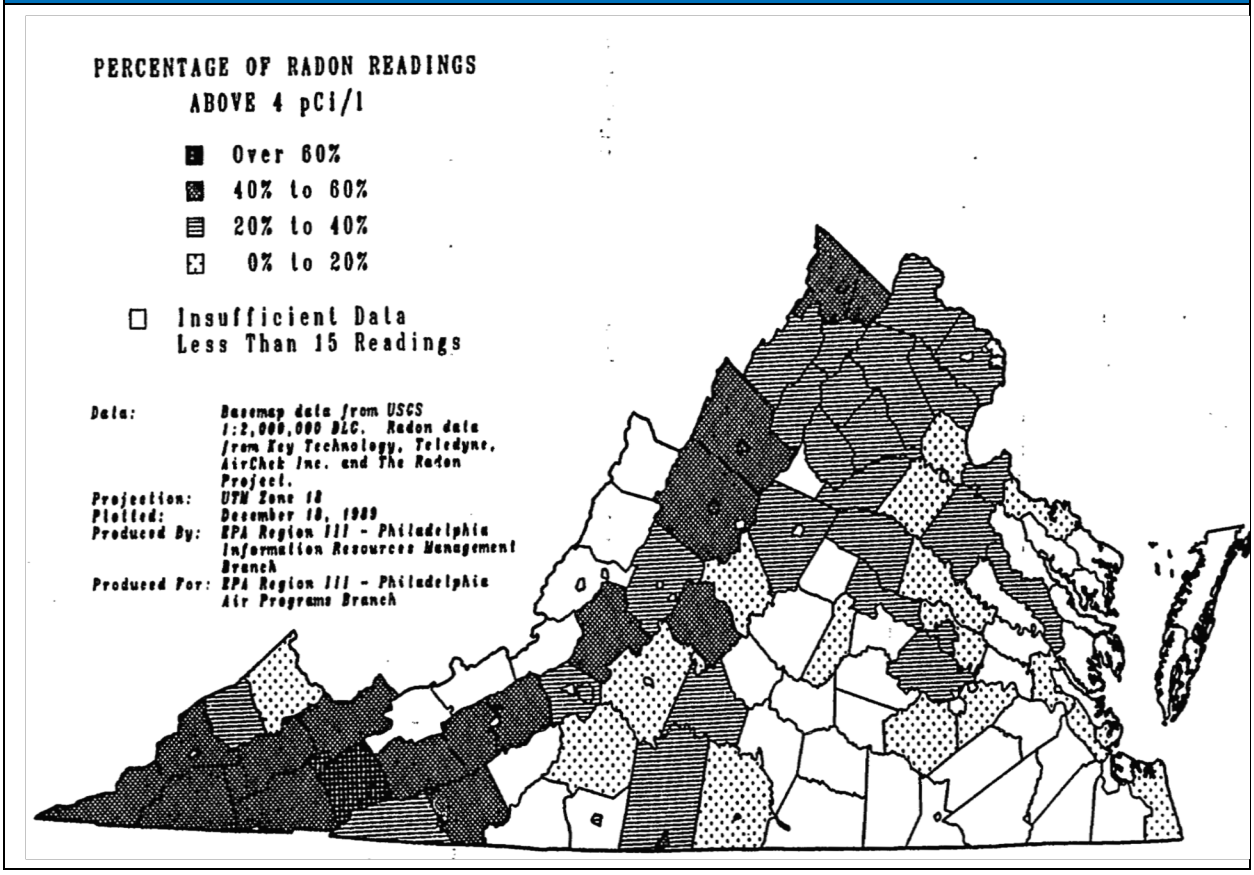
Hazard History

Radon exposure from ground sources happens over a long period of time, often remaining undetected, thus historical "events" are rarely quantifiable. Section 307 and 209 of the 1988 Indoor Radon Abatement Act directed the EPA to identify areas of the United States that have the potential to produce elevated levels of radon. As part of this study, two data sources were analyzed in Virginia: 1) indoor radon data from 1,156 random homes were sampled in the winter of 1991-1992 (results shown in **Table 5.40**); and 2) non-random commercial data compiled by EPA Region 3 were examined as shown in **Figure 5.45**. Additional data from 1990-2017 from a private vendor, Air Chek, are also included in Table

[37] Born, Rebecca Skye. *Radon in Yorktown Formation Sediments and Petersburg Granite, Eastern Virginia.* Undergraduate Thesis, College of William & Mary, April 1994.
[38] US EPA, *A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon,* EPA 402/K-12/002, 2016.

5.40 for jurisdictions with more than 50 test results. Alpha-Energy Laboratories non-random data from the region since 2001 are also included in Table 5.40.

Figure 5.45: Vendor Screening, Indoor Radon Data for Virginia



Source: US EPA's Map of Radon Zones, Virginia. Radon Division, Office of Radiation and Indoor Air, September 1993.

Table 5.40: Screening Indoor Radon Data											
Jurisdiction	**1991-1992, Residential**				**1990-2017, Air Chek**			**Alpha Energy Laboratories January 2001 to June 2020**			
	Number of Tests	**Mean (pCi/L)**	**% >4 pCi/L**	**%>20 pCi/L**	**Number of Tests**	**Mean (pCi/L)**	**% ≥4 pCi/L**	**Number of Tests**	**Mean (pCi/L)**	**% >4 pCi/L**	**%>10 pCi/L**
Charles City County	1	1.1	0	0				6	1.08	0	0
Chesterfield County	59	3.1	17	3	1,319	3.5	26	2089	4.13	18.0	8.8
City of Colonial Heights	5	2.4	20	0				33	3.29	21.2	6.1
Dinwiddie County	6	13.9	17	17				38	4.07	21.1	15.8
City of Emporia	2	0.5	0	0				None reported	n/a	n/a	n/a
Goochland County	3	3.1	33	0				285	3.51	23.2	6.0
Greensville County	2	0.5	0	0				16	1.60	6.3	0
Hanover County	13	0.9	0	0	195	4.9	19	327	2.37	17.1	1.2
Henrico County	30	1.7	7	0				1544	3.23	15.2	5.7
City of Hopewell	5	0.6	0	0				29	3.01	13.8	6.9

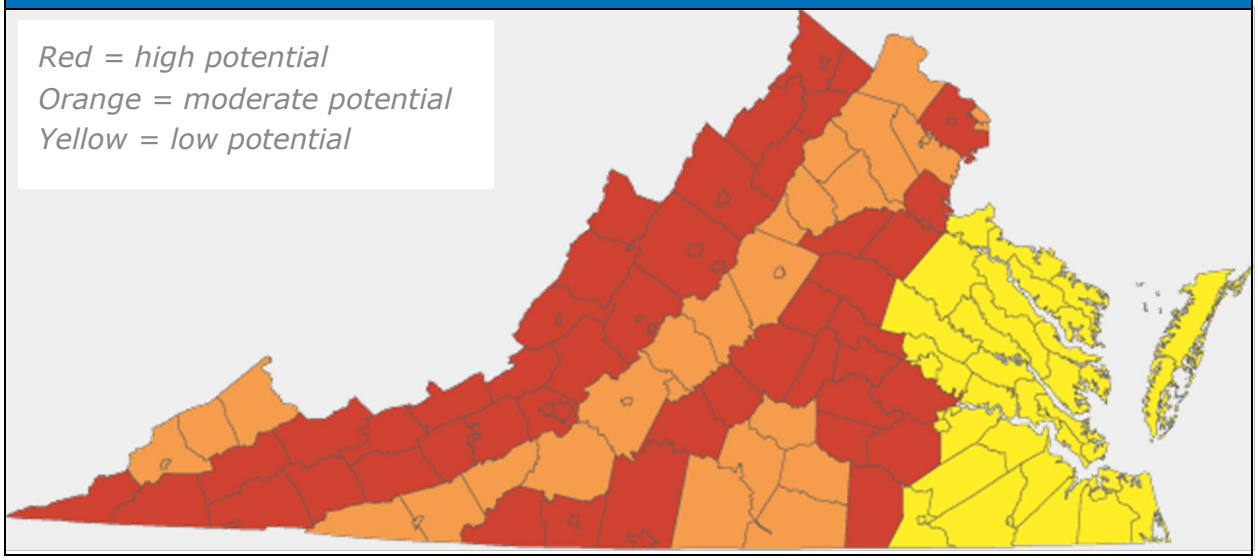
New Kent County	6	2.1	17	0				44	3.62	13.6	9.1
City of Petersburg	5	1.1	0	0				61	1.99	6.1	1.6
Powhatan County	3	0.4	0	0				162	2.98	17.2	4.3
Prince George County	3	0.3	0	0				29	2.61	17.2	3.5
City of Richmond	73	1.4	7	0	611	2.5	18	800	3.28	20.4	5.4
Surry County	1	0.6	0	0				5	1.00	0	0
Sussex County	2	0.7	0	0				3	1.00	0	0
Source: US EPA's Map of Radon Zones, Virginia. Radon Division, Office of Radiation and Indoor Air, September 1993.					*Source: Radon in Virginia Real Estate Transactions, Virginia Department of Health, ~2017*			*Source: Non-random test results by private business.* https://getresults.doctorhomeair.com/fmi/webd/Alpha_ResultsInArea			

Vulnerability Analysis

The types and distribution of lithologic units and other geologic features in an assessment area are of primary importance in determining radon potential. Rock types that are most likely to cause indoor radon problems include carbonaceous black shales, glauconite bearing sandstones, certain kinds of fluvial sandstones and fluvial sediments, phosphorites, chalk, karst-producing carbonate rocks, certain kinds of glacial deposits, bauxite, uranium-rich granitic rocks, metamorphic rocks of granitic composition, silica-rich volcanic rocks, many sheared or faulted rocks, some coals, and certain kinds of contact metamorphosed rocks. Rock types least likely to cause radon problems include marine quartz sands, non carbonaceous shales and siltstones, certain kinds of clays, silica-poor metamorphic and igneous rocks, and basalts. Uranium and radium are commonly found in heavy minerals, iron-oxide coatings on rock and soil grains, and organic materials in soils and sediments. Less common are uranium associated with phosphate and carbonate complexes in rocks and soils, and uranium minerals.

Figure 5.46 provides the EPA's map of Radon Zones for Virginia, released in 1993. The map is based on an assessment of five factors that are known to be important indicators of radon potential: indoor radon measurements, geology, aerial radioactivity, soil parameters and foundation types.

Figure 5.46: EPA Map of Radon Zones, Virginia



Source: U.S. EPA 1993 Map of Radon Zones in Virginia, modified by Virginia Department of Energy

The Coastal Plain of Virginia, including Hanover, Henrico, Charles City, New Kent, Prince George, Surry, Sussex, Greensville Counties and the Cities of Emporia, Richmond, Colonial Heights and Petersburg, are ranked low in geologic radon potential. In general, the upper Tertiary to Quaternary-aged sediments of the Coastal Plain have low radon potential. However, recent studies of radon potential in the sediments and marine fossils of the Yorktown Formation, a 4- to 5-million-year-old widespread geological unit in the Coastal Plain, could be a source for elevated levels of indoor radon. The Yorktown Formation is a marine unit, meaning the sediments that it is made of were once deposited underwater when sea-level was much higher than it is today. As a marine unit, it holds whale bones that are mixed into the sand/clays. The bones that accumulate in the Yorktown Formation are perhaps able to enrich themselves under certain geochemical conditions with heavy metals that might be in the water. Since the Yorktown Formation is so widespread and close to the earth's surface throughout the Virginia Coastal Plain, it is the only geologic unit that has been investigated thus far for radon potential in the Coastal Plain. These hypotheses are part of ongoing research at the College of William and Mary.[39] Future updates to this plan should include results of such research, particularly if the findings point to changes in the relative vulnerability presented above. The westernmost edge of the Yorktown Formation intersects the study area as shown in **Figure 5.47** below.

The rest of the study area lies within the Piedmont, including Goochland, Powhatan, Chesterfield, and Dinwiddie Counties and the City of Hopewell. Here the Goochland

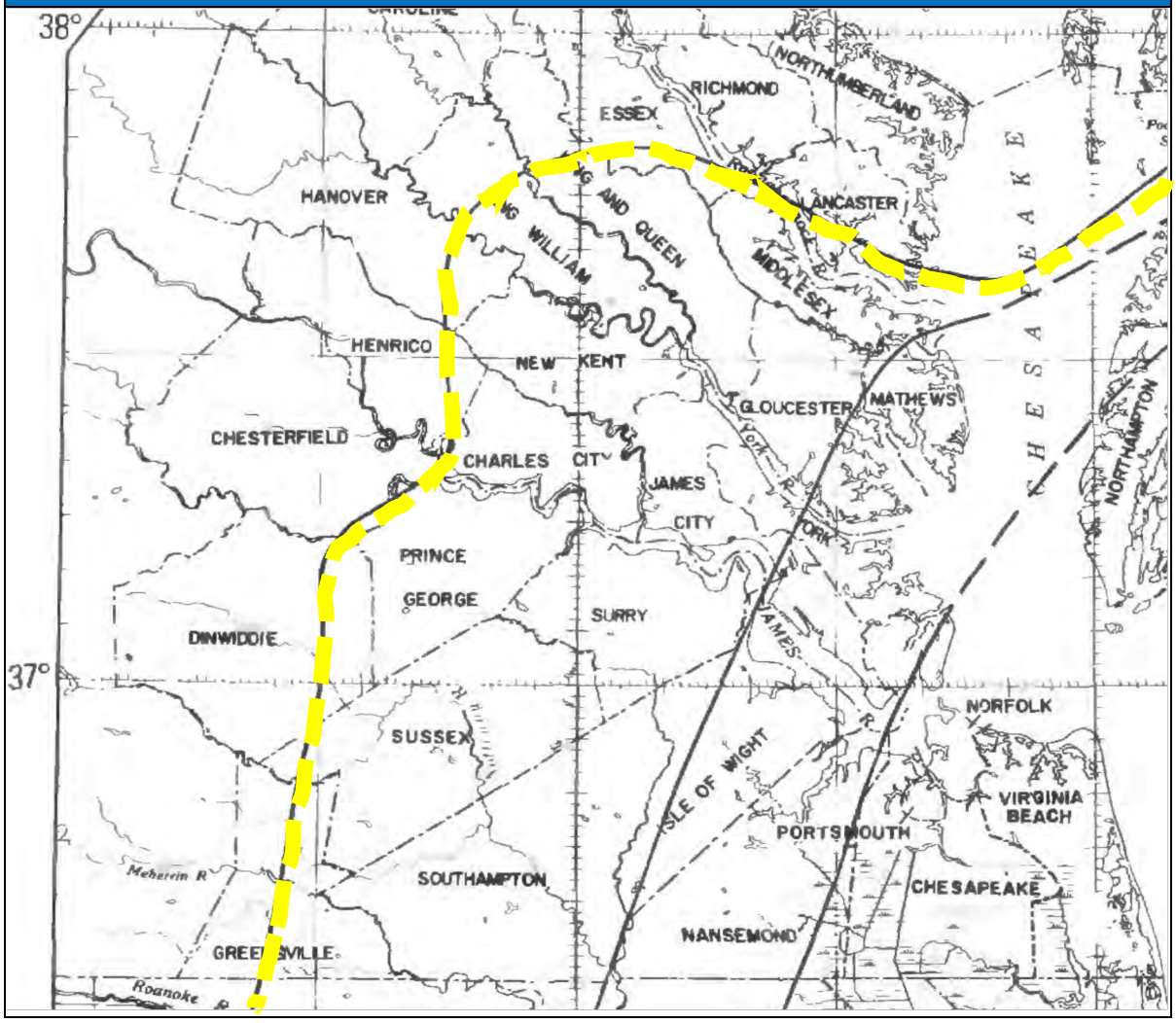
[39] Email exchanges with Anne Witt, Geohazards Specialist, Virginia Department of Mines, Minerals and Energy, spring 2021.

terrane and Inner Piedmont have been ranked high in radon potential, with numerous well-documented uranium and radon occurrences.

In 1994, an undergraduate student at the College of William & Mary studied radon emittance from the Petersburg Granite, a large body of intrusive igneous rock, extending from Hanover County to the southern border of Dinwiddie County[40]. The Petersburg Granite was selected for her study as a possible source of radon because the mineral zircon was found in the granite, which can have uranium and thorium incorporated into its crystal structure. Outcrops of the granite in Pocahontas State Park were studied using alpha-track radon detectors to determine concentrations of the gas being emitted as a decay product. Radon concentrations in a series of eight wells, tested over four time periods each, indicated radon concentrations in the ground ranging from 140 pCi/L to 3,536 pCi/L. The student concluded that these concentrations are high, and that homes built on the Petersburg Granite should be tested for radon. The general location of the Petersburg Granite, or Petersburg batholith, is shown in stippled red in **Figure 5.48**.

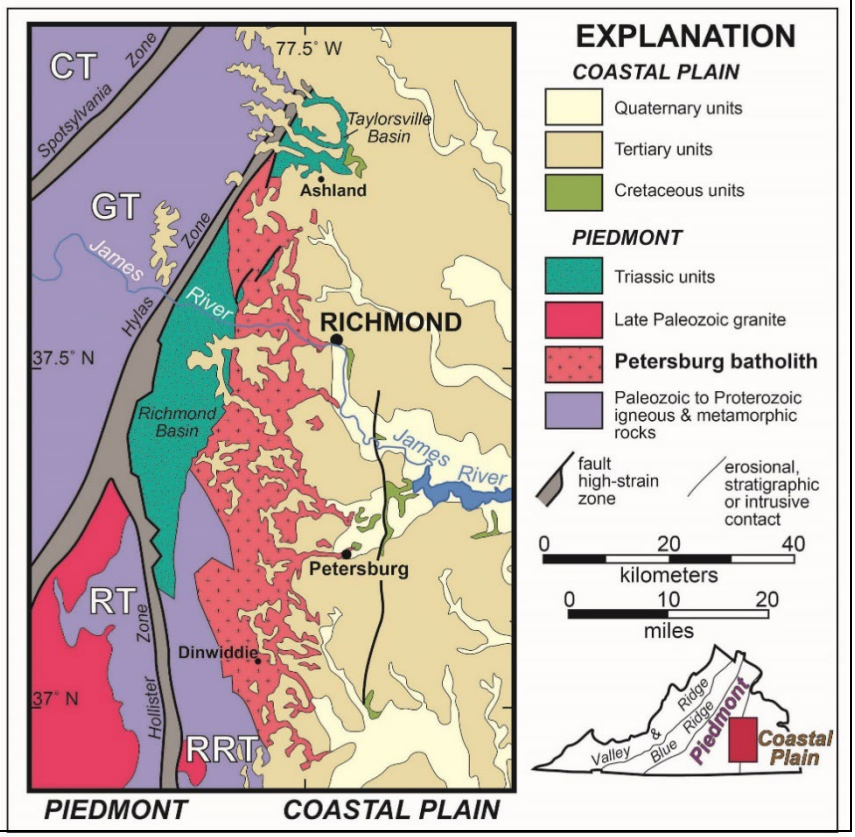
[40] Born, Rebecca Skye. *Radon in Yorktown Formation Sediments and Petersburg Granite, Eastern Virginia.* Undergraduate Thesis, College of William & Mary, April 1994.

Figure 5.47: Westernmost Extent of the Yorktown Formation (yellow line)



Source: Ward, Lauck W. and Blake W. Blackwelder. Stratigraphic Revision of Upper Miocene and Lower Pliocene Beds of the Chesapeake Group, Middle Atlantic Coastal Plain. Geological Survey Bulletin 1482-D, U.S. Department of the Interior, 1980.

Figure 5.48: Generalized Geologic Map of the Petersburg Batholith



Source: Online blog https://wmblogs.wm.edu/cmbail/power-washing-paleozoic-petersburg-pluton/ and as modified from Owens, B.E., Carter, M., and Bailey, C.M., 2017, Geology of the Petersburg batholith, eastern Piedmont, Virginia, in Bailey, C.M., and Jaye, S., eds., From the Blue Ridge to the Beach: Geological Field Excursions across Virginia: Geological Society of America Field Guide 47, p. 123–133.

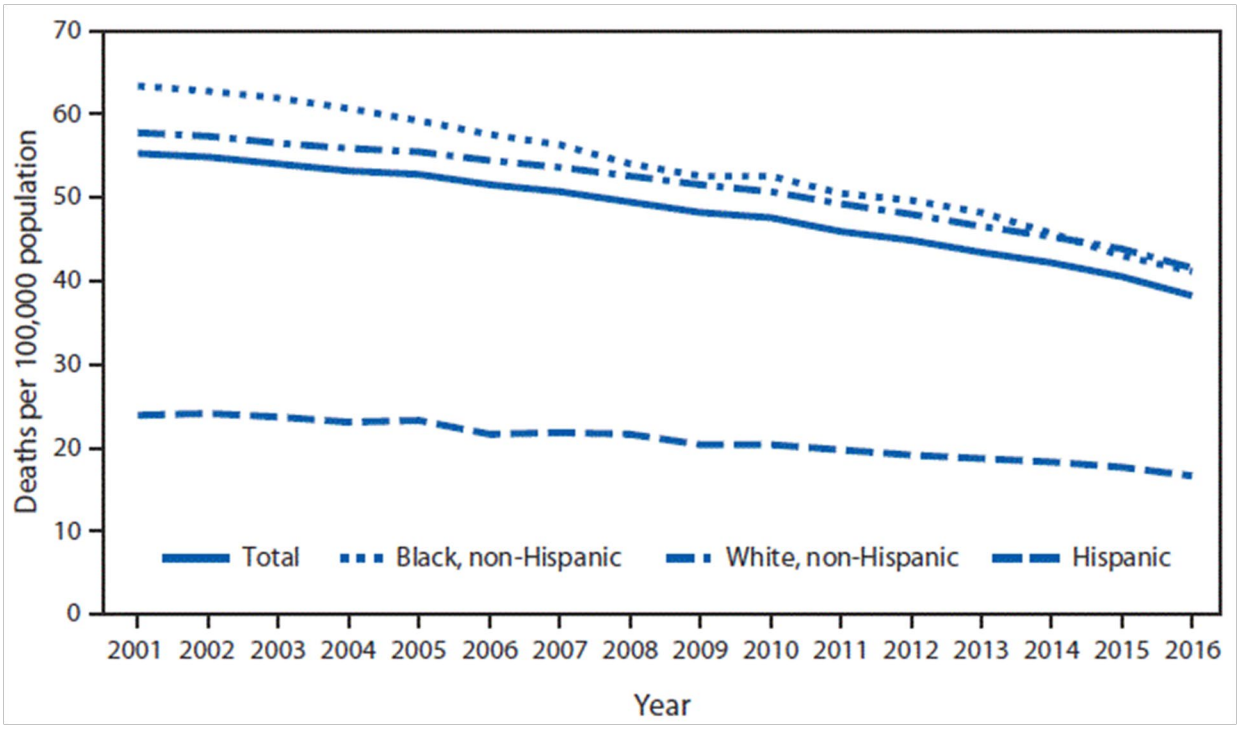
Radon testing in Virginia has been sporadic and not necessarily reported to any single data repository. Thus, the only way to know if any structure or group of structures has a radon problem is to test. Testing of residential structures is easy and inexpensive. Low-cost test kits are available through the mail and at home improvement stores. Qualified testers can also do long-term residential testing and set up systems for testing larger non-residential buildings. Mitigation or treatment of structures with high radon concentrations is also possible, relatively inexpensive and can be very effective if done properly. Testing is most important for structures in the red or orange zones indicated in Figure 5.46 above, and especially important for structures in which inhabitants spend their time in parts of the structure below ground or in contact with the ground. Future updates to this plan may include identification of specific structure

types, for example structures with basements, in the highest radon potential counties to further define vulnerability, especially if the EPA's 1993 map of radon zones is updated based on more testing or other new scientific information.

Social Vulnerability

Unlike many other hazards in this plan, structures are not physically damaged by radon exposure; instead, human lives are directly at risk. CDC QuickStats show that death rates from lung cancer declined between 2001 and 2016, but also indicate a disparity based on race/ethnicity (see **Figure 5.49**). During this period, the lung cancer death rates for the total population (deaths per 100,000 population) declined from 55.3 to 38.3, as well as for each racial/ethnic group shown. The death rate for the non-Hispanic Black population decreased from 63.3 to 41.2, for the non-Hispanic white population from 57.7 to 41.5, and for the Hispanic population from 23.9 to 16.6. Throughout this period, the Hispanic population had the lowest death rate.

Figure 5.49: Age-Adjusted Death Rates from Lung Cancer, by Race/Ethnicity, United States, 2001-2016

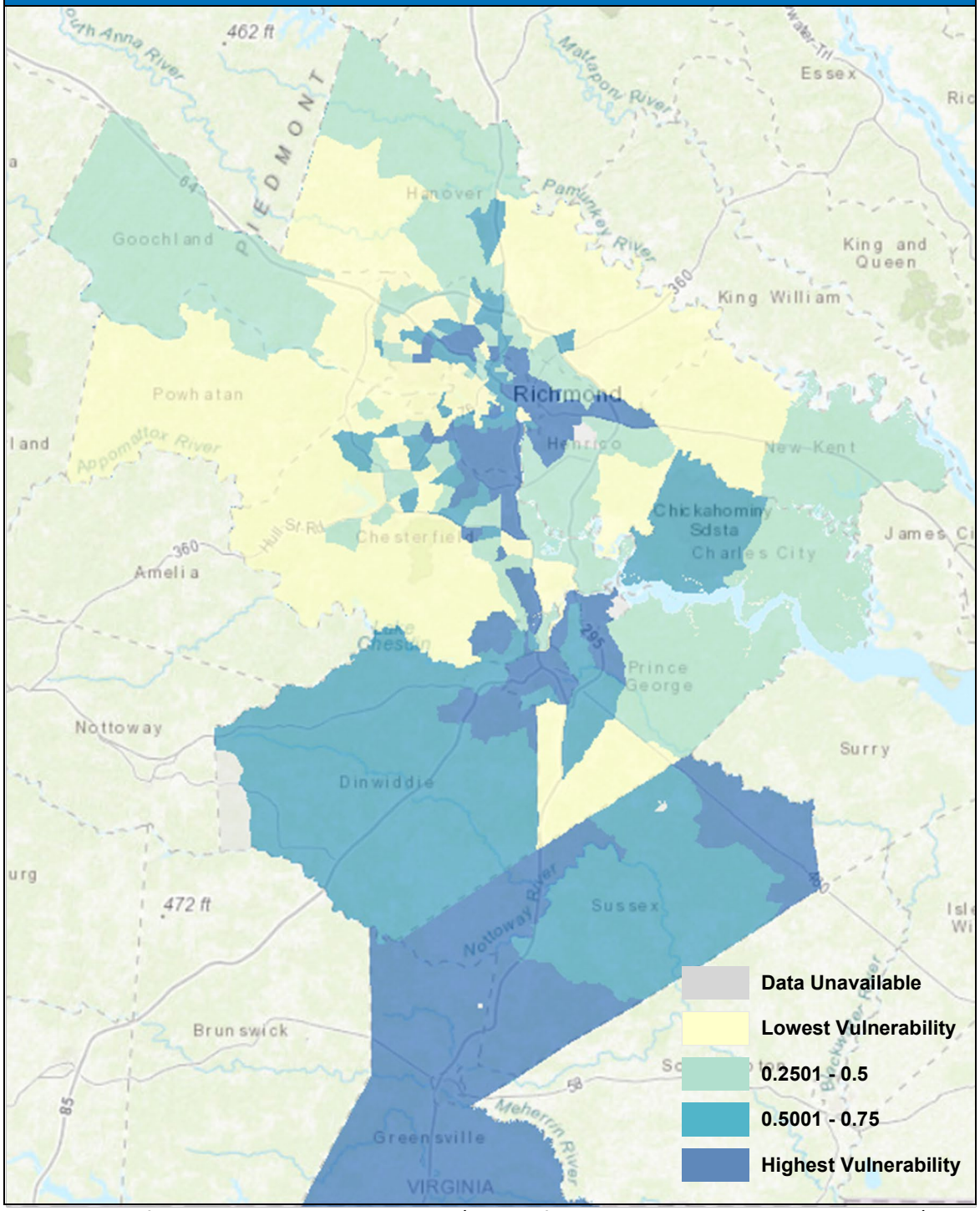


** Deaths per 100,000 population age-adjusted to the 2000 U.S. standard population.*
Source: Centers for Disease Control and Prevention, accessed online 4/22/22 at:
https://www.cdc.gov/mmwr/volumes/67/wr/mm6730a8.htm

The Centers for Disease Control and Prevention Agency for Toxic Substances and Disease Registry (ATSDR) created a Social Vulnerability Index geared toward preparing for and responding to exposure to dangerous chemicals (and other natural hazards, as well). This index is better suited to examining the social vulnerability related to radon, although many of the inputs are the same. Overall vulnerability for this index is based on: socioeconomic status (below poverty, unemployed, income, no high school diploma); household composition and disability (aged 65 or older, aged 17 or younger, civilian with disability, single-parent households); minority status and language; and housing type and transportation (multi-unit structures, mobile homes, crowding, no vehicle, group quarters). **Figure 5.50** provides the CDC ATSDR 2018 data for the study region. Perhaps once more information is collected regarding the underlying geology of the region and the relationship to radon, this map can be further refined in the future to more accurately isolate the social vulnerability to radon. Structures with basements could also be identified to further enhance the analysis.

The CDC ATSDR map below shows the highest social vulnerability is in the southernmost region of the study area, north into Petersburg and Colonial Heights, and in the central and eastern parts of Richmond.

Figure 5.50: CDC ATSDR Social Vulnerability Index



Source: Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC/ATSDR Social Vulnerability Index 2018 Database State.

Note: The Town of Surry has medium/high social vulnerability through the CDC index.

Future Vulnerability, Land Use and Climate Change

According to Memorial Sloan Kettering Cancer Center, major scientific organizations believe that radon contributes to approximately 12% of lung cancers annually in the United States. It is the second leading cause of lung cancer.[41] With 5,820 new cases of lung and bronchus cancer expected in Virginia in 2021[42], this translates to approximately 700 of those new cases being caused by radon exposure.

Radon levels are localized down to the household level and additional testing is needed to verify EPA zones for the study area. There are no federal or state laws that require radon testing prior to a real estate transaction, but some contracts do include radon testing or mitigation contingency clauses at the buyer's request.

Virginia Code at Section 15.2-2280 currently gives all red zone (Zone 1) counties and cities the option of requiring passive radon resistant construction features, but as of 2021 none of the study area Zone 1 communities had adopted the ordinance into their building codes.

In 1993, the Virginia General Assembly passed legislation that requires all schools in the Commonwealth to be tested for radon after July 1, 1994 and includes any new school buildings and additions built after that date. Each school is required to maintain files of their radon test results.

In the early 1990s the Virginia Department of Education purchased long-term radon test kits that were used to test all Virginia public school K-12 classrooms that were in contact with the ground at that time. Long term tests are generally more accurate than short term tests because they sample anywhere from 90 to 365 days. Short term tests usually sample for only 2 to 7 days. Since radon levels can fluctuate over time, the longer the test duration, the more accurate the results will be. The EPA school testing protocol recommends testing during the heating season which runs roughly from late October through the end of March. A VDH review of the original testing data from the long-term tests done at that time indicated that some of these test results were not valid or usable due to:

- School classrooms not being identified on the test report;
- Testing periods that were outside of the preferred heating season; and
- Improper testing of unoccupied areas such as boiler and storage rooms.

In general, radon test results for the vast majority of school classrooms in Virginia are below the EPA action level of 4.0 pCi/L for indoor air. For the few classrooms that have shown elevated radon levels, the problem was usually solved by making adjustments to the school's HVAC system. However, in some cases the HVAC adjustments did not work, and a radon mitigation system was installed to reduce the radon to acceptable

[41] Memorial Sloan Kettering Cancer Center https://www.mskcc.org/news/5-myths-about-radon-and-lung, accessed online 4/22/21

[42] American Cancer Society, Cancer Statistics Center accessed online 4/22/21 at: https://cancerstatisticscenter.cancer.org/#!/state/Virginia

levels. Future updates to this plan may include evaluation of data for study area schools, as available.

With regard to future climate change, changes in the environment and human behavior may alter the risks associated with radon for individual buildings. According to the EPA, the primary factors that influence radon entry into buildings include: 1) radon content of the soil; 2) pressure differential between the interior of a structure and the soil; 3) air exchange rate for the building; 4) moisture content surrounding the structure; and 5) presence and size of entry pathways. Climate change can affect these same factors and, therefore, may cause direct or indirect changes in indoor air quality within a structure. In addition, certain changing human behavioral factors driven by climate change may further impact air quality. Examples of how climate change may impact indoor air quality include:

1. Increased Air Conditioning and Decreased Fan Usage: air conditioning used as a result of rising temperatures contributes to "closed house conditions" and reduced stratification of radon between floors;

2. Activity Patterns and Spatial Radon Variation: rising outdoor temperatures may result in increased use of basements where radon concentrations are generally higher;

3. Weatherization and Energy Efficiency: although undetermined, tightening structures for energy efficiency may increase radon concentrations for structures with indoor radon sources;

4. Weather-Related Influences: increased wind can change pressure differentials between structure levels and the outside, and increased precipitation rates or totals may change hydrologic conditions causing a rise in the water table and force vapors from the vadose zone, or unsaturated zone, into a less dense media, such as a basement.

5. High Density Housing: concrete construction used in high density housing (constructed to reduce greenhouse emissions) may be an increasing source of elevated radon exposure for some occupants. 43

Radon exposure is not expected to be associated with any types of mass evacuation.

5.17 Infectious Diseases

Hazard Profile

Both influenza pandemics and communicable diseases can affect large numbers of people in a short period of time. An influenza pandemic is an epidemic of an influenza virus that spreads on a worldwide scale and infects a large proportion of the human

[43] Field, William R., Contractor Report prepared for U.S. EPA. *Climate Change and Indoor Air Quality*, June 10, 2010.

population. In contrast to the regular seasonal epidemics of influenza, these pandemics occur irregularly. Pandemics can cause high levels of mortality.

Influenza pandemics occur when a new strain of influenza virus is transmitted to humans from another animal species. These novel strains are unaffected by any immunity people may have to older strains of human influenza and can therefore spread extremely rapidly and infect very large numbers of people.

The CDC uses a Pandemic Intervals Framework (PIF) to describe the progression of an influenza pandemic (**Table 5.41**). This framework is used to guide influenza pandemic planning and provides recommendations for risk assessment, decision-making, and action in the United States. These intervals provide a common method to describe pandemic activity which can inform public health actions. The duration of each pandemic interval might vary depending on the characteristics of the virus and the public health response.

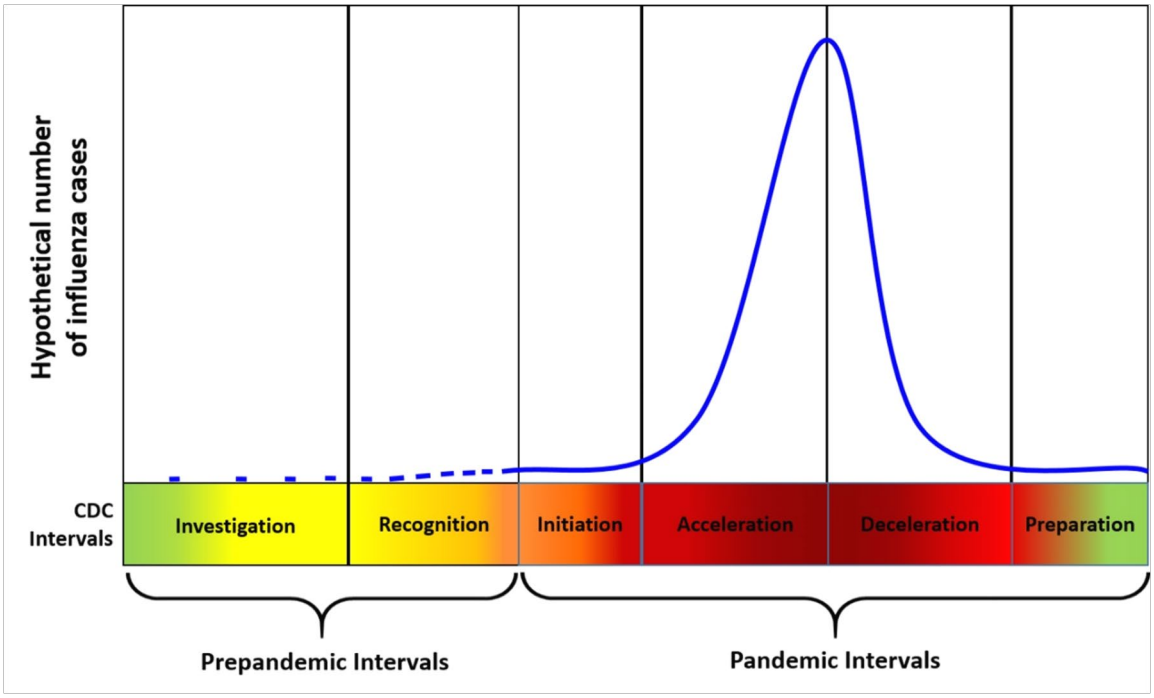
Table 5.41: CDC Pandemic Intervals Framework

Interval	Description
1) Investigation of cases of novel influenza A virus infection in humans	When novel influenza A viruses are identified in people, public health actions focus on targeted monitoring and investigation. This can trigger a risk assessment of that virus
2) Recognition of increased potential for ongoing transmission of a novel influenza A virus	When increasing numbers of human cases of novel influenza A illness are identified and the virus has the potential to spread from person-to-person, public health actions focus on control of the outbreak, including treatment of sick persons.
3) Initiation of a pandemic wave	A pandemic occurs when people are easily infected with a novel influenza A virus that has the ability to spread in a sustained manner from person-to-person.
4) Acceleration of a pandemic wave	The acceleration (or "speeding up") is the upward epidemiological curve as the new virus infects susceptible people. Public health actions at this time may focus on the use of appropriate non-pharmaceutical interventions in the community (e.g., school and child-care facility closures, social distancing), as well the use of medications (e.g., antivirals) and vaccines, if available. These actions combined can reduce the spread of the disease and prevent illness or death.
5) Deceleration of a pandemic wave	The deceleration (or "slowing down") happens when pandemic influenza cases consistently decrease in the United States. Public health actions include continued vaccination, monitoring of pandemic influenza A virus circulation and illness, and reducing the use of non-pharmaceutical interventions in the community (e.g., school closures).
6) Preparation for future pandemic waves	When pandemic influenza has subsided, public health actions include continued monitoring of pandemic influenza A virus activity and preparing for potential additional waves of infection. It is possible that a 2nd pandemic wave could have higher severity than the initial wave. An influenza pandemic is declared ended when enough data shows that the influenza virus, worldwide, is similar to a seasonal influenza virus in how it spreads and the severity of the illness it can cause.

Source: https://www.cdc.gov/flu/pandemic-resources/national-strategy/intervals-framework.html

Figure 5.51 provides a graphical illustration of the intervals for a hypothetical virus pandemic.

Figure 5.51: Preparedness and response framework for novel influenza A virus pandemics: CDC intervals



Source: CDC, online at https://www.cdc.gov/flu/pandemic-resources/national-strategy/intervals-framework.html

A pandemic is characterized by human-to-human spread of the virus over a very wide area, crossing international boundaries and affecting a large number of people. While many countries may not be affected early on in a pandemic, the CDC collaborates with the World Health Organization (WHO) and other international agencies to monitor and assess influenza viruses and illness. These organizations send strong signals to the public when research indicates a pandemic is imminent in their country, region, state or locality, and that the time to finalize the communication and implementation of planned mitigation measures is short.

Previous pandemics have been characterized by waves of activity spread over months and separated by oceans. Once the level of disease activity drops, a critical communications task is balancing this information with the possibility of another wave. Pandemic waves can be separated by months and an immediate "at-ease" signal may be premature. Pandemic waves can also be specific to a country or a subregion or state

within a country, making local messaging a critical component in controlling the spread of the virus.

A modern global economy that is focused on international trade and shipping, business and leisure travel to other countries can help spread an early-phase pandemic across the globe far more quickly than in past centuries. While quarantines and travel restrictions may help restrict the spread in later intervals, the damage wrought by virus carriers early on is irreversible.

Communicable diseases are illnesses spread by bacteria or viruses that are spread from one person to another through contact with bodily fluids, blood products, contaminated surfaces, insect bites or through the air. Examples include HIV, hepatitis A, B, and C, Salmonella, measles, and blood-borne illnesses. Mitigation of spread may include testing, vaccination, and educating the public on methods of transmission.

Hazard History

Flu pandemics have occurred throughout history. There have been about three influenza pandemics in each century for the last 300 years. Since 1918, five significant events stand out, each with different characteristics.

1918 – 1919: Spanish Flu

Illness from the 1918 flu pandemic, also known as the Spanish flu, came on quickly. Some people felt fine in the morning but died by nightfall. People who caught the Spanish Flu but did not die from it often died from complications caused by bacteria, such as pneumonia. Approximately 20% to 40% of the worldwide population became ill, and an estimated 50 million people died, including early 675,000 people in the United States. Unlike earlier pandemics and seasonal flu outbreaks, the 1918 pandemic flu saw high mortality rates among healthy adults. In fact, the illness and mortality rates were highest among adults 20 to 50 years old. The reasons for this remain unknown.

1957 – 1958

In February 1957, a new flu virus was identified in the Far East. Immunity to this strain was rare in people younger than 65. A pandemic was predicted. To prepare, health officials closely monitored flu outbreaks. Vaccine production began in late May 1957 and was available in limited supply by August 1957.

In the summer of 1957, the virus came to the United States quietly with a series of small outbreaks. When children returned to school in the fall, they spread the disease in classrooms and brought it home to their families. Infection rates peaked among school children, young adults, and pregnant women in October 1957. By December 1957, the worst seemed to be over. However, a dangerous "second wave" of illness came in January and February of 1958.

Most influenza–and pneumonia–related deaths occurred between September 1957 and March 1958. Although the 1957 pandemic was not as devastating as the 1918 pandemic, about 69,800 people in the United States died. The elderly had the highest rates of death.

1968 – 1969: Hong Kong Flu Virus

In early 1968, a new flu virus was detected in Hong Kong. The first cases in the United States were detected as early as September 1968. Illness was not widespread in the United States until December 1968. Deaths from this virus peaked in December 1968 and January 1969. Those over the age of 65 were most likely to die. The number of deaths between September 1968 and March 1969 was 33,800, making it the mildest flu pandemic in the 20th century. The same virus returned in 1970 and 1972.

Several reasons may explain why fewer people in the United States died as a result of this virus:

The Hong Kong flu virus was similar in some ways to the 1957 pandemic flu virus. This might have provided some immunity against the Hong Kong flu virus.

The Hong Kong flu virus hit in December of 1968, when school children were on vacation. This caused a decline in flu cases because children were not at school to infect one another. This also prevented it from spreading into their homes.

Improved medical care and antibiotics that are more effective for secondary bacterial infections were available for those who became ill.

2009 – 2010: H1N1 (Swine Flu)

In the spring of 2009, a new flu virus spread quickly across the United States and the world. The first U.S. case of H1N1 (swine flu) was diagnosed on April 15, 2009. By April 21, the Centers for Disease Control and Prevention (CDC) was working to develop a vaccine for this new virus. On April 26, the U.S. government declared H1N1 a public health emergency.

By June, 18,000 cases of H1N1 had been reported in the United States. A total of 74 countries were affected by the pandemic. H1N1 vaccine supply was limited in the beginning. People at the highest risk of complications got the vaccine first.

By November 2009, 48 states had reported cases of H1N1, mostly in young people. That same month, over 61 million vaccine doses were ready. Reports of flu activity began to decline in parts of the country, which gave the medical community a chance to vaccinate more people. An estimated 80 million people were vaccinated against H1N1, which minimized the impact of the illness.

The CDC estimates that 43 million to 89 million people had H1N1 between April 2009 and April 2010. They estimate between 8,870 and 18,300 H1N1 related deaths.

On August 10, 2010, the WHO declared an end to the global H1N1 flu pandemic

March 2020 - 2022: COVID-19 or SARS-CoV-2

In early 2020, a novel, infectious respiratory disease began to spread worldwide and eventually impacted all aspects of life throughout the world for over a year. Scientists determined that COVID-19 spread by droplets or aerosols from the nose and mouth when an infected person coughed, sneezed or exhaled. Airborne transmission also happened in indoor spaces without good ventilation, especially with infected people breathing heavily, like when singing or exercising. Infected people were able to spread the disease before having symptoms or feeling sick, and asymptomatic people could also spread the disease without ever exhibiting a single symptom. Several variants circulated globally as the virus mutated over time. In the case of COVID-19, the variants were determined to be more contagious.

Symptoms of COVID-19 could appear 2 to 14 days after exposure and include fever, cough, shortness of breath, chills, headache, muscle pain, sore throat, fatigue, congestion, or loss of taste or smell. Other less common symptoms included gastrointestinal symptoms like nausea, vomiting, or diarrhea. Even after recovering from the virus, many people experienced lingering symptoms such as fatigue, cough or joint pain. The elderly, those living in group settings (*e.g.,* nursing homes, jails) and people of any age with serious underlying medical conditions such as lung disease or diabetes, were at highest risk for developing complications from COVID-19. Fully effective and dependable treatments for the virus were limited.

Mitigation of COVID-19 depended on wearing protective masks, distancing from others who were able to transmit disease, washing hands to prevent disease spread, contact tracing to warn those who may have had exposure, and rapid development of testing measures to determine COVID-positive populations. Despite public health campaigns to prevent spread, the disease sickened millions and killed over 965,000 in the United States alone (https://covid.cdc.gov/covid-data-tracker/#datatracker-home, 3/15/22). As of March 15, 2022, the VDH reported 1,656,000 total cases, 48,188 hospitalizations and 19,356 deaths in Virginia. The virus also impacted the Richmond-Crater region as shown in **Table 5.42**.

Table 5.42: COVID-19 Regional Impacts

Jurisdiction	Cases	Hospitalizations	Deaths
Charles City County	1,146	51	27
Chesterfield County	71,667	1,345	738
City of Colonial Heights	4,796	111	94
Dinwiddie County (inc. Town of McKenney)	5,262	165	84

Table 5.42: COVID-19 Regional Impacts			
Jurisdiction	**Cases**	**Hospitalizations**	**Deaths**
City of Emporia	1,147	59	53
Goochland County	3,884	90	46
Greensville County (inc. Town of Jarratt)	3,313	78	37
Hanover County (inc. Town of Ashland)	21,520	463	269
Henrico County	63,707	1,387	890
City of Hopewell	6,096	164	119
New Kent County	4,576	99	32
City of Petersburg	8,279	251	139
Powhatan County	4,951	97	55
Prince George County	8,222	145	67
City of Richmond	43,954	1,051	478
Surry County	1,082	58	19
Sussex County (inc. Towns of Stony Creek, Wakefield, Waverly)	2,409	73	39
Totals	**256,011**	**5,687**	**3186**

Source: https://www.vdh.virginia.gov/coronavirus/covid-19-in-virginia/, accessed online March 15, 2022

In addition to the pandemic history described above, several pandemic flu threats have occurred that did not prove as dangerous as the events described above. When the 1976 swine flu was identified at Fort Dix, New Jersey it was called the "killer flu." Experts were concerned because they thought the virus was similar to the 1918 Spanish flu. To prevent a major pandemic, the United States launched a vaccination campaign. In fact, the virus—later named "swine flu"—never moved outside the Fort Dix area. Later, research on the virus showed that it would not have been as deadly as the 1918 flu if it had spread.

In 1997, at least a few hundred people caught H5N1 (avian flu) in Hong Kong. Like the 1918 pandemic, most severe illness affected young adults. Eighteen people were hospitalized. Six of those people died. This avian flu was unlike other viruses because it passed directly from chickens to people. Avian flu viruses usually spread from chickens to pigs before passing to humans. To prevent the virus from spreading, all chickens in Hong Kong—approximately 1.5 million— were slaughtered. Because this flu did not spread easily from person to person, no human infections were found after the chickens were killed.

In 1999, a new avian flu virus appeared. The new virus caused illness in two children in Hong Kong.

In the Central Virginia Health District, the VDH indicates that Hepatitis B and C, Salmonella and Campylobacteriosis are the most commonly reported communicable diseases during the period 2013 to 2018, the most recent data available. **Table 5.43** summarizes the VDH data for the region during this period. Hepatitis B and C are viruses that cause an infection that attacks the liver and leads to inflammation. The infection is spread by blood products such as unclean needles, and most people have no symptoms. Campylobacteriosis is an infection by the Campylobacter bacterium, a common bacterial infection of humans, often a foodborne illness. The bacteria produce an inflammatory diarrhea or dysentery syndrome, mostly including cramps, fever and pain. The salmonella bacteria have a similar food-related source and causes upset stomach, diarrhea, fever, and pain and cramping in the belly.

Table 5.43 Communicable Disease in the Virginia's Central Health District		
Year	**Top Four Diseases**	**Number Of Cases**
2013	Hepatitis C, chronic	1308
	Hepatitis B, chronic	263
	Salmonellosis	166
	Campylobacteriosis	116
2014	Hepatitis C, chronic	1269
	Hepatitis B, chronic	237
	Salmonellosis	212
	Campylobacteriosis	146
2015	Hepatitis C, chronic	1715
	Hepatitis B, chronic	250
	Salmonellosis	221
	Campylobacteriosis	183
2016	Hepatitis C, chronic	2560
	Hepatitis B, chronic	256
	Salmonellosis	219
	Campylobacteriosis	196
2017	Hepatitis C, chronic	2545
	Hepatitis B, chronic	230
	Campylobacteriosis	225
	Salmonellosis	220
2018	Hepatitis C, chronic	2374
	Salmonellosis	255
	Hepatitis B, chronic	249
	Campylobacteriosis	221

Source: VDH, https://www.vdh.virginia.gov/data/communicable-diseases/ accessed 4/15/21 and confirmed to be most recent 3/15/2022

Vulnerability Analysis

Based on historical experience and the fact that at the time of this planning process an ongoing pandemic threatens public health, the region is expected to experience waves of pandemic flu and communicable disease outbreak in the future.

An outbreak of widespread disease may burden local medical facilities in terms of capacity for treatment, may burden the region's health departments, emergency responders and other essential workers with additional staff responsibilities, and may burden local funeral homes with higher demand for services, but would not be expected to damage the built environment or community infrastructure in any significant way. Experience with COVID-19 has shown that economic impacts and job losses may affect housing starts, and the number of people remaining at home for work and schooling can increase demand for home renovation services. These impacts are somewhat temporary and may be further ameliorated by Federal stimulus dollars distributed as a result of a public health disaster, and eviction prohibitions issued at various government levels.

Social Vulnerability

Analysis of the impacts of COVID-19 on populations of varying economic, social and ethnic backgrounds is ongoing at the time of this study. Understanding how the virus spread requires examination of the specific geographic circumstances of where people are required to travel. Social isolation was quickly recognized as a critical element in managing the spread, but isolation is not an option for many essential workers who are critical to the healthcare system, food supply chain and transportation systems. There are clear divides in the region's communities regarding who can work from home and who is required to go out in public. COVID-19 clearly did not affect everyone equally. The Virginia Center for Inclusive Communities (https://inclusiveva.org/covid19/) noted the following disparities:

- older adults were more susceptible to the virus itself, leading to large numbers of socially isolated seniors;
- school closures led to food insecurity, disparities in technology and internet access, and a need for special services for students with disabilities and students learning English;
- persons with pre-existing conditions but less access to high quality, preventive healthcare were more susceptible to the virus;
- small businesses with existing banking relationships had better access to State and Federal financial assistance, especially during the early part of 2020;
- inequities related to transportation access impacted how the virus affected people;
- and violence against intimate partners, Asians, Islamics and others increased during the pandemic.

Fortunately, by February 2021, at least seven different vaccines had already been developed and were being administered to the most vulnerable populations throughout the world. Three primary vaccines were being used in Virginia, and by mid-March

2022, over 6.2 million Virginians, or 72.3% of the population, were fully vaccinated against the virus.[44]

As COVID-19 demonstrated, the nature and characteristics of a virus, such as how it is transmitted and who is most likely to suffer from severe symptoms, affects the populations most likely to be impacted. Social vulnerability can be influenced by financial health, physical health, mental health and other aspects of where and how a person lives. Similarly, access to virus testing, healthcare for those who contract the virus, and access to medications and vaccinations are all components in an assessment of social vulnerability to each virus and such assessment is difficult to manage while resources are committed to managing an ongoing virus. Communication and outreach to socially vulnerable groups is a key mitigation measure for lessening the impact of viruses that unequally impact demographic groups.

Future Vulnerability, Land Use and Climate Change

Future land use is expected to have less impact on future vulnerability than the protection of public health through dissemination of proper individual protection measures and emergency notification with regard to flu or disease outbreak.

Many causes of climate change also increase risk of pandemic, including deforestation, loss of habitat and loss of species. Warming temperatures and increasingly severe rainfall patterns make conditions better for Lyme disease, waterborne diseases and mosquito-borne diseases.

Mass evacuation is not expected to be a factor related to infectious disease, although COVID-19 did change transportation habits and work habits in the study area.

5.18 Conclusions on Hazard Risk

The risk and vulnerability assessment performed for the Richmond-Crater region provides significant findings that allow committee members to prioritize hazard risks and proposed hazard mitigation strategies and actions. Prior to assigning conclusive risk levels for each hazard, the committee reviewed the results of the assessments shown in the following tables.

Damages and frequency information from the risk and vulnerability assessments are summarized in **Table 5.44**. This table provides a quantitative assessment of existing data for the hazards, recognizing that some hazards are not readily assessed, nor are the assessments truly comparable.

[44] Virginia Department of Health, accessed online at: www.vdh.virginia.gov/coronavirus/see-the-numbers/covid-19-in-virginia/covid-19-vaccine-summary/

Table 5.44: Frequency and Damage Assessment from the Hazard Identification and Risk Assessment			
Hazard	**NCEI Annual Frequency**	**NCEI Annualized Damages**	**Other Damages and Notes**
Flooding	9.59	$95,000	$3,877,630,847 100-year flood damages (Hazus)
Severe Wind Events	0.852	$1,436,741	$9.7 million annual damage (Hazus)
Droughts	0.40	$1,765,040	
Tornadoes	1.97	$1,488,825	
Thunderstorms	3.22	$17,601	Annualized events include hail, lightning and thunderstorm events
Severe Winter Weather	0.06-0.75	$40,411	
Extreme Heat	0.01	$0	
Wildfires	n/a	n/a	$1,488,825 annual damage (VDOF) 1.97 events per year
Sinkholes	n/a	n/a	1.1 events per year
Infectious Diseases	n/a	n/a	.05 events per year (Pandemic Flu)
Earthquakes	n/a	n/a	$4,167,000 annual (Hazus)
Shoreline Erosion	n/a	n/a	
Radon Exposure	n/a	n/a	
Flooding Due to Impoundment Failure	n/a	n/a	

Table 5.45 summarizes the relative degree of mitigation priority assigned for all identified hazards in the region based on the application of the workshop qualitative assessment voting tool discussed in Methodologies Used (Section 5.2.1) at the beginning of Section 5.

Table 5.45: Summary of Qualitative Assessment	
Hazard	**Mitigation Priority Ranking**
Flooding and Flooding due to Impoundment Failure	$ 19,850,000
Severe Wind Events	$ 4,125,000
Shoreline Erosion	$ 3,125,000
Infectious Diseases	$ 2,575,000
Severe Winter Weather	$ 2,500,000
Droughts and Extreme Heat	$ 1,950,000
Tornadoes	$ 1,225,000
Thunderstorms	$ 325,000
Sinkholes	$ 325,000
Earthquakes	$ 300,000
Wildfires	$ 275,000
Radon Exposure	$ 50,000
Landslides	$ -

Risk level ranking was based on historical and anecdotal data, as well as input from committee members. This ranking was done collaboratively in Workshop #1 for each hazard, using the matrix shown in **Figure 5.52**. Each hazard was discussed and analyzed based on the participants' knowledge about consequences and likelihood. This risk scoring tool is a simplified approach to estimating risk that is easy to understand, based on a method developed for the Australian Institute for Disaster Resilience (AIDR)[45]. Scores from likelihood and consequence are then multiplied to provide a risk score, as shown in **Table 5.46**. Some hazards, such as landslides, sinkholes and shoreline erosion were grouped for simplicity's sake.

[45] AIDR. (2015). *Handbook 10: National Emergency Risk Assessment Guidelines*. 2nd Edition. Australian Institute for Disaster Resilience, Australian Government Attorney-General's Department.

Figure 5.52: Results of Committee Workshop Hazard Ranking Exercise

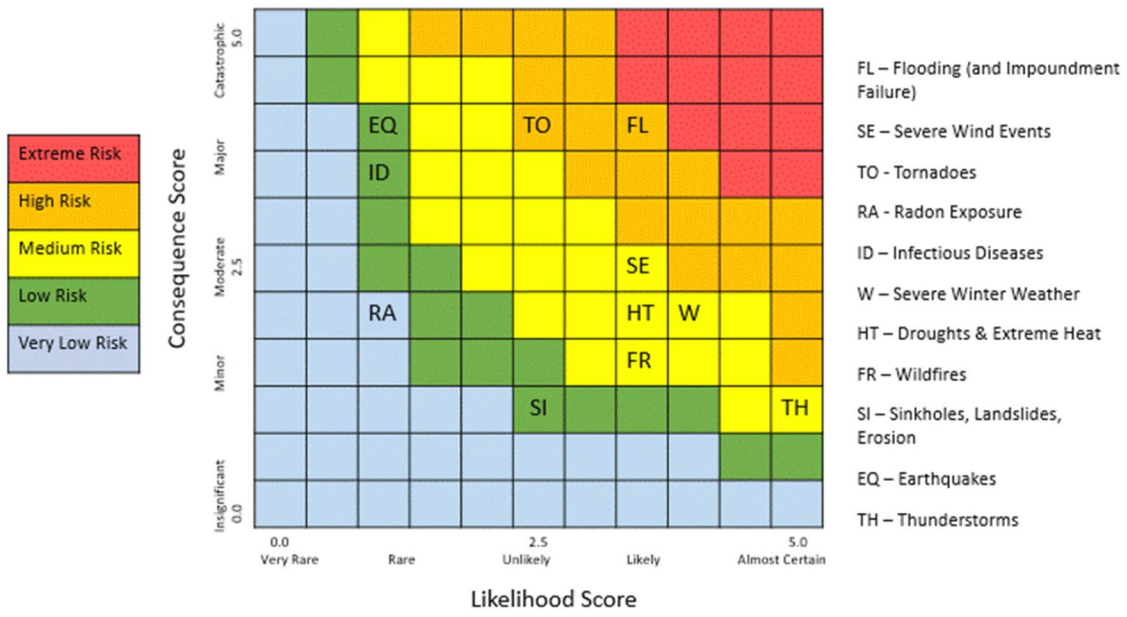


Table 5.46: Risk Scores for Each Hazard

Hazard	Risk Score	Risk Description
Flooding and Flooding due to Impoundment Failure	14	High
Tornadoes	10	High
Severe Wind Events	8.75	Medium
Severe Winter Weather	8	Medium
Droughts and Extreme Heat	7	Medium
Wildfires	5.25	Medium
Thunderstorms	5	Medium
Earthquakes	4	Low
Infectious Diseases	3.5	Low
Sinkholes, Landslides, Erosion	2.5	Low
Radon Exposure	2	Very Low

The conclusions drawn from the assessments, combined with an examination of the rankings in the 2017 plan, as well as final determinations and discussion from the committee, were considered for a final summary of hazard risk for the region based on High, Moderate, Low, or Negligible designations (**Table 5.47**). Although some hazards are classified as posing Low or Negligible risk, their occurrence is still possible.

Table 5.47: Conclusions on Hazard Risk for Richmond-Crater Region	
CRITICAL HAZARD - HIGH RISK	FLOODING SEVERE WIND EVENTS TORNADOES
CRITICAL HAZARD - MODERATE RISK	SEVERE WINTER WEATHER DROUGHTS AND EXTREME HEAT THUNDERSTORMS
NONCRITICAL HAZARD - LOW RISK	WILDFIRES INFECTIOUS DISEASES EARTHQUAKES SHORELINE EROSION FLOODING DUE TO IMPOUNDMENT FAILURE RADON EXPOSURE
NEGLIGIBLE CONSEQUENCES	SINKHOLES LANDSLIDES

6.0 Capability Assessment

6.1 Updates for 2022

The Capability Assessment was updated in 2021/2022 using a new questionnaire distributed to communities, interviews and discussions with committee members, and research on new capabilities added at the state and Federal levels. Local government highlights were expanded to capture many of the mitigation actions and programs completed since the previous plan was enacted.

6.2 Introduction

A "capability assessment" qualitatively summarizes the current and anticipated future capacity of the communities within the Richmond-Crater study area to mitigate the effects of the natural hazards identified in Section 5.0 of this plan. The capability assessment includes a comprehensive examination of the following local government capabilities:

- *Administrative Capability* – describes the forms of government in the region, including the departments that may be involved in hazard mitigation.
- *Technical Capability* – addresses the technical expertise of local government staff.
- *Fiscal Capability* – examines budgets and current funding mechanisms.
- *Policy and Program Capability* – describes past, present, and future mitigation projects in the region and examines existing plans (e.g., emergency operations plan, comprehensive plan).
- *Legal Authority* – describes how jurisdictions in the region use the four broad government powers (i.e., regulation, acquisition, taxation, and spending) to influence hazard mitigation activities.

The purpose of a capability assessment is to identify resources that will support implementation of potential hazard mitigation opportunities available to the region's local governments. For the most part, the towns in the region, with the exception of Ashland, are extremely small with several functions such as building inspections and public safety supported or performed by the corresponding county. To the extent information regarding towns was available, it is included in the capability assessment.

Analysis of capabilities helps planners detect existing gaps, shortfalls, or weaknesses within existing government activities that could exacerbate a community's vulnerability. The assessment will highlight positive measures already in place or being taken at the local level, which should continue to be supported and enhanced, if possible, through future mitigation efforts.

The capability assessment serves as a foundation for designing an effective hazard mitigation strategy. It not only helps establish the goals and mitigation actions for the Richmond-Crater region communities to pursue, but assures that those goals and actions are realistically achievable by communities.

6.3 Staff and Organizational Capability

The counties within the PlanRVA region operate under a Board of Supervisors – County Administrator/Manager system. In this form of government, the elected board of supervisors hires a county administrator/manager who oversees daily operations of the county. Charles City County has the smallest board with three members. Goochland, Henrico, New Kent, and Powhatan Counties each have five board members. Hanover County's board is the largest in the region with seven members.

The City of Richmond operates under the Mayor-Council system of government. The nine members of the council and the mayor are elected. The mayor appoints, with council approval, a chief administrative officer who oversees daily business operations of the city.

Charles City and Chesterfield Counties are dual members of both regional planning district commissions. Within the Crater region, the size of the Board of Supervisors also varies from jurisdiction to jurisdiction. Greensville has the smallest board with four members, Dinwiddie has a five-member board, and the remaining counties have six-member boards. The cities in the Crater region operate under the City Council -City Manager system. The city council is an elected body. Emporia has an eight-member council and the other cities have seven-member councils. The council, in turn, appoints a city manager who acts as the city's chief executive officer.

Incorporated towns in the Commonwealth of Virginia also have an elected governing body. Towns have zoning and planning authority though most choose to use the county planning commission as their town planning commission. Towns have the ability to issue general obligation and revenue bonds. In addition, towns of more than 5,000 residents may appoint an emergency services director and exercise emergency powers separate from the county.

Under the county administrator/manager, city mayor/manager, or town manager/mayor, each jurisdiction has numerous departments and boards that are responsible for the various functions of local government. Committee members for this mitigation planning process are members of various departments as shown in Table 3.2; their primary contributions or skills with regard to hazard mitigation are also provided in that table. While exact responsibilities differ from jurisdiction to jurisdiction, the general duties of the primary departments involved in this process are described below.

Building Inspections offices enforce the VUSBC, which contains the building regulations that govern new buildings, structures, and additions or repairs to existing buildings. The regulations must also be referenced when maintaining or repairing an existing building or renovating or changing the use of a building or structure. The VUSBC is comprised of three parts: Virginia Construction Code, Virginia Existing Building Code and Virginia Maintenance Code. Design requirements set out a minimum level of protection from wind, flood and snow loads, as well as requiring foundation protection from a variety of hazards. Building inspectors play a critical role in inspecting buildings damaged by hazards and determining if they are safe to inhabit or if repairs must be made prior to reoccupation.

Departments of Emergency Management/Fire/Emergency Medical Services (EMS)/Public Safety are responsible for the mitigation, preparedness, response, and recovery operations that deal with both natural and human-caused disaster events. These departments are typically categorized as "first responders" and encompass emergency response, emergency management, and fire safety. In addition, Fire/EMS departments provide medical aid and fire suppression at the scene of accidents and emergencies. These departments are often responsible for responding to hazardous materials incidents, water rescues, and entrapments. Many departments are also active in public engagement activities, informing community members through reverse 911, social media, and other outreach. Members of the Richmond Regional-Crater Hazard Mitigation Steering Committee were primarily emergency managers who also engaged local participation from other departments within their jurisdictions. They also work with other departments to ensure that their vulnerability analysis and mitigation actions are integrated into appropriate jurisdictional comprehensive plan updates, zoning and floodplain management regulatory or policy changes, emergency operations plan updates, disaster recovery plans and resiliency planning as these plans and policies are updated and renewed.

The Police or Sheriff's department is responsible for public safety and evacuation activities that might occur prior to events and assists in the response and recovery operations that deal with both natural and human-made disaster events. They also work to ensure the safety and security of residents and businesses as well as personal property during the immediate recovery period.

Parks and Recreation departments may be responsible for open-space programs. If acquisition projects are undertaken, coordination with this department becomes critical.

The Planning Department (or Department of Community Development) addresses land use planning and zoning. Planning and Community Development departments are typically responsible for managing grant programs funded by the U.S. Department of Housing and Urban Development (HUD), but some larger jurisdictions may have

separate housing departments or authorities who manage HUD programs. These grant programs provide assistance to low- and moderate-income persons for needed housing improvements. These departments also may develop residential and commercial revitalization plans for older areas, serve as a resource for housing and community development issues, and manage special redevelopment projects. Zoning ordinances, which may include the floodplain management and Chesapeake Bay Act overlay districts, are typically enforced by the Planning or Planning and Zoning Department, as well.

Economic Development departments concentrate on ensuring the growth and prosperity of existing businesses. These departments often administer small business loan programs, state economic development programs, and workforce training programs. In smaller jurisdictions, such as Charles City County, this function is managed through the County Administrator's office. Government entities such as Economic Development departments are also increasingly involved in recruiting new businesses to a jurisdiction.

Public utilities departments or cooperatives, in some jurisdictions, oversee community potable water treatment and natural gas services. Rural areas may be served by rural electric cooperatives which are not for profit, while a large extent of the region is served by Dominion Energy.

In many jurisdictions, Public Works or Engineering departments oversee maintenance of infrastructure including roadways, stormwater management, sewer, and wastewater treatment facilities. These departments may also review new development plans, ensure compliance with stormwater management and erosion and sediment control regulations, and work with VDOT on road issues.

GIS staff, vital in their support of mitigation with tools such as multiple data sets and mapping capability, provide data to various local government departments and residents. GIS staff may be located within one of several departments, or in multiple departments, depending on the local government organizational structure. Some communities in the region contract with a private firm for GIS services.

Depending on the jurisdiction, departments of Planning, Public Works, Engineering or Zoning may enforce the NFIP requirements. Two communities, the City of Richmond and the Town of Ashland, participate in the FEMA Community Rating System, which provides NFIP policyholders within the regulated floodplain a discount on their flood insurance policy premium at rate commensurate with the participating community's CRS classification.

6.4 Technical Capability

A mitigation program typically depends on a broad range of staff with diverse technical capabilities. Planners, engineers, building inspectors, emergency managers, floodplain

managers, GIS staff, and grant writers are all important in supporting mitigation actions implemented at the local level. **Table 6.1** provides information on each jurisdiction's technical capabilities.

All localities have GIS capabilities or receive technical support from their county (in the case of most towns) or their planning district commission. Most local governments have incorporated basic GIS systems into their existing planning and management operations. Several of the larger localities are expanding their GIS capabilities to provide more enhanced assistance to first responders and to improve data needed for hazard identification and risk analysis. For instance, Chesterfield County used information on power outages to examine communities dependent on well water. The fire department was then able to prioritize delivery of drinking water to these homes. The county also uses their GIS system to link data to damage assessment photos, a process that speeds up communication with VDEM after a disaster.

Staff members in all the jurisdictions have internet access. Most local governments use social media; fire, police, and emergency managers leverage Facebook pages and Twitter feeds for messaging. Some localities keep these sites active year-round while others activate them only during emergencies to relay vital information to the public.

Table 6.1: Technical Capabilities of Richmond-Crater Jurisdictions

Jurisdiction	Mitigation Assigned to Specific Department	GIS	Adequate Zoning Staff	Dedicated Floodplain Management Staff	Building Inspectors	Overall Technical Capabilities
Charles City County	Planning	Yes	Yes	No	Yes	Moderate
Chesterfield County	Environmental Engineering Planning Building Inspections	Yes	Yes	Yes	35	Moderate
City of Colonial Heights	Engineering Public Works Fire Department Building Official	Yes	Yes	1	3	Moderate
Dinwiddie County	Public Safety/	Yes	Yes	Yes	3	Moderate

Table 6.1: Technical Capabilities of Richmond-Crater Jurisdictions						
Jurisdiction	**Mitigation Assigned to Specific Department**	**GIS**	**Adequate Zoning Staff**	**Dedicated Floodplain Management Staff**	**Building Inspectors**	**Overall Technical Capabilities**
	Emergency Services					
Town of McKenney	County handles mitigation	Yes	Yes	No	N/A	Limited
City of Emporia	City Manager/Emergency Management	Yes	Yes	Yes	2	Moderate
Goochland County	Fire and Rescue	Yes	Yes	No	3	Moderate
Greensville County	No	Yes	Yes	Yes	2	Moderate
Town of Jarratt	County handles mitigation	Yes	Yes	No	N/A	Limited
Hanover County	Planning Fire/EMS	Yes	Yes	No	4	Moderate
Town of Ashland	Planning Police	Yes	Yes	No	Yes	High
Henrico County	Emergency Management	Yes	Yes	Yes	35	High
City of Hopewell	Emergency Management	Yes	Yes	Yes	2	Moderate
New Kent County	Fire , Sheriff and Social Services	Yes	Yes	No	Yes	Moderate
City of Petersburg	Fire/Rescue; Public Works	Moderate	No	No	2	Moderate
Powhatan County	Emergency Management	Yes	Yes	No	Yes	Moderate
Prince George County	All Departments	Yes	No	No	6	Limited
City of Richmond	Emergency Management/ Police/Fire	Yes	Yes	Yes	Yes	High
Town of Surry	County handles mitigation	Surry County	Surry County	Surry County	Surry County	Limited
Sussex County	Public Safety	Yes	Yes	No	2	Limited

Table 6.1: Technical Capabilities of Richmond-Crater Jurisdictions						
Jurisdiction	**Mitigation Assigned to Specific Department**	**GIS**	**Adequate Zoning Staff**	**Dedicated Floodplain Management Staff**	**Building Inspectors**	**Overall Technical Capabilities**
	Planning and Zoning					
Town of Stony Creek	County handles mitigation	Sussex County	Sussex County	No	Sussex County	Limited
Town of Wakefield	County handles mitigation	Sussex County	Sussex County	No	Sussex County	Limited
Town of Waverly	County handles mitigation	Sussex County	Sussex County	No	Sussex County	Limited

High: No increase in capability needed.
Moderate: Increased capability desired but not needed.
Limited: Increased capability needed.

6.5 Fiscal Capability

The counties and cities in the study area receive most of their revenue through local real estate tax, state and local sales tax, local services, and restricted intergovernmental contributions (federal and state pass-through dollars). With regard to mitigation, since 1998 Virginia has provided a 20% match on all eligible HMGP projects. These in-kind matches help to reduce the local contribution to less than 5% cash match, making mitigation projects much more feasible for local jurisdictions and for interested property owners. **Table 6.2** provides an indication of the operating budgets for the cities and counties in the study area.

Table 6.2: Fiscal Capability		
Jurisdiction	**Total FY22 Budget**	**Public Safety FY22 Budget**
Charles City County	$9,126,683	$1,400,107
Chesterfield County	$807,045,000	$207,070,800
Colonial Heights	$96,978,695	$ 12,694,931
Dinwiddie County	$51,552,250	$3,342,951
City of Emporia	$25,283,809	$4,913,139

Table 6.2: Fiscal Capability		
Jurisdiction	**Total FY22 Budget**	**Public Safety FY22 Budget**
Goochland County	$141,274,251	$16,076,318
Greensville County	$21,246,995 (FY 21)	$243,784 (FY 21)
Hanover County	$513,200,000	$88,000,000
Henrico County	$1,431,936,068	$932,525 (EM only)
City of Hopewell	$54,356,282	$5,261,335
New Kent County	$114,283,910	$12,500,685
City of Petersburg	$103,613,656	$17,322,301
Powhatan County	$135,866,359	$592,384
Prince George County	$112,000,000	$112,000,000
City of Richmond	$772,831,959	$200,528,261
Sussex County	$22,050,598	$1,612,820

Sources: Jurisdictional budget offices; websites.

Most communities in the Richmond-Crater region use capital improvement plans and general obligation bonds to plan and fund large-scale public expenditures. Most jurisdictions in the study area also use intergovernmental agreements to leverage resources.

6.6 Policy and Program Capability

6.6.1 Previous Mitigation Efforts

The region does not currently have strong participation amongst jurisdictions in FEMA HMA programs. However, some highlights of past grant-funded projects and other mitigation projects are presented below. Most localities in the region do not apply for HMA grants but instead incorporate mitigation strategies and actions into other regulatory and non-regulatory programs and support activities. Such programs include, but are not limited to, emergency preparedness outreach, floodplain management and building inspections.

6.6.2 Hazard Mitigation Activity Highlights

The region's Central Virginia Emergency Management Alliance is supported by an emergency management planner from PlanRVA. Since local adoption of the *2011 Richmond-Crater Hazard Mitigation Plan*, which merged the previous Crater PDC and Richmond Regional PDC plans, local mitigation has been intertwined with emergency management activities, especially for outreach and messaging. Regional mitigation program highlights are outlined below.

Education and Outreach: Prior to the COVID-19 pandemic, local emergency managers kept a busy calendar of outreach festivals and events which centered on hazard-based safety outreach. The pandemic has limited gatherings in recent years, which has impacted some community outreach efforts. Many previous projects were nationally-branded efforts, which each jurisdiction customized to their locality. Examples include tornado awareness month in March with preparedness drills, annual preparedness days for hazards such as floods, wind, and tornado, Turn Around Don't Drown, the June 1 beginning of hurricane season, and promotion of Virginia preparedness supplies sales tax free weekends. On August 27, 2016, a regional PreparAthon community festival was sponsored by local media and corporations and conducted at the Virginia Science Museum in Richmond Virginia. Preparedness was celebrated by teaching participants how to prepare for and react to disasters and emergencies. Participants who signed up for a Disaster Preparedness Workshop received a free kit worth $45.

Early Warning and Notification: Most communities have refined their early warning and notification systems to allow cell phone and sometimes text notifications and other technological advances, often with targeted abilities for populations with disabilities. Localities with river flood stage monitoring use river and stream gage data to inform warning messaging, but rarely to target detailed evacuation planning. Virginia Commonwealth University uses a loudspeaker system as well as digital notification.

Plan Integration: The 2011 plan was used by some locality planners to inform sections of local comprehensive plans. GIS technicians used some data-layers from the 2011 plan. The 2022 plan's map data will be provided to the PDCs, so the data can be easily integrated into other local government emergency management and planning documents. The Crater Planning District Commission Director of Planning and Information Technology provides GIS technical support to any Crater PDC jurisdictions so will ensure integration of hazard information. The Hazus flood analysis is expected to be used for resiliency planning, especially in coastal jurisdictions.

The region's experienced floodplain program administrators conduct activities on a regular basis to make certain local floodplain management ordinances are administered in accordance with the NFIP. Building officials are partners in working to ensure adherence to hazard-related regulations and criteria in the VUSBC.

Community Rating System (CRS): FEMA's CRS program provides flood insurance premium reductions in five-percent increments following a rigorous, comprehensive floodplain management program review by FEMA and FEMA's partners. The City of Richmond enjoys a CRS rating of Class 8, meaning NFIP policyholders in the SFHA receive a 10% reduction on their annual flood insurance premiums. The Town of Ashland has a CRS Rating of Class 9, giving its policyholders a 5% annual flood insurance policy reduction. Henrico County is actively preparing an application to the CRS.

Critical and Public Facilities Protection: Due to increased power outages from more frequent severe storms with high winds causing tree loss, the region's local governments have intensified efforts to provide redundant power to critical facilities such as public safety buildings, 911 communications centers, health care facilities, as well as schools and other buildings to be used as shelters. Additionally, redundant power or backflow wiring or "quick connects" so that public buildings are able to accept temporary generators have become a local priority. While sometimes eligible for FEMA HMA grant support, most of the generator quick connects and installations have been done through local funding. Most new critical facilities are pre-wired for generator acceptance if a permanent generator is not installed. Communities typically have programs in place to test and fuel the generators on a regular basis to ensure dependability. The trend toward smaller shelters or opening community resource centers in lieu of sheltering has introduced new considerations in determining which facilities are critical and expanding the options for modern disaster sheltering.

6.6.3 Local Government Highlights

Local jurisdictions within the Richmond-Crater region have had numerous successes with mitigation actions that reduce vulnerability from a variety of hazards. The following list of programs, projects and policy changes highlight both successfully completed mitigation actions and illustrate how the mitigation planning process and plan itself have been integrated into other community plans, policies and regulations.

Ashland

Ashland officials report considerable progress with Continuity of Operations (COOP) planning, a need identified in the 2017 plan. The new threat assessment, COOP and EOP have been prepared jointly with the county, although each department will have their own operational plans. The COOP is substantially complete, but must be finalized and implemented with the county in the next planning period.

Charles City County

Charles City County is now considered an ingestion pathway community for Surry nuclear power plant emergencies and participates in appropriate testing. All community critical facilities have adequate generator capabilities. The county has established an effective emergency operations center within its Judicial Center. Emergency communications are being enhanced by the addition of a communication tower in the vicinity of the Judicial Center.

Chesterfield County

Chesterfield County has acquired four repetitive loss properties along Beach and Old Beach Road in the central part of the county. FEMA mitigation grant funds were used for this project.

More recently, the county was successful in implementing a recommended action in the previous plan regarding incorporating the 2017 Mitigation Action Plan into the comprehensive plan update being conducted simultaneously. Mitigation actions are similar throughout the two documents. The county also has a new COOP that will aid in the process of identifying needs for protecting critical facility infrastructure, an action in the previous mitigation plan that is retained in this update.

The county strives to provide a variety of emergency management—related training opportunities to county staff on an annual basis. Emergency Management is currently revising their recovery training and developing new best practices. Simultaneously, they have expanded their public outreach efforts to focus on the whole community concept of including seniors, people with disabilities, civic associations and faith-based organizations.

County officials report that through coordination with Virginia Department of Energy and use of the agency's maps of abandoned mines, the county has modified their development review process to include consideration of physical abandoned mine and related sinkhole hazards.

City of Colonial Heights

City officials report that two mitigation actions identified in the previous plan have been completed in the past five years. The city has completed a project to purchase and distribute NOAA weather radios for public facilities. They have also worked with Crater PDC to obtain and begin using GIS data regarding building footprint data to enable more precise flood hazard analysis for a variety of purposes.

Dinwiddie County

COVID-19 created a number of lessons learned that will inform the refinement of the county's new COOP over the next several years. The COOP was finalized, as recommended in the 2017 plan, just before COVID impacted the globe. The county also implemented their new Debris Management Plan in the past five years as called for the in the 2017 plan. Also, the county's Computer Aided Dispatch system has been improved with regard to road and railroad crossings, better correlating the crossing numbers to geographic locations.

Goochland County

Goochland County has been working with VDOF to promote best management practices among landowners in the county. The department and the county have offered joint courses on forestry management and wetlands protection. In addition, the county has thinned more than 160 acres of flammable pine plantations vulnerable to wildfire and insect infestation while instituting best management practices on county-owned property.

Greensville County

In 2009, the USACE, Norfolk District, completed a stream and rain gauging network study within the Chowan River Basin. The study identified gauging station needs that would improve flood forecasts by the NWS. An additional study in 2009 evaluated water resource issues, such as environmental restoration, flood risk management, navigation, and water quality. These two studies helped to determine Risk Mapping, Assessment, and Planning (Risk MAP) program activities implemented in the Chowan River Basin. The three Risk MAP activities included:

- Assessment of basin flood hazard data.
- Establishment of local community officials' knowledge and understanding of flood risk management concepts and increasing public awareness of flood hazards and the NFIP.
- Support to state and local governments to engage in risk-based mitigation planning.

The Chowan River Basin report provides an in-depth assessment of the river basin and mitigation activities for understanding flood risk. Areas of concern are highlighted throughout the report, which should be used to identify future mitigation actions.

Hanover County

Fire Station #5, the location of the Hanover County EOC, has been updated since the first regional hazard mitigation plan to address its electrical power capacity issues. The county also used the proceeds of a bond issuance to improve the communication system and interoperability. The basement of the Hanover County Sheriff's Office is still subject to flooding through the windows. This flooding could affect the emergency communications ability of the Sheriff's Office. Hanover County has also used FEMA mitigation funds for minor, localized drainage improvement projects. County officials indicate that, per the mitigation actions in the previous plan, needs related to electrical hook-ups, wiring and switches for connections to emergency power generation at key critical facilities has been substantially completed.

Henrico County

Henrico County has implemented higher standards in floodplain management, including a prohibition on new residential structures in identified floodplains. As a FEMA Cooperating Technical Partner, the county has mapped floodplain drainage areas in 100 acre units, providing far more discrete floodplain modeling than industry standards of 1 square mile (640 acres). Development or redevelopment is prohibited if it will cause a rise in the base flood elevation (or 100-year flood level). In addition, the lowest floor of new development and substantially improved structures must be two foot above the BFE if within the SFHA, and one foot above the BFE if within the 500-

year floodplain or within 40 feet of the SFHA. Finally, through the Chesapeake Bay Preservation Act ordinance, a mandatory stream buffer further prohibits development adjacent to streams and wetlands.

In 2005, the county purchased several properties in the Bloomingdale neighborhood along with the property at the intersection of Brook and Lakeside Avenues that were high flood risk, repetitive damage sites.

More recently, the county implemented a mitigation action from the previous plan regarding enhanced water availability for wildfire fighting in the eastern portion of the county. As sheltering needs evolve in this century, the county is focusing more on multi-hazard vulnerability assessments and mitigation planning for all schools to determine their suitability as temporary shelters during tornadoes and earthquakes, for example. Henrico County is also currently developing a floodplain acquisition program.

Hopewell

A 2017 mitigation action involving stream channel and road embankment stabilization along the City's primary emergency route is substantially complete. Work along Winston Churchill Drive between High Avenue and Arlington Road to protect adjacent residences is substantially complete.

New Kent County

As recommended in the 2017 plan, the county has applied for and will retain StormReady certification from the NWS. A prior mitigation action related to continuing participation in the NFIP and CRS, to include training and CFM certifications and other related actions, is echoed in the county's comprehensive plan. County officials report that road construction in the Fannies Creek area is mitigated as suggested in the previous plan. The county has also completed measures that requires substantial coordination with regional stakeholders, including coordination with various state agencies regarding traffic management concerns related to a Hampton Roads evacuation. The county has also assessed earthquake vulnerability in the area as recommended by the previous plan.

Prince George County

A mitigation action in the 2017 plan called for construction of a new burn building for the Fire Department to conduct exercises. As of late fall 2021, the designs are complete and construction is expected to begin shortly. The county also constructed a new fire station at Route 10 and Moody Road.

City of Richmond

Following numerous floods from the 1970's through 1990's, the USACE performed a study and ultimately constructed a flood wall to protect the Shockoe Bottom area and a small area of the south bank from James River flooding. The City of Richmond has been very active since 2011 with new mitigation projects and programs to help reduce its vulnerability to future events. The city received about 14 inches of rain from Tropical Storm Gaston, which the stormwater system was not able to manage effectively. Drainage features such as the East Gravity Outlet, which are part of the floodwall project, were found to contribute to increased damages on the protected side of the floodwall. The occurrence of back-to-back flooding brought attention to the city's older infrastructure system and its need for a dedicated source of funding. Using Capital Improvement Plan (CIP) funds in 2008–2010, the city completed many improvements to the Shockoe Bottom area.

During the additional budget cycles, the City of Richmond added three gate structures on the Northeast Interceptor to prevent the transfer of flow from the Arch Sewer to the main Box Sewer, which is the primary sewer collector in the Shockoe Bottom area. The city also installed or modified approximately 100 curb inlets to improve the capture of stormwater from the steeper slopes leading to the Shockoe Bottom watershed, helping to prevent flooding in the lowest parts of the Shockoe Bottom area. In addition, the city redesigned the storm drainage system in Pine Alley to capture a significant portion of the stormwater that would normally enter the alley and flood area businesses. Separation of the East Gravity Outlet from the combined sewer overflow system was also done to eliminate the need for gate operations to minimize interior flooding, increase the reliability of both the flood-reduction system and environmental protection system, and allow the operation of the system with a fail-safe mode. City contractors also connected the Box Sewer to the East Gravity Outlet to provide a high-rate overflow, and restored the Upper Shockoe Creek Retention Basin to further improve the capacity of the Shockoe Bottom Drainage system.

The major improvements in the Shockoe Bottom area were facilitated by the creation of a stormwater utility controlled by the Department of Public Utilities in 2009. This new utility transferred maintenance and improvements of the city's stormwater system from Public Works to Public Utilities and created a long-term source of funding. The new utility now creates an annual CIP list of projects and has begun working to improve the various systems throughout the city to reduce the potential loss of life and damages from future events.

Tropical Storms Gaston and Ernesto led the City of Richmond to complete two large residential mitigation projects that helped reconstruct and remove homes from the floodplain. The first was Broad Rock Creek Floodway Mitigation Project. This project included the acquisition, demolition, and relocation of several homes. The project also

identified other structures in the city that were then reconstructed to move their systems out and above the BFE. All properties were located in the Broad Rock Creek floodway and were adjacent to a 100-year floodplain where structures sustained severe damage as a result of the remnants of Tropical Storm Gaston in 2004.

The second project occurred with the acquisition and relocation of structures in the Battery Park community. The historic city park and several homes immediately adjacent to it sustained heavy damage during Tropical Storm Ernesto in 2006. The project resulted in the removal of homes from the floodplain and the creation of new parkland.

Richmond successfully used HMGP grant funds to add several stream monitoring gaging stations to augment its flood warning system. These are tied to the Commonwealth's Integrated Flood Observing and Warning System (IFLOW) system. Recently, Richmond has distributed NOAA weather radios to residents to expand their communication capabilities when power is out after disaster events, and they have successfully integrated GIS capabilities with emergency management needs, although additional opportunities remain. Emergency managers indicate the City has conducted wind studies on many City-owned facilities as part of a more comprehensive inventory assessment identified in Richmond 300.

Sussex County

Following the early 2016 tornado which killed three in Waverly, a Waverly Tornado Recovery Urgent Needs Study was conducted, which focused on long-term recovery efforts for the area. Meetings were conducted in late 2016 with the objective of submission of HUD grant applications to support neighborhood recovery and manufactured housing rehabilitation/mitigation. Mitigation action 11 in the MAP (in Section 7) was developed for the previous Hazard Mitigation Plan. Although some progress has been made, the action is retained in this plan with additional action expected in partnership with HUD in the future.

6.6.4 Emergency Operations Plans (EOP)

A comprehensive emergency management operations plan (or emergency operations plan) sets out a series of actions to be taken by government agencies and private organizations in response to an emergency or disaster event. The plan describes the jurisdiction's capabilities to respond to emergencies and establishes the responsibilities and procedures for responding effectively to the actual occurrence of a disaster.

Emergency operations plans in the Richmond-Crater region typically reference the Richmond-Crater PDC mitigation plan rather than including a mitigation section to the EOP. EOPs describe the responsibilities of various departments and agencies, private businesses, and the public in a post-disaster scenario. Importantly, I EOP outlines a concept of operations that explains and supports activities to be undertaken before and

during a disaster. Specific tasks are assigned to the local governing body and various agencies, such as Emergency Services, Health, Building Officials/County Engineer/Planning and Zoning, Law Enforcement, Fire Department and Emergency Crew, Superintendent of Schools, and the Public Information Officer. Each of the operational subplans is part of a total response plan typically overseen by the Director of Emergency Management or a comparable division lead. Emergency Managers for each city and county were included preparation of the MAP because their knowledge of their jurisdiction's EOP and its strengths and weaknesses is a valuable component of this planning process. In this way, the EOP was integrated into the update to the hazard mitigation plan.

In addition to local EOPs, VDOT and VDEM have worked with the localities to develop incident plans that include evacuation routes. When an event occurs, the Emergency Alert System (EAS) provides the latest information on evacuation. The majority of the Richmond and Crater regions are within the Richmond Extended EAS area. Surry County is an exception and is part of the Eastern Virginia EAS area.

Many of the region's community emergency operations plans outline the concerns surrounding mass evacuation, in terms of jurisdictional evacuation, evacuation of other areas in which the locality acts as a "host," or as a transit route locale. In addition to EOPs, many jurisdictions without comprehensive COOPs for all internal agencies were interested in supplementing their existing EOP or existing COOP with additional planning, and this insight was included in the MAP planning process.

6.6.5 Floodplain Management

Communities that regulate development in floodplains are able to participate in the NFIP. In return, the NFIP makes federally-backed flood insurance policies available for properties in the community. In Virginia, local governments are provided the power to regulate land use through Code of Virginia, Title 15.2 Counties, Cities and Towns, Subtitle II Powers of Local Government. Floodplain management in the study area communities is administered as a zoning overlay in the Zoning Ordinance (§ 15.2-2280) or through a standalone Floodplain Management ordinance (§ 15.2-984). Table 5.5 summarizes the history of NFIP participation for the study area jurisdictions. The table also provides the current FIRM effective date for each community.

The Towns of Surry, McKenney and Waverly did not have initial identified SFHA boundaries on the FIRMs; however, McKenney has chosen to adopt an ordinance and participate to make flood insurance available. **Table 6.3** below provides additional information for the study area jurisdictions. Community floodplain management ordinances were reviewed by the consultant as part of the preparation for Workshop #3; analysis from the review was discussed and incorporated into the planning process through recommendations for mitigation actions.

Each community has designated staff who enforce their floodplain management ordinance. The staff of the DCR Floodplain Management Program, including the NFIP State Coordinator, serve as state level administrators of the program, providing assistance to communities upon request.

DCR's Virginia Dam Safety Program operates under the authority of the Virginia Soil and Water Conservation Board. The division regulates impounding structures in the Commonwealth to ensure that they are 'properly and safely constructed, maintained and operated.' The Virginia Dam Safety Act, Article 2, Chapter 6, Title 10.1 (10.1-604 et seq) of the Code of Virginia and Dam Safety Impounding Structure Regulations (Dam Safety Regulations), were established and published by the Virginia Soil and Water Conservation Board. Virginia's Dam Safety Regulations were last updated on March 23, 2016.

Ongoing dam inspections and Virginia's participation in the National Dam Safety Program administered by FEMA and the USACE serve as a preventative measure against dam failures. Disaster recovery programs include assistance to dam owners and local officials in assessing the condition of dams following a flood disaster and assuring the repairs and reconstruction of damaged structures in compliance with the NFIP regulations.

6.6.7 Comprehensive Plans

Virginia law requires that all communities have a comprehensive land use plan and that it be updated every five years. A community's comprehensive plan provides the future vision for the community regarding growth and development; not by coincidence, many of the study area plans include land use or environmental protection goals that could support future mitigation efforts. For example, limiting development in the floodplain (which is considered mitigation) may also help meet open space goals laid out in a comprehensive plan. Several comprehensive plans in the study area address mitigation, green space, resiliency and long-term community sustainability. These are relatively new inclusions, and as communities continue to update their comprehensive plans and to create separate resilience plans, mitigation and resiliency issues will likely be more comprehensively addressed.

For the most part, these strategies address development in the floodplain or otherwise flood-prone areas. In addition, the plans indicate that communities in the Richmond-Crater region are experienced with and willing to use growth management tools such as zoning, subdivision regulations, and preferential tax assessment. In many cases, demographic information, land use characteristics and growth projections found in the most current available local comprehensive plans were used to update Section 4.0 Community Profile. Comprehensive plans for the communities were also consulted during the development of mitigation actions to identify areas of potential overlap or synergy, where previously-identified recommendations in the comprehensive plan could

be integrated into new or modified mitigation actions that address specific hazard vulnerabilities. This practice also helps prevent conflict between community planning efforts.

Table 6.3 summarizes the local planning mechanisms used by the jurisdictions in the study area.

Table 6.3: Local Planning Mechanisms

Locality	Disaster Recovery Plan	Comprehensive Plan	Floodplain Management Ordinance	Stormwater Management Plan	Emergency Operations Plan	Other
Charles City County	✓	✓	✓		✓	Chesapeake Bay Preservation Program
Chesterfield County	✓	✓	✓		✓	Continuity of Operations (COOP); Evacuation Plan; Wetlands Preservation Program; Open Space Program; Riparian Buffers Program
City of Colonial Heights	✓	✓	✓	✓	✓	Historic preservation ordinance; Chesapeake Bay Preservation Program (wetlands)
Dinwiddie County		✓	✓		✓	
City of Emporia		✓	✓		✓	Transportation plan, 1984
Hanover County	✓	✓	✓	✓	✓	Chesapeake Bay Preservation Program
Town of Ashland		✓	✓		✓	CRS
Henrico County	✓	✓	✓	✓	✓	Chesapeake Bay Preservation Program
Goochland County	✓	✓	✓	✓	✓	

Table 6.3: Local Planning Mechanisms						
Locality	Disaster Recovery Plan	Comprehensive Plan	Floodplain Management Ordinance	Stormwater Management Plan	Emergency Operations Plan	Other
Greensville County	✓	✓	✓		✓	Erosion control and sediment ordinance
City of Hopewell	✓	✓	✓	✓	✓	COOP, 2001 Evacuation plan
New Kent County		✓	✓	✓	✓	Chesapeake Bay Preservation Program
City of Petersburg	✓	✓	✓	✓	✓	Transportation plan; Chesapeake Bay Preservation Program Riparian buffers Open space program and plan
Powhatan County	✓	✓	✓	✓	✓	Open Space; Natural Resources Inventory; Debris Management Plan
Prince George County	✓	✓	✓	✓	✓	Chesapeake Bay Preservation Program Riparian buffers
City of Richmond	✓	✓	✓	✓	✓	Chesapeake Bay Preservation Program; CRS
Town of Surry		✓ (through county)			✓ (through county)	Chesapeake Bay Preservation Program Evacuation plan
Sussex County		✓	✓		✓	Evacuation plan Transportation plan, 1997
Town of Wakefield		✓ (through county)	✓		✓ (through county)	Chesapeake Bay Preservation Program Evacuation plan
Town of Waverly		✓ (through county)			✓ (through county)	Chesapeake Bay Preservation Program Evacuation plan

Table 6.4 summarizes how individual communities expect to continue integrating hazard mitigation actions into other planning tools, regulations and activities beyond those activities listed above. Check marks indicate which planning mechanisms are targeted for existing or future coordination and integration with that community's mitigation action plan. None of the communities currently participating in the NFIP are considering a change in status at this time.

Table 6.4: Integration Of Hazard Mitigation Actions Into Other Planning Mechanisms

Locality	Regulations	Administrative & Technical Procedures	Fiscal Planning (CIP, grants, budgeting)	Land Use Planning (comprehensive, resilience, transportation)	Other (public information, activities, etc)
Charles City County	✓	✓	✓	✓	✓
Chesterfield County	✓	✓	✓	✓	✓
City of Colonial Heights	✓	✓	✓	✓	✓
Dinwiddie County	✓	✓	✓	✓	✓
City of Emporia	✓	✓	✓	✓	✓
Hanover County	✓	✓	✓	✓	✓
Town of Ashland	✓	✓	✓	✓	✓
Henrico County	✓	✓	✓	✓	✓
Goochland County	✓	✓	✓	✓	✓
Greensville County	✓	✓	✓	✓	✓
City of Hopewell	✓	✓	✓	✓	✓
New Kent County	✓	✓	✓	✓	✓
City of Petersburg	✓	✓	✓	✓	✓
Powhatan County	✓	✓	✓	✓	✓
Prince George County	✓	✓	✓	✓	✓
City of Richmond	✓	✓	✓	✓	✓
Town of Surry	✓	✓		✓	
Sussex County	✓	✓	✓	✓	✓
Town of Wakefield	✓		✓	✓	
Town of Waverly	✓		✓	✓	

6.7 Legal Authority

Local governments in Virginia, including those in the Richmond-Crater region, have a wide range of tools available to them for implementing mitigation programs, policies,

and actions. A hazard mitigation program can use any or all of the four broad types of government powers granted by the Commonwealth of Virginia, which are (a) regulation, (b) acquisition, (c) taxation, and (d) spending. The scope of this local authority is subject to constraints; however, as all of Virginia's political subdivisions only have the power to act with proper delegation from the state. All power is vested in the state and can only be exercised by local governments to the extent it is delegated (in accordance with Dillon's Rule). Thus, this portion of the capabilities assessment will summarize Virginia's enabling legislation that grants the four types of government powers within the context of available hazard mitigation tools and techniques.

6.7.1 Regulation

General Police Power

Virginia's local governments have been granted broad regulatory powers in their jurisdictions. Virginia State Statutes bestow the general police power on local governments, allowing them to enact and enforce ordinances that define, prohibit, regulate or abate acts, omissions, or conditions detrimental to the health, safety, and welfare of the people, and to define and abate nuisances (including public health nuisances). Since hazard mitigation can be included under the police power (as protection of public health, safety, and welfare), towns, cities, and counties may include requirements for hazard mitigation in local ordinances. Local governments may use their ordinance-making power to abate "nuisances," which could include, by local definition, any activity or condition making people or property more vulnerable to any hazard.

All of the jurisdictions located in the Richmond-Crater region have enacted and enforce regulatory ordinances designed to promote the public health, safety, and general welfare of its citizenry.

Land Use

Regulatory powers granted by the state to local governments are the most basic manner in which a local government can control the use of land within its jurisdiction. Through various land use regulatory powers, a local government can control the amount, timing, density, quality, and location of new development. All these characteristics of growth can determine the level of a community's vulnerability in the event of a natural hazard. Land use regulatory powers include the power to plan, enact and enforce zoning ordinances, floodplain ordinances, and subdivision controls. Each local community in the Richmond-Crater region possesses legal authority to prevent unsuitable development in hazard-prone areas.

Planning

According to state statutes, local governments in Virginia may create or designate a planning agency. The planning agency may perform a number of duties, including:

- making studies of the area;
- determining objectives;
- preparing and adopting plans for achieving those objectives;
- developing and recommending policies, ordinances, and administrative means to implement plans; and
- performance of other related duties.

The importance of the planning powers of local governments is illustrated by the requirement that zoning regulations be made in accordance with a comprehensive plan. While the ordinance itself may provide evidence that zoning is being conducted "in accordance with a plan," the existence of a separate planning document ensures that the government is developing regulations and ordinances that are consistent with the overall goals of the community.

The cities and counties within the Richmond-Crater region all have planning departments and comprehensive plans. Most of the towns in the region, with the exception of Ashland, have no formal planning and limited zoning authority; these small towns rely on the county in which they are located to enforce most planning and zoning regulations. For purposes of the NFIP, towns are required to have their own floodplain management ordinances, but may rely on the county for help with administration, preferably through a mutual aid agreement.

Zoning

Zoning is the traditional and most common tool available to local governments to control the use of land. Broad authority is granted for municipalities and counties in Virginia to engage in zoning. Land "uses" controlled by zoning include the type of use (e.g., residential, commercial, and industrial), as well as minimum specifications that control height and bulk such as lot size, building height and setbacks, and density of population. Local governments are authorized to divide their territorial jurisdiction into districts, and to regulate and restrict the erection, construction, reconstruction, alteration, repair or use of buildings, structures, or land within those districts. Districts may include general-use districts, overlay districts (such as for floodplains), and special-use or conditional-use districts. Zoning ordinances consist of maps and written text.

Subdivision Regulations

Subdivision regulations control the division of land into parcels for the purpose of building development or sale. Flood-related subdivision controls may prohibit the subdivision of land subject to flooding unless flood hazards are identified and addressed. Subdivision regulations may also require that developers install adequate drainage facilities or stormwater controls, address erosion and sediment control, and design water and sewer systems to minimize flood damage and contamination.

All PlanRVA jurisdictions continue enforcement of their adopted subdivision ordinances and in many instances, have updated those ordinances during the past ten years. Some of the ordinances contain floodplain-specific provisions. For instance, Powhatan County requires a 100-foot natural vegetative buffer along all perennial streams as well as setbacks for residential structures from the floodplain. In New Kent County, new subdivisions with 50 or more homes are required to have at least two ingresses and egresses. This requirement will allow an alternate route if one is blocked in case of emergency. Since subdivisions of four lots or more trigger major subdivision review standards in Charles City County, most subdivisions are smaller to avoid these more rigorous standards.

Likewise, the jurisdictions in the Crater PDC have adopted subdivision ordinances. Many of the ordinances require that land be suited for development, and specifically, that land platted for residential use not be subject to flooding. The City of Emporia and Surry County require that utilities be buried underground.

Floodplain Management

All communities with a FEMA-designated SFHA in the Richmond-Crater region have adopted floodplain management regulations. Powhatan County's regulations have been in place since 1973, prior to joining the NFIP. The other jurisdictions adopted floodplain regulations as part of joining the NFIP.

In several cases, the regulations adopted by the study communities go beyond the minimum standards of the NFIP. Goochland and Powhatan Counties restrict uses in the floodplain. Henrico County prohibits new residential development in the floodplain and the county has developed, mapped and regulates their own floodplains that extend beyond the boundaries of the FEMA SFHA. The majority of communities set design criteria for utilities and other public infrastructure.

Goochland County and the City of Richmond prohibit manufactured homes in all or portions of the floodplain. Chesterfield County prohibits new manufactured home parks, while Greensville County prohibits new manufactured homes unless located in an existing park.

Twelve of the ordinances in the Richmond-Crater region describe procedures for structures built before the regulations were in place. While the ordinances must, at a

minimum, require that lowest floors of new and improved structures in the SFHA be constructed with the lowest floor at or above the base, or 100-year, flood elevation, freeboard refers to an extra level or protection that some communities incorporate into their regulations above the minimums. All localities that allow development in the floodplain require at least a 1-foot freeboard for development with some localities having higher freeboard requirements. The City of Hopewell and Henrico County require a 2-foot freeboard for all new and substantially reconstructed homes in the floodplain, Greensville County requires 18 inches of freeboard in its ordinance, and Surry County includes a 1-foot freeboard. Goochland County has the highest freeboard with a level of 3 feet above the base flood elevation for construction within the regulated floodplain.

Effective January 1, 2022, a new flood disclosure requirement of Virginia Code Section 55.1-708.2, requires that an owner of residential real property who knows that the dwelling unit is a repetitive risk loss structure must disclose such fact to the purchaser. A "repetitive risk loss structure" is defined as a property for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program within any rolling 10-year period since 1978. The law further requires that the owner of a property subject to the disclosure requirement must provide notification to the purchaser of any disclosure before the ratification of a contract.

Resiliency

In 2021, the Commonwealth began working with 2,000 stakeholders to build the *Coastal Resilience Master Plan*. This plan documents which land is exposed to coastal flooding hazards now and into the future, as well as the impacts of future flooding scenarios on coastal Virginia's community resources and manmade and natural infrastructure.

The Master Plan concluded that between 2020 and 2080:

- the number of residents living in homes exposed to extreme coastal flooding is projected to grow from approximately 360,000 to 943,000, an increase of 160%;
- the number of residential, public, and commercial buildings exposed to an extreme coastal flood is projected to increase by almost 150%, from 140,000 to 340,000, while annualized flood damages increase by 1,300% from $0.4 to $5.1 billion;
- the number of miles of roadways exposed to chronic coastal flooding is projected to increase from 1,000 to nearly 3,800 miles, an increase of nearly 280%; and
- an estimated 170,000 acres, or 89%, of existing tidal wetlands and 3,800 acres, or 38%, of existing dunes and beaches may be permanently inundated, effectively lost to open water.

The Commonwealth intends to develop successive updates of the Master Plan on at least a five-year cycle, managed by DCR in consultation with the Chief Resilience Officer, the Special Assistant to the Governor for Coastal Adaptation and Protection, and the Technical Advisory Committee.

The next phase of the Master Plan anticipated by 2024, will aim to address recommendations of the Technical Advisory Committee to broaden the analysis of natural hazards by including rainfall-driven, riverine, and compound flooding, expand and improve the inventory of resilience projects by continuing to add efforts and working with project owners to better understand the benefits of projects, and extend this critical work beyond the coastal region to encompass statewide resilience needs.

Projects identified in the Master Plan must go through a specified resiliency planning process to be funded through the Community Flood Preparedness Fund (CFPF), also launched in 2021. Several communities in the Richmond-Crater region are beginning initial stages of the planning process. CFPF is a statewide program maintained by DCR that fills pressing needs by prioritizing low-income communities and provides a permanent funding stream to finance flooding resilience projects, studies, and capacity-building initiatives. The Regional Greenhouse Gas Initiative (RGGI) is an initiative made up of eleven states that aims to reduce greenhouse gas emissions. RGGI holds carbon dioxide auctions, which will fund the Virginia CFPF.

North Atlantic Coast Comprehensive Study

The USACE recently completed a report detailing the results of a two-year study to address coastal storm and flood risk to vulnerable populations, property, ecosystems, and infrastructure affected by Hurricane Sandy in the North Atlantic region of the United States.

The *North Atlantic Coast Comprehensive Study* is designed to help local communities better understand changing flood risks associated with climate change and to provide tools to help those communities better prepare for future flood risks. It builds on lessons learned from Hurricane Sandy and attempts to bring to bear the latest scientific information available for state, local, and tribal planners.

The conclusions of the study, as detailed in the final report, include several findings, outcomes, and opportunities, such as the use of a nine-step Coastal Storm Risk Management Framework that can be customized for any coastal watershed. The study ranked localities risk impacts as to High, Medium or Low Impact. Within the Richmond-Crater region, Henrico, Charles City, Chesterfield, Prince George and Sussex Counties were ranked “Low” and Surry County was ranked “Medium.” This comprehensive study can provide planners with additional information on long-term impacts of coastal storms.

Stormwater Management

A stormwater management plan is designed to address flooding associated with stormwater runoff. The stormwater management plan is typically focused on design and construction measures that are intended to reduce the impact of frequent urban nuisance flooding.

Virginia Department of Environmental Quality (VDEQ) is the lead agency for developing and implementing statewide stormwater management and nonpoint source pollution control programs to protect the Commonwealth's water quality and quantity. Currently, three laws apply to land disturbance activity in Virginia: the Stormwater Management Act (§ 62.1-44.15:24 et seq.), Erosion and Sediment Control Law (§ 62.1-44.15:51 et seq.), and Chesapeake Bay Preservation Act (§ 62.1-44.15:67 et seq.). These laws evolved at different times, have been administered by different agencies throughout the years, and created three distinct regulatory programs with varying requirements. At the request of the Chairs of the Virginia House and Senate Natural Resources committees, VDEQ pulled together a group of stakeholders to consider ways to streamline and possibly combine these programs. The goal is to make the requirements clearer, more consistent and more "user-friendly", while continuing to ensure the protection of the Commonwealth's water quality. The Department asked representatives of all affected constituencies to take part in this important effort – including local governments, the development community, environmental organizations, agriculture, and others.

Local governments in Virginia are required to administer the stormwater management and erosion and sediment control laws and regulations promulgated by the State through local ordinances. Surry County's program is administered directly by VDEQ.

Chesapeake Bay Preservation Act (CBPA)

The Virginia General Assembly enacted the Chesapeake Bay Preservation Act in 1988, requiring local governments statewide to include water quality protection measures in their zoning and subdivision ordinances and in their comprehensive plans. Although the Act was developed with the intent of improving water quality throughout Virginia, the regulations have the additional benefit of controlling or restricting development in floodplain areas. The CBPA Overlay District consists of three components: Resource Protection Area (RPA) that includes a 100 foot RPA buffer, a Resource Management Area (RMA), and the Intensely Developed Areas (IDA). The lands that make up Chesapeake Bay Preservation Areas are those that have the potential to impact floodplains and water quality most directly. Generally, there are two main types of land features: those that protect and benefit water quality (RPAs); and those that, without proper management, have the potential to damage water quality (RMAs). Areas with intensive waterfront industrial land uses and activities are categorized as IDAs.

Localities within the plan update region that are within the Chesapeake Bay watershed and thus enforce the CBPA regulations include: Charles City, Chesterfield, Hanover, Henrico, New Kent, Prince George, and Surry Counties, the cities of Colonial Heights, Hopewell, Petersburg and Richmond and the towns of Ashland, and Surry.

Building Codes and Building Inspection

Building codes regulate design and construction standards. Permits are issued and work is inspected on new construction and building alterations. Permitting and inspection processes both before and after a disaster can affect the level of hazard risk faced by a community.

Under Virginia law, the Department of Housing and Community Development (DHCD) has authority to promulgate building regulations and a regulatory process for development and adoption of a statewide mandatory mini/maxi construction code that all 167 units of local government (counties and incorporated cities) must adopt and implement. As stated above, the VUSBC is administered by the Virginia Board of Housing and Community Development and regulates construction and maintenance of buildings and structures. Effective July 1, 2021, Virginia adopted the 2018 I-codes as referenced in the Virginia Construction Code Part 1, the 2018 Statewide Fire Prevention Code; and the 2017 National Electrical Code. Implementation for state colleges and universities is the responsibility of the Virginia General Services Department. The State Fire Marshal within DHCD is responsible for statewide implementation of the Fire Code unless localities elect to adopt this code at the local level. Localities can and do adopt the Property Maintenance Code, which is within the scope of the statewide code. Enforcement of the VUSBC is the responsibility of the local government's building inspections department. Many of the towns in the study area rely upon the county building department for code-related functions.

DHCD has a resiliency subcommittee on codes that met and made recommendations for the 2018 code, and each code change had to have a resiliency impact considered. The 2018 version of the codes incorporates several resiliency measures, including: a requirement for 3 Elevation Certificates at various stages of construction for structures built in the SFHA; various freeboard requirements based on building characteristics (1 foot minimum for residential); and coastal high hazard area requirements for Coastal A Zones, or areas seaward of the LiMWA. The resiliency subcommittee is doing the same for the 2021 update currently underway.

Radon Exposure Remediation

The Code of Virginia requires that Radon testers and mitigators be currently certified by either the National Radon Proficiency Program or the National Radon Safety Board. The program is administered by VDH, Office of Radiological Health, Indoor Radon Program. In 1993, the Virginia General Assembly passed legislation that requires all

schools in the Commonwealth to be tested for radon after July 1, 1994, and also any new school buildings or additions built after that date. Each school is required to maintain files of their radon test results. Upon request, the Department's Radon Coordinator can present a course on radon for real estate transactions in Virginia. The department has a limited supply of radon test devices that are distributed annually, free upon request.

6.7.2 Acquisition

The power of acquisition can be a useful tool for pursuing local mitigation goals. Local governments may find that the most effective method for completely "hazard-proofing" a particular piece of property or area is to acquire the property (either in fee simple or a lesser interest, such as an easement), thus removing the property from the private market and eliminating or reducing the possibility of inappropriate development. Virginia legislation empowers jurisdictions to acquire property for public purpose by gift, grant, devise, bequest, exchange, purchase, lease, or eminent domain.

The City of Richmond completed acquisition projects after 2006 Tropical Depression Ernesto, in both the Broad Rock Creek and Battery Park neighborhoods. All projects were completed without using FEMA mitigation funds. Virginia CDBG Urgent Needs funds were used following Ernesto to acquire and demolish flood-damaged properties. Once the structures were demolished, the lots were dedicated to permanent open space. In some instances, Richmond has used city funds available to the Building Official to acquire and demolish disaster-impacted properties, such as with some trailer park communities and a residence impacted by the landslide on Church Hill following Tropical Depression Gaston. Chesterfield County acquired several repetitive loss properties along Beach and Old Beach Roads using FEMA HMGP funds following Hurricane Isabel. Development of an acquisition program is proposed in the City of Petersburg Comprehensive Plan. The City of Colonial Heights continues to consider a voluntary acquisition program along high-risk creeks to eliminate repetitive flood claims in the city. Henrico County is currently developing a floodplain acquisition program, as well.

6.7.3 Taxation

Real estate taxes are a significant source of local revenue. Code of Virginia §58.1-3201 requires that a structure be assessed at 100% of fair market value. A building that increases in value of more than $500 due to repairs or additions must be assessed as new (Code of Virginia §58.1-3291), also at 100% of fair market value. At the same time, the code allows the abatement of local real estate taxes for buildings unusable for at least 30 days during the year (Code of Virginia §58.1-3222); however, the abatement is prorated based on what portion of the year the property was impacted.

Specified local governments in the Commonwealth have the ability to levy special assessments on property owners for all or part of the costs of acquiring, constructing,

reconstructing, extending, or otherwise building or improving flood protection works within a designated area (Code of Virginia §15.2-2404(D)); however, none of the specified communities are within the Richmond-Crater study area. Special assessments for flood control structures can serve to increase the cost of building in such areas, thereby effectively discouraging development. Because the usual methods of apportionment seem mechanical and arbitrary, and because the tax burden on a particular piece of property is often quite large, the major constraint in using special assessments is policy-oriented. Special assessments seem to offer little in terms of control over land use in developing areas. They can, however, be used to finance the provision of necessary services within municipal or county boundaries. In addition, they are useful in distributing the costs of the infrastructure required by new development to new property owners.

The State Corporation Commission collects communication taxes in Virginia, including a 75 cent E911 tax on landlines and Voice Over Internet Protocol phones, a 94 cent postpaid wireless E-911 tax for mobile phones, and a 63 cent prepaid wireless E-911 tax for mobile phones. These taxes pay for the cost of an emergency response communications system that identifies both the caller and the location of the call.

6.7.4 Spending

The fourth major power that has been delegated from the Virginia General Assembly to local governments is the power to make expenditures in the public interest. Hazard mitigation principles should be made a routine part of relevant spending decisions made by the local government, including the adoption of annual budgets and the CIP.

A CIP is a schedule for the provision of municipal or county services during a specified period of time. Capital programming, by itself, can be used as a growth management technique, with a view to hazard mitigation. By tentatively committing itself to a timetable for the provision of capital to extend services, a community can control growth to some extent, especially in areas where the provision of on-site sewage disposal and water supply are unusually expensive.

In addition to formulating a timetable for the provision of services, a local community can regulate the extension of and access to services. A CIP that is coordinated with extension and access policies can provide a significant degree of control over the location and timing of growth. These tools can also influence the cost of growth. If the CIP is effective in directing growth away from environmentally-sensitive or high-hazard areas, for example, it can reduce environmental costs.

The majority of the jurisdictions in the Richmond-Crater region have some form of a CIP. The construction or renovation of capital facilities, such as schools, municipal offices, and police/fire stations is often a highlight of their capital improvements. Investments in stormwater and sewer systems are included in the capital

improvements program for most municipalities. Some jurisdictions also have included open space and other park acquisition costs as part of their CIP.

6.8 Summary

Most of the information in the capability assessment was provided by the jurisdictions in the study area through a capability assessment survey. **Table 6.5** summarizes the self-reported capability and priority assessment; note that several jurisdictions have not returned the 2016 or 2021 update capability assessment surveys.

Table 6.5: Mitigation Capability & Priority Self-Assessment by Jurisdiction

Jurisdiction	Planning and Regulatory Capability	Administrative Capability	Technical Capability	Fiscal Capability	Overall Capability
PlanRVA	Planning High	Moderate	Moderate	Moderate	Moderate
Crater PDC	Planning High	Moderate	Moderate	Moderate	Moderate
Charles City County	Moderate	Moderate	Moderate	Moderate	Moderate
Chesterfield County	High	High	High	High	High
City of Colonial Heights	Moderate	Moderate	Moderate	Moderate	Moderate
Dinwiddie County	Moderate	Moderate	Moderate	Moderate	Moderate
Town of McKenney	Limited	Limited	N/A	Limited	Limited
City of Emporia	Moderate	Moderate	Moderate	Moderate	Moderate
Goochland County	Moderate	Moderate	Moderate	Moderate	Moderate
Greensville County	Moderate	Moderate	Moderate	Moderate	Moderate
Town of Jarratt	Limited	Limited	N/A	Limited	Limited
Hanover County	Moderate	Moderate	Moderate	Moderate	Moderate
Town of Ashland	Moderate	High	Moderate	Limited	Moderate
Henrico County	High	High	High	High	High
City of Hopewell	Moderate	Moderate	Moderate	Limited	Moderate
New Kent County	Moderate	High	Moderate	Moderate	Moderate
City of Petersburg	Limited	Limited	Moderate	Limited	Limited
Powhatan County	Moderate	High	Moderate	Moderate	Moderate
Prince George County	Moderate	Moderate	Moderate	Moderate	Moderate
City of Richmond	Moderate	Moderate	Moderate	Limited	Moderate
Town of Surry	Limited	Limited	Limited	Limited	Limited
Sussex County	Moderate	Limited	Limited	Limited	Limited
Town of Stony Creek	Limited	Limited	Limited	Limited	Limited
Town of Wakefield	Moderate	Moderate	Limited	Moderate	Moderate
Town of Waverly	Limited	Limited	Limited	Limited	Limited

High: No increase in capability needed (e.g., extensive regulations on development in place).

Moderate: Increased capability desired but not needed (e.g., funding exists for mitigation but availability fluctuates).

Limited: Increased capability needed (e.g., additional staff are needed to successfully implement mitigation projects).

7.0 Mitigation Strategy

7.1 Updates for 2022

During the 2022 update, Section 7 was updated to reflect the Committee's work to update the Goals and Objectives. The following major changes were incorporated:

1. All tables were added or updated to reflect new information, including the new goals and objectives;
2. Mitigation actions were reviewed, completed actions were deleted; and, new mitigation actions were revised and added as directed by Committee members; and
3. Mitigation actions were modified to include a ranking for social vulnerability.

7.2 Introduction

This section of the Plan provides the "blueprint" for the Richmond-Crater region to become less vulnerable to natural hazards. It is based on the general consensus of the Committee along with the findings and conclusions of the Capability Assessment and Risk Assessment. The Mitigation Strategy section consists of the following four subsections:

7.1 Mitigation Goals

7.2 Identification and Analysis of Mitigation Techniques

7.3 Selection of Mitigation Techniques

7.4 Mitigation Action Plan

The intent of the Mitigation Strategy is to provide participating communities with the goals that will serve as the guiding principles for future mitigation policy and project administration, along with a list of proposed actions available to meet those goals and reduce the impact of natural hazards. It is designed to be comprehensive and strategic in nature.

The development of the strategy included a thorough review of all natural hazards and identified policies and projects intended to not only reduce the future impacts of hazards, but also to assist the region in achieving compatible economic, environmental, and social goals. The development of this section is also intended to be strategic, in that all policies and projects are linked to established priorities assigned to specific departments responsible for their implementation and assigned target completion deadlines. Funding sources are identified when possible, that can be used to assist in project implementation.

The first step in designing the Mitigation Strategy includes the identification of mitigation goals. Mitigation goals represent broad statements that are achieved through the implementation of more specific, action-oriented tasks listed in the Mitigation Action Plan (MAP). These actions include both hazard mitigation policies (such as the regulation of land in known hazard areas), and hazard mitigation projects that seek to address specifically targeted at-risk properties (such as the acquisition and relocation of flood-prone structures). Additional mitigation measures are then considered over time as new mitigation opportunities are identified, new data become available, technology improves, and mitigation funding becomes available.

The last step in designing the Mitigation Strategy is the creation of a set of jurisdictionally specific MAPs. The MAPs represent the key outcome of the mitigation planning process. MAPs include a prioritized list of proposed hazard mitigation actions (policies and projects), including accompanying information such as those agencies or individuals responsible for their implementation, potential funding sources, and an estimated target date for completion. The MAPs provide those individuals or agencies responsible for implementing mitigation actions with a clear roadmap that also serves as an important tool for monitoring progress over time. The collection of actions listed in the MAP also serves as a synopsis of activities for local decision makers.

In preparing the MAPs, committee members considered their overall hazard risk and capability to mitigate natural hazards, in addition to the mitigation goals. The prioritization of mitigation actions was based on the following five factors: (1) effect on overall risk to life and property; (2) ease of implementation; (3) political and community support; (4) a general economic cost/benefit review; and (5) funding availability.

A separate ranking for each MAP's impact on socially vulnerable populations is also included. This High, Moderate or Low impact rating is based on the NRI vulnerability information provided in Section 5. Where projects were identified in a specific location and/or tied to reducing vulnerability from a single hazard, the hazard-specific ranking for that Census tract and hazard was used. Projects geared toward reducing risk community-wide, such as general outreach, were evaluated based on the relative NRI social vulnerability of that community versus the percent of counties/cities with lower social vulnerability in Virginia (–ow - less than 40% of other counties/cities have lower social vulnerability; Moderate – 41-75%; High –75-100%). In cases where an action was specifically geared toward highly socially vulnerable populations within a community, the NRI risk was overridden, and the action was rated High.

7.3 Mitigation Goals

The goals of the Richmond-Crater Hazard Mitigation Plan were crafted as part of Workshop #3, a facilitated discussion and brainstorming session with committee members (see Section 3: Planning Process). As part of the 2022 update, the planning consultant reviewed the goals and objectives of the previous plan as well as pertinent

goals and objectives from Virginia Beach's Sea Level Rise: Adaptation Strategy, Virginia's Coastal Resilience Master Planning Framework, the most recent Hampton Roads Hazard Mitigation Plan (2021 draft), the 2016 Middle Peninsula Hazard Mitigation Plan, and the 2018 Commonwealth of Virginia Hazard Mitigation Plan. In this way, the committee was able to incorporate some important regional resilience goals and work to find common ground in statewide, regional and local mitigation programming.

The group reassessed each goal word for word, reprioritized the list, and edited overall for brevity. The original document ("2017 Plan Goals and Objectives") and updated ("2022 Plan Goals and Objectives") goals are provided in **Table 7.1** below, with notes about the discussion leading to the changes. Each of the following updated goal statements represents a broad target to achieve through associated objectives which are fulfilled through implementation of specific Mitigation Action Plans, both for the region as a whole and for each community.

Table 7.1: Updated Goals and Objectives

2017 Plan Goals and Objectives	2022 Plan Goals and Objectives
~~**Goal 1:** Reduce risk exposure and vulnerabilities to hazards ranked "medium" and "high" by focusing on regional and local mitigation actions on priority hazards.~~	Deleted **Why the Change:** The goal was worded so broadly as to encompass the purpose of the whole plan.
Goal 2: Prepare and protect the whole community within the Central Virginia Emergency Management Alliance (EMACV) region through all-hazards planning staff, outreach publications and activities, and through training, and exercising volunteers and the general public.	**Goal 1: Equitably prepare and protect the whole community against natural hazards** 1.1 Increase staff capabilities regarding multi-hazard management and mitigation 1.2 Conduct outreach and educational opportunities for diverse groups of citizens 1.3 Share mitigation successes with citizens and stakeholders 1.4 Reduce disparities in how communities prepare for, respond to, and recover from hazards. **Why the Change:** Previous goal was divided into several objectives to show how the goal can be achieved. The EMACV does not cover the entire study area. The word "equitably" was added to reflect group's desire to identify mitigation actions for socially vulnerable areas of their communities.
Goal 3: Strengthen and sustain response coordination and collaboration through planning, equipment, training, and exercises to increase interoperability between all stakeholders in the EMACV region and other regions/entities that impact interoperability within the region, to include, but not limited to voice, video, and data.	**Goal 2: Strengthen and develop partnerships for mitigating and reducing hazard impacts** 2.1 Include stakeholders and other regions in planning and training actions. 2.2 Expand outreach and educational opportunities to influence and inform a broad spectrum of stakeholders. 2.3 Collaborate on public safety and support effective system redundancies

Table 7.1: Updated Goals and Objectives	
2017 Plan Goals and Objectives	**2022 Plan Goals and Objectives**
	Why the Change: The focus on stakeholders was retained, but goal was divided into several manageable objectives to fulfill of overall goal. The EMACV does not cover entire study area.
~~**Goal 4:** Provide support for public health and human service needs of the whole community through robust and coordinated sheltering capability, to include planning, resources, equipment, training, and exercises to include support of client needs tracking, family reunification services, information sharing, and public health response support.~~	Deleted **Why the Change:** The concepts captured in the action were similar to old Goal 5, and thus were merged into new Goal 3.
Goal 5: In the aftermath of a catastrophic incident, provide restoration of basic services, long term housing, and revitalization of a sustainable economy that includes the health, social, cultural, historic, and environmental fabric of the community, through planning, staffing, equipment, training, and exercises.	**Goal 3: Encourage sustainable government practices that support the short- and long-term health, safety and welfare of citizens** 3.1 Identify and protect important elements of the economic, social, cultural, historic, and environmental fabric of the community and neighborhoods 3.2 Address restoration of long-term housing and continuity of basic government services for affected populations, especially socially vulnerable communities, during recovery from hazard events **Why the Change:** The focus on sustainability was retained as was the concept of community "fabric", but the goal was broken down into several manageable objectives to show how to attain the overall goal.
~~**Goal 6:** Enhance and maintain public safety and incident management response capabilities to all hazard emergencies including acts of terrorism, through planning, staffing, equipment, training, and exercises.~~	Deleted **Why the Change:** The concepts captured in the previous action were similar to old Goal 5, and thus were merged into new Goal 3.
Goal 7: Protect the critical infrastructure of the CVEMA region, and enhance the capability to disrupt criminal or terrorist threats through effective information and intelligence gathering and sharing, outreach, planning, equipment, training, and exercises.	**Goal 4: Protect critical infrastructure** 4.1 Identify opportunities for information- and intelligence-sharing regarding threats and hazards 4.2 Collaborate on utility management and support effective system redundancies 4.3 Identify and assist owners to maintain and upgrade high hazard potential dams, and protect the people and property downstream **Why the Change:** The focus on critical infrastructure was retained, but overall goal was divided into several objectives to show how to attain goal. The EMACV does not cover entire study area. Added high hazard potential dam protection.

7.4 Identification and Analysis of Mitigation Techniques

44 CFR Requirement

Part 201.6(c)(3)(ii): The mitigation strategy shall include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effect of each hazard, with particular emphasis on new and existing buildings and infrastructure.

In formulating the Richmond-Crater Mitigation Strategy, a wide range of activities was considered in order to help achieve the goals and address specific hazard concerns. At the third workshop, committee members considered six broad categories of mitigation techniques. Committee discussions regarding each category are summarized beneath each category, including notes on the appropriateness and applicability of each as it applies to the region.

1. Prevention

Preventative activities are intended to reduce the impact of future hazard events, and are typically administered through government programs or regulatory actions that influence the way land is developed and buildings are constructed. They are particularly effective in reducing a community's future vulnerability, especially in areas where development has not occurred or capital improvements have not been substantial. Examples of preventative activities include:

- Planning and zoning
- Building codes
- Open space preservation
- Floodplain regulations
- Stormwater management regulations
- Drainage system maintenance
- Capital improvements programming
- Shoreline/riverine setbacks

Committee Discussion: Prevention activities have been implemented in the past in the region, are ongoing, and will continue to be included in this and future mitigation action plans. Many communities will mitigate flood damage through planning and zoning actions, such as amendments to their floodplain management ordinances which are viewed as very effective mitigation tools locally. Most communities in the region are continually updating zoning ordinances, especially for flood zones. The statewide building code is viewed as a rather static mitigation tool; it

has components that mitigate especially for wind and flood, but is not a product that local governments exert a great deal of influence upon regularly. Appendix F of the building code could be adopted by communities concerned about protecting future construction from the impacts of radon exposure.

Open space preservation strategies are contained in most of the regional comprehensive plans, and some communities such as Richmond, have targeted planning in place for protecting green spaces and adding to their inventory. In the more urbanized areas of the region, open space preservation is also addressed in subdivision regulations. Several communities have integrated information from their existing hazard mitigation plans into Comprehensive Plan revisions, and vice versa.

Stormwater management regulations and drainage system maintenance rules promulgated at the state level are viewed as quite robust and not in need of additional local action at this time, although several communities are considering adopting more stringent regulations to require use of better future precipitation levels (similar to Virginia Beach); in addition, VDOT performs much of the drainage system maintenance in the region. Similarly, the state's Chesapeake Bay Act regulations governing shoreline setbacks are enforced locally in the Chesapeake Bay watershed communities. Capital improvements programming is seen as a useful tool in the implementation of high priority mitigation activities across the participating communities.

2. Property Protection

Property protection measures involve the modification of existing buildings and structures or the removal of the structures from hazardous locations. Examples include:

- Acquisition
- Relocation
- Building elevation
- Critical facilities protection
- Retrofitting (i.e., windproofing, floodproofing, seismic design)
- Safe rooms, shutters, shatter-resistant glass
- Insurance

Committee Discussion: Property protection measures have been implemented in the past in the region and across the state, and are ongoing primarily through HMGP projects. These measures will continue to be included in this and future mitigation action plans. Communities expressed various priorities for acquisition versus elevation versus relocation of flood-prone structures. Critical facilities

protection and floodproofing/retrofitting are popular alternatives with the region's emergency managers, and many communities continually seek ways to increase insurance coverage for vulnerable property owners. The Community Rating System and related activities encompass and highlight several property protection measures ongoing in the participating communities of Richmond and Ashland.

The Committee decided to continue acquisition, relocation, and elevation measures for repetitively flooded properties, including critical facilities retrofits, in the Mitigation Action Plan, but did not act on any measures specifically for safe rooms or shatter-resistant glass as tornadoes are not a high risk critical hazard. Some communities had discussions about providing safe rooms in designated areas, particularly in manufactured home parks, but only Sussex County expressed interest in pursuing that action at this time.

Existing building code requirements are seen as sufficient with regard to wind and tornado protection; however, hurricane shutters and shatter-resistant glass may be an option for critical facility or emergency shelter retrofits as necessary. Many of the study area communities have installed or are considering installation of back-up generators for specific critical facilities, although some communities prefer mobile and some communities prefer permanent generators.

With regard to insurance, many of the communities have produced community flyers regarding the importance of having insurance coverage on structures.

3. Natural Resource Protection

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Natural areas could include floodplains, wetlands, steep slopes, barrier islands and sand dunes. Parks, recreation or conservation agencies and organizations often implement these measures. Examples include:

- Land acquisition
- Floodplain protection
- Watershed management
- Beach and dune preservation
- Riparian buffers
- Forest and vegetation management (i.e., fire resistant landscaping, fuel breaks)
- Erosion and sediment control
- Wetland preservation and restoration
- Habitat preservation

- Slope stabilization
- Historic properties and archaeological site preservation

Committee Discussion: Natural resource protection measures remain commonly-used throughout the state. Many state programs discussed in Section 6, such as the Chesapeake Bay Act, are long-established natural resource protection measures considered effective and pro-active. The most important of these measures in relation to the region's critical hazards are floodplain protection, erosion and sediment control, and watershed management. Several communities indicated the cost of flood-prone land mitigation is often prohibitive for their local governments due to the level of administrative oversight required for grant programs.

Several rivers in the study area are designated scenic rivers and that designation has positively impacted watershed management efforts. Forest management in conjunction with VDOF is important in parts of the region, and affects vulnerability for wildfire. Beach and dune preservation is another state-promulgated program that requires permitting for impacts in the eastern or coastal portions of the study area. Friends of the Lower Appomattox River (FOLAR) participated in Committee discussions And expressed interest in partnering with riverside communities in protecting open space floodplains through land acquisition, and other eco-tourism related measures.

Several communities decided to continue floodplain protection measures and land acquisition in the MAP, but did not act specifically on other natural resource protection measures as those are considered to be sufficiently addressed through state regulations. Slope stabilization is important along the James River, although individual projects are not identified in the MAP. Abandoned mines are mapped by the state and development in relation to them is strictly regulated at the local level to ensure natural land cover disturbances are minimized.

4. Structural Projects

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the hazard itself through construction. These projects are usually designed by engineers and managed or maintained by public works staff. Examples include:

- Reservoirs
- Dams/levees/dikes/floodwalls/seawalls
- Diversions/detention/retention
- Channel modification
- Beach nourishment
- Storm sewers

Committee Discussion: New large-scale reservoirs are not under consideration at this time in the region. Dam regulations at the state level are considered sufficient and communities are not considering additional regulation. Several structural protection measures are in place and must be maintained by the communities or private owners. Channel modifications, diversions, detention/retention, and stream restoration have been effective in reducing flood hazards in some areas and will remain viable mitigation actions in the future, especially for reducing the compounding effects of increased precipitation, floods and sea level rise. Stream restoration was recently included as a best management practice (BMP) in the State's BMP clearinghouse and some committee members believe that this may result in this method being considered and possibly used more in the future. Dry hydrants, and smoke testing of sanitary sewers, and the stormwater management preventive maintenance schedule are potential structural projects, with dry hydrants particularly important in wildfire control in the rural counties, including Charles City County. Beach nourishment is not being considered for limited beaches in the study area's eastern counties; erosion is typically on private proper

5. Emergency Services

Although not typically considered a "mitigation" technique, emergency services can minimize the impacts of a hazard event on people and property. These actions are often taken prior to, during, or in response to an emergency or disaster. Examples include:

- Warning systems
- Evacuation planning and management
- Emergency response training and exercises
- Sandbagging for flood protection
- Installing temporary shutters for wind protection

Committee Discussion: Riverine warning systems are being considered to help address some of the region's flood hazards. Several communities have recently implemented unified critical communications software to deliver messages to targeted audiences, and most communities have some form of reverse 911. Leveraging the various communities' flood warning systems to create a more regional approach would aid the people who live and commute through multiple jurisdictions. Regional cooperation on this front could benefit residents and visitors to the region and may result in savings to communities. Some communities with industrial waterfronts are concerned with hazardous materials in the floodplain and storm surge zones, and this generated discussion on actions related to business resilience and readiness in communities such as the City of Hopewell.

Evacuation planning is aided at the regional and state levels, but local planners use many tools to continually manage and improve the program; several are now considering more use of targeted evacuations in accordance with an evacuation plan that includes timed evaluation of road elevations and predicted flood elevations. Evacuation and sheltering plans for vulnerable populations are a high priority for the region's emergency planners at this time, and planners continue to express concerns about mass evacuation from coastal Virginia, North Carolina and the Washington D.C. area, which can have devastating impacts on the region's infrastructure.

Sandbagging for flood protection is generally considered helpful, but local governments are not typically involved in helping property owners sandbag. Individual property owners may decide to sandbag for protection, but this is not an action committee members want to include in the MAP, as longer-term retrofit protection methods are deemed preferable. Adding generator electrical circuits to support critical operations during power outages was discussed by almost every community. This activity is both an Emergency Services action and a Property Protection measure.

6. Public Education and Awareness

Public education and awareness activities are used to advise residents, elected officials, business owners, potential property buyers, and visitors about hazards, hazardous areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures used to educate and inform the public include:

- Outreach projects
- Speaker series/demonstration events
- Hazard mapping
- Real estate disclosure
- Library materials
- School children educational programs
- Hazard expositions
- Inter-governmental coordination

Committee Discussion: Public education and outreach activities are a particular focus of emergency planners in the region and are ongoing, particularly through existing web sites, social media outlets and several CRS-related activities. Speaker series and demonstration events are supported by several of the local governments throughout the year, but may not rise to the importance of being included in the MAP for each of these communities. Many of these activities are supported or promoted by the PDCs, such as annual preparedness days. Some of these activities have been on hold because of COVID-19.

FEMA, working with the USACE, has revised many of the Flood Insurance Rate Maps for the region as studies are completed. Additional hazard mapping has been done by Henrico County in particular. Real estate disclosure, particularly for flood risk and radon risk, is guided by current State regulations and not influenced by local government. Library materials, school programs, and open houses are included in the MAP for interested communities.

Committee members discussed use of Community Emergency Response Teams (CERT) and potential existing actions; however, in several cases CERTs have altered functions or been reduced or eliminated during the COVID-19 disaster. The PDCs support several efforts at inter-governmental coordination, including the Emergency Management Alliance of Central Virginia, a voluntary association of government and key stakeholder organizations that manage emergency preparation, response, relief, recovery and mitigation in Central Virginia. There is also a CRS User's Group, facilitated by Wetlands Watch, that is very active among CRS and CRS-interested communities in some parts of the study area.

7.5 Selection of Mitigation Techniques

In order to determine the most appropriate mitigation techniques, committee members reviewed and considered the findings of the Capability Assessment and Risk Assessment. Other considerations included each mitigation action's effect on overall risk reduction, its ease of implementation, its degree of political and community support, its general cost-effectiveness and funding availability.

FEMA guidance for meeting the planning requirements of the Disaster Mitigation Act of 2000 also specifies that local governments should prioritize their mitigation actions based on the level of risk a hazard poses to the lives and property of a given jurisdiction. A Mitigation Technique Matrix (**Table 7.2**) shows that those hazards posing the greatest threat are addressed by the updated MAP.

The matrix provides the committee with the opportunity to cross-reference each of the priority hazards (as determined through the Risk Assessment) with the comprehensive range of available mitigation techniques, including prevention, property protection, natural resource protection, structural projects, emergency services, and public education and awareness. The Mitigation Action Plan includes an array of actions targeting multiple hazards, not just those classified as either high or moderate risk.

As part of the 2022 update, the committee reviewed several documents to assist with the development of new mitigation actions and the assessment of existing actions. Review documents included: 1) a spreadsheet of each community's capabilities and any mitigation program gaps subsequently identified; 2) each community's Comprehensive Plan, specifically components that may be compatible with mitigation goals, or that may be appropriate as mitigation actions; 3) contractor review of local floodplain

regulations; 4) the mitigation action items from the existing plans with 2022 status information; and 5) several recommended publications, including FEMA Publication *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*, January 2013, FEMA's *Mitigation Best Practices* and *Mitigation Action Portfolio* web site, and resilience design guidelines for Miami Beach, Boston and New York City.

Table 7.2: Mitigation Technique Matrix

Mitigation Technique	HIGH RISK HAZARDS			MODERATE RISK HAZARDS		
	Flooding	Severe Wind Events	Tornadoes	Severe Winter weather	Droughts and Extreme Heat	Thunderstorms
Prevention	✓	✓	✓	✓	✓	✓
Property Protection	✓	✓	✓	✓		✓
Natural Resource Protection	✓				✓	
Structural Projects	✓	✓	✓	✓		
Emergency Services	✓	✓	✓	✓	✓	✓
Public Education and Awareness	✓	✓	✓	✓	✓	✓

The mitigation actions proposed for local adoption are listed in the MAP on the pages that follow. They will be implemented according to the plan maintenance procedures established for the Richmond-Crater Hazard Mitigation Plan (see Section 8: Plan Maintenance Procedures). The action items have been designed to achieve the mitigation goals and priorities established by the committee.

Each proposed mitigation action has been identified as an effective measure to reduce hazard risk in the Richmond-Crater region. Each action is described with available background information such as the location of the project and general cost benefit information.

Other information provided includes data on cost estimates and potential funding sources to implement the action should funding be required (not all proposed actions are contingent upon funding). Most importantly, implementation mechanisms are provided for each action, including the designation of a lead agency or department responsible for carrying the action out, as well as a timeframe for its completion. These implementation mechanisms ensure that the Richmond-Crater Hazard Mitigation Plan remains a functional document that can be monitored for progress over time. Proposed actions are not listed in exact priority order though each has been assigned a priority level of "high," "moderate" or "low" as described in the previous section.

Table 7.3 describes the key elements of the Mitigation Action Plan, and **Table 7.4** lists the additional considerations that were evaluated for each proposed action once selected for inclusion in the Mitigation Action Plan. This includes social, technical, administrative, political, legal, economic, and environmental considerations collectively known as "STAPLEE" evaluation criteria.

As part of the plan update process, the committee reviewed the list of recommended actions included in their respective existing plans to determine if the actions should be deleted because they are completed, cancelled, or retained, and made recommendations regarding modified and new actions. Summary results of this review are included in Appendix G.

Table 7.3: Key Elements of the Mitigation Action Plan

Proposed Action	Identifies a specific action that, if accomplished, will reduce vulnerability and risk in the impact area. Actions may be in the form of local policies (i.e., regulatory or incentive-based measures), programs or structural mitigation projects and should be consistent with any pre-identified mitigation goals and objectives.
Site and Location	Provides details with regard to the physical location or geographic extent of the proposed action, such as the location of a specific structure to be mitigated, whether a program will be Citywide, countywide or regional, etc.
Cost Benefit	Provides a brief synopsis of how the proposed action will reduce damages for one or more hazards.
Hazard(s) Addressed	Lists the hazard(s) the proposed action is designed to mitigate for.
Goal(s) Addressed	Indicates the Plan's established mitigation goal(s) the proposed action is designed to help achieve.
Priority	Indicates whether the action is a "high" priority, "moderate" priority, or "low" priority based on the established prioritization criteria.
Impact on Socially Vulnerable Populations	Indicates whether the action has a "high" impact, "moderate" impact , or "low" impact based on the established ranking criteria.
Estimated Cost	Indicates what the total cost will be to accomplish this action. This amount will be an estimate until actual final dollar amounts can be determined.

Table 7.3: Key Elements of the Mitigation Action Plan	
Potential Funding Sources	If applicable, indicates how the cost to complete the action will be funded. For example, funds may be provided from existing operating budgets or general funds, a previously established contingency fund, or a cost-sharing federal or state grant program.
Lead Agency/Department Responsible	Identifies the local agency, department or organization that is best suited to implement the proposed action.
Implementation Schedule	Indicates when the action will begin and when it is estimated to be completed. Some actions will require only a minimal amount of time, while others may require a long-term or continuous effort.

Table 7.4: STAPLE/E Prioritization Criteria for Actions to be Taken
Socially Acceptable
• Is the proposed action socially acceptable to the community(s)? • Are there equity issues involved that would mean that one segment of a community is treated unfairly? • Will the action cause social disruption?
Technically Feasible
• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of other community(s) goals?
Administratively Possible
• Can the community(s) implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
Politically Acceptable
• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
Legal
• Is the community(s) authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? • Are there legal side effects? Could the activity be construed as a taking? • Is the proposed action allowed by a comprehensive plan, or must a comprehensive plan be amended to allow the proposed action? • Will the community(s) be liable for action or lack of action? • Will the activity be challenged?

Table 7.4: STAPLE/E Prioritization Criteria for Actions to be Taken
Economically Sound
• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account? • Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the community(s)? • What burden will this action place on the tax base or local economy? • What are the budget and revenue effects of this activity? • Does the action contribute to other community goals, such as capital improvements or economic development? • What benefits will the action provide?
Environmentally Sound
• How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and state regulatory requirements? • Are endangered or threatened species likely to be affected?

The following is a list of current funding sources and their acronyms as may be indicated in the mitigation actions. Additional acronyms used throughout this plan are interpreted in Appendix H. The pool of potential funding mechanisms is changing very rapidly as a result of COVID-19 and other Federal and state legislative priorities at the time of this update.

Key to Potential Funding Source Acronyms:

DHS U.S. Department of Homeland Security
- BRIC – Building Resilient Infrastructure and Communities
- HMGP – Hazard Mitigation Grant Program
- FMA – Flood Mitigation Assistance Program
- HHPD – Rehabilitation of High Hazard Potential Dams (HHPD) grant program

ARPA American Rescue Plan Act

USACE U.S. Army Corps of Engineers
- SFCP – Small Flood Control Projects
- FPMS – Flood Plain Management Services Program
- CAP – Continuing Authorities Program

DOI U.S. Department of the Interior
- LWCF – Land and Water Conservation Fund Grants

EDA U.S. Economic Development Administration
- DMTA – Disaster Mitigation and Technical Assistance Grants

EPA U.S. Environmental Protection Agency
- CWA – Clean Water Act Section 319 Grants

HUD U.S. Department of Housing and Urban Development
- CDBG – Community Development Block Grant Program

USDA U.S. Department of Agriculture
- EWP – Emergency Watershed Protection
- WPFP – Watershed Protection and Flood Prevention
- WSP – Watershed Surveys and Planning

Virginia

CFPF – Virginia Community Flood Preparedness Fund

Table 7.5 provides a matrix indicating that each critical and noncritical hazard affecting communities is addressed in the Mitigation Action Plan. Section 7.4 contains the Mitigation Action Plan for the Richmond-Crater region.

Table 7.5: Mitigation Actions for Critical and Non-Critical Hazards												
	Flooding	Severe Wind Events	Tornadoes	Severe Winter Weather	Droughts and Extreme Heat	Thunderstorms	Wildfires	Infectious Diseases	Earthquakes	Shoreline Erosion	Flooding Due to Impoundment Failure	Radon Exposure
Regional Actions	M*	M	M	M	M	M	M	M	M	M	M	M
Charles City Co	M	M	M	M	2	M	M	2	M	2	M	1,2
Chesterfield Co	M	M	M	M	M	M	M	M	M	M	M	M
Colonial Heights	M	M	3, 5	M	3	M	M	3	M	7	M	2,3
Dinwiddie Co	M	M	M	M	M	M	M	M	M	M	M	M
Town of McKenney	M	M	M	M	3,4	M	M	3	M	3	M	3,5
City of Emporia	M	M	M	M	4,8	M	M	4,8	M	4,8	M	M
Goochland Co	M	M	M	M	M	M	M	M	M	M	M	M
Greensville Co	M	M	M	M	M	M	M	M	M	1,9	M	M
Town of Jarratt	1, 2	1, 2	1	1, 2		1, 2	1		1, 2		1,2	1
Hanover Co	M	M	M	M	M	M	M	M	M	M	M	M
Town of Ashland	M	M	M	M	M	M	M	M	M	M	M	M
Henrico Co	M	M	M	M	M	M	M	M	M	M	M	M
City of Hopewell	M	M	M	M	M	M	M	M	M	M	M	M
New Kent Co	M	M	M	M	M	M	M	M	M	M	M	M
City of Petersburg	M	M	M	M	M	M	M	M	M	M	M	M
Powhatan Co	M	M	M	M	M	M	M	M	M	M	M	M
Prince George Co	M	M	M	M	M	M	M	M	M	M	M	M
City of Richmond	M	M	M	M	M	M	M	M	M	M	M	M
Town of Surry	1, 2	1, 2	1	1, 2		1, 2	1		1, 2		1,2	1
Sussex Co	M	M	M	M	M	M	M	M	M	M	M	M
Town of Stony Creek	1, 2	1, 2	2	1, 2		1, 2	1		1, 2		1,2	1
Town of Wakefield	1, 2	1, 2	2	1, 2		1, 2	1		1, 2		1,2	1
Town of Waverly	1, 2	1, 2	2	1, 2		1, 2	1		1, 2		1,2	1

** "M" indicates that 3 or more actions address this hazard.*

7.6 Mitigation Actions

REGIONAL MITIGATION ACTIONS

REGIONAL MITIGATION ACTION 1	
Strengthen regional strategy for incoming evacuees, to include plan development, traffic management, sheltering, and information sharing.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the Richmond-Crater study area
Benefit Cost:	No single community can effectively assess and address the impacts of mass evacuations alone. Regional participation in the analysis and planning can reduce redundant resource expenditures and streamline the approach. Communities with fewest resources are most likely to benefit.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Wildfires, Earthquakes, Infectious Diseases
Goal(s) Addressed:	Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	DHS: BRIC, HMGP
Lead Agency/Department Responsible:	PDCs with local Emergency Managers
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

REGIONAL MITIGATION ACTION 2	
Continue to improve the quality, detail and availability of data used to prepare effective hazard assessments and vulnerability analyses. Data may include, but are not limited to, gauging systems, inundation mapping using existing gauges, GIS data, flood insurance coverage and loss data, assessor data and other structure-specific information, landslide- and radon-related geological data, and pandemic-related economic impact data. Local reports that are fed into NCEI are also important for calculating event frequency and total losses. Hazard data are multi-purpose and may be used to support evacuation mapping and planning. The PDCs should consider serving as administrator(s) of a regional hazard data hub.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the Richmond-Crater study area
Benefit Cost:	Economies of scale can be realized with the regional PDCs acting as data hubs. Better data on hazard frequency and impacts improve BCR calculations for other hazard mitigation projects, and in cases such as evacuation planning, make the planning more effective.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All Hazards
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	DHS; USACE
Lead Agency/Department Responsible:	PlanRVA and Crater PDC
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
An example of a related project might be improving critical infrastructure data in coastal communities, and more critically examining the relationship of critical facilities to projected flood risk and sea level rise.	

REGIONAL MITIGATION ACTION 3	
Integrate mitigation goals and actions into other regional planning mechanisms, for example regional economic development, resiliency, transportation, parks and trail, and watershed plans.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the Richmond-Crater study area
Benefit Cost:	The PDCs play a large role in local and regional level planning in the study area. Their knowledge and expertise regarding the various planning efforts underway will create low-cost synergies among each community's plans, and among regional efforts as a whole.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 2: Objective 2.1; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	PlanRVA and Crater PDC
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

REGIONAL MITIGATION ACTION 4	
Work with state partners and neighboring localities to monitor and implement Next Generation 911 GIS data standards.	
BACKGROUND INFORMATION	
Site and Location:	Crater PDC region
Benefit Cost:	Improvements to 911 GIS data reduce response times and reduce hazard impacts.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 2: Objective 2.1; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS
Lead Agency/Department Responsible:	Crater PDC
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

REGIONAL MITIGATION ACTION 5	
Identify communities that need more current NFIP repetitive flood loss data for CRS and other planning purposes. **1. Request data from FEMA for all NFIP-participating communities on a regular basis, to include repetitive flood loss data and minus-rated policies;** **2. Update repetitive flood loss area polygons every 2 years;** **3. Rank repetitive flood loss areas by social vulnerability and provide areas and rankings to communities; and** **4. Identify areas subject to future flooding due to climate change and sea level rise.**	
BACKGROUND INFORMATION	
Site and Location:	Throughout the PlanRVA and Crater regions
Benefit Cost:	Handling these data requests at the regional level and on a regular basis will help communities be more prepared to examine the data for useful analysis. Mitigation projects to address repetitive flood loss properties are more likely to have positive BCRs.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Variable across the region
Estimated Cost:	Staff time
Potential Funding Sources:	HMGP, State funds
Lead Agency/Department Responsible:	PDCs with VaDCR and VDEM
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	
The PDCs and VDEM may also be able to support development of Substantial Damage Management Plans and Repetitive Flood Loss Area Analyses (RLAAs), which are creditable for CRS communities. Data may also be integrated with data from the State's Crisis Track software post-disaster.	

REGIONAL MITIGATION ACTION 6	
Provide Community Rating System (CRS) support for interested communities, to include: application assistance, Plans for Public Information (PPI), Substantial Damage Management Plans, Repetitive Flood Loss Area Analyses (RLAAs), web site development, and library resources.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the PlanRVA and Crater regions
Benefit Cost:	The time investment to apply for and participate in the CRS is substantial. Regional assistance through provision of application assistance, templates for certain activities, and labor assistance with some of the record keeping could increase the number of participating communities, which reduces costs of flood insurance and keeps premium money *in the community*.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding; Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate to High; variable across the region
Estimated Cost:	Staff time
Potential Funding Sources:	USACE; existing resources
Lead Agency/Department Responsible:	PDCs with VaDCR and Wetlands Watch
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

REGIONAL MITIGATION ACTION 7	
Address high and significant hazard dam safety in the region. Assist Virginia DCR with investigating significant hazard dams region-wide for possible reclassification as high hazard. Inspect high hazard potential dams for necessary retrofits/repairs. Implement retrofits in partnership with dam owners. This action includes outreach to: 1) private dam owners to either provide or offer to collect data, and to provide additional guidance and resources; and 2) the public, to build awareness through signage installation and other media regarding the dangers associated with low-head dams.	
BACKGROUND INFORMATION	
Site and Location:	High and significant hazard dams throughout the PlanRVA and Crater regions
Benefit Cost:	Local engineering expertise and regional knowledge may prove effective in supplementing existing, limited state resources for inspecting and rating dams. Dam inundation planning is similarly impacted.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding due to Impoundment Failure, Flooding
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.2, 1.4; Goal 2; Goal 4: Objectives 4.1, 4.2, 4.3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High, if dams in areas with high NRI risk for flooding are prioritized
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HHPD, BRIC, HMGP; USACE
Lead Agency/Department Responsible:	Virginia DCR, Crater PDC, PlanRVA
Implementation Schedule:	Continuously over next 5 years
ADDITIONAL COMMENTS	

REGIONAL MITIGATION ACTION 8	
Use commercially available radon test kits to determine radon levels in structures. Evaluate radon data against known geological formations in the region to determine geographic variability in vulnerability. End product will be a refined map of radon zones.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the PlanRVA and Crater regions, particularly areas of suspected high radon concentration over the western extent of the Yorktown Formation.
Benefit Cost:	Radon exposure has a high cost; it is a known cause of lung cancer, especially in smokers. Radon tests are inexpensive (<$50) and structural mitigation is inexpensive. The results of additional testing and map refinement will provide local and state officials with additional tools to advise homeowners when testing is advised, resulting in mitigation of lung cancer. Leaders at the local, regional and State level will gain valuable information to determine if a change in capabilities is warranted (e.g., building code requirements, real estate transaction disclosures, or testing).

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Radon Exposure
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Variable across region; more data required to make determination
Estimated Cost:	Estimated $30/structure, plus mapping costs
Potential Funding Sources:	EPA, DHS: HMGP, BRIC
Lead Agency/Department Responsible:	PDCs, College of William & Mary
Implementation Schedule:	Begin project within 2 years of plan adoption; project may extend beyond 2027 planning horizon

REGIONAL MITIGATION ACTION 9	
Provide assistance to communities and residents regarding Risk Rating 2.0, the NFIP's new flood insurance rating policy standards. This action includes assistance with: **1) Evaluation of rating methodology and accuracy;** **2) Messaging and outreach to homeowners and renters;** **3) Elevation Certificate correction; and** **4) Mitigation assistance for property protection, including retrofit guidance and physical alterations to structures or structure components.**	
BACKGROUND INFORMATION	
Site and Location:	Flood-prone areas throughout the region
Benefit Cost:	The rollout of Risk Rating 2.0 is likely to introduce uncertainty in the flood insurance market. The state and region have an interest in helping ensure that property owners retain flood insurance, so good information available locally will help alleviate uncertainty.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding; Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 3: Objective 3.2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Variable across the region; High, if effort is focused on areas with high NRI flood risk such as portions of Dinwiddie and Sussex counties
Estimated Cost:	<$5,000
Potential Funding Sources:	HMGP, BRIC
Lead Agency/Department Responsible:	VaDCR, PDCs
Implementation Schedule:	Within 1 year of plan adoption

REGIONAL MITIGATION ACTION 10	
Work with private companies to advance continuity of operations, including but not limited to power, gas, and water service restoration. Mitigation actions may include implementation of system redundancies, mutual aid agreements or other partnerships to address critical capability gaps. Physical retrofits may increase resilience of critical infrastructure, such as burying power lines and provision of dependable backup power to water and wastewater treatment facilities.	
BACKGROUND INFORMATION	
Site and Location:	Throughout Richmond-Crater region
Benefit Cost:	Damages are reduced when critical lifelines are returned to service promptly after a disaster. By creating partnerships between private utility providers, the region can expect a faster return to full operations, thereby reducing losses to business and property owners.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	ARPA; DHS
Lead Agency/Department Responsible:	Dominion Energy, public and private utility providers, PDCs
Implementation Schedule:	Within 4 years of plan adoption
ADDITIONAL COMMENTS	

REGIONAL MITIGATION ACTION 11	
Partner with VDOF on sharing Wildland Urban Interface data in support of efforts to develop local tools (ordinances, outreach templates, etc.) to determine impacts of fire and climate change as well as potential local projects. **Partner with Virginia Department of Wildlife Resources (VDWR) regarding Wildlife Action Plan climate change assessment and development of Wildlife Climate Change Adaptation Committee.**	
BACKGROUND INFORMATION	
Site and Location:	Throughout Richmond-Crater region
Benefit Cost:	Builders and property owners benefit when regional and state plans set out clear, concise direction for planning and policy.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire, Severe Wind Events; Droughts and Extreme Heat
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	PDCs, VDOF, VDWR
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Existing Capabilities at VDOF include: Forest Action Plan, FireWise, Ready Set Go – includes mitigation planning guidance at community level and grant fund guidance. The PDCs can support these capabilities by taking part in planning committees as regional stakeholders, and by disseminating information to their respective community partners.	

REGIONAL MITIGATION ACTION 12	
Convene interested parties to discuss NFIP status of the Town of Waverly, and encourage participation. Notify FEMA that town boundaries are incorrect on the FIRM.	
BACKGROUND INFORMATION	
Site and Location:	Town of Waverly
Benefit Cost:	NFIP participation would benefit Waverly property owners by making flood insurance available, and opening up some types of disaster assistance.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 3: Objective 3.2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	
Estimated Cost:	Staff time only
Potential Funding Sources:	n/a
Lead Agency/Department Responsible:	PlanRVA, with assistance from VDCR, Sussex County and Waverly
Implementation Schedule:	Immediately
ADDITIONAL COMMENTS	
FEMA FIRM for Waverly/Sussex County does not show the town's current boundaries correctly. The town does not participate in the NFIP. The town's sewage treatment plant is also located near the SFHA.	

REGIONAL MITIGATION ACTION 13	
Strengthen community resilience planning and project implementation through: **1) Public Education/Awareness – Create resilience dashboard to share information and data with the general public about resilience issues, including flood risk. Enhance other outreach efforts to educate the public about hazard risk and regional resilience.** **2) Engage communities in Resilience Adaptation Feasibility Tool (RAFT) process and support training and implementation.** **3) Combine elements of regional resilience efforts into regional plan to satisfy DCR and CFPF requirements.** **4) Resilience Program and Project Cobenefit Connector - expand current PDC staff capacity, web presence and guidance documents to better understand and educate localities on fully harnessing existing and future grant programs given the cobenefits of resilience-related projects.** **5) Business resiliency training.**	
BACKGROUND INFORMATION	
Site and Location:	Throughout Richmond-Crater region
Benefit Cost:	Community resilience measures that permeate all facets of local and regional government save resources in post-disaster scenarios.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	~$100,000
Potential Funding Sources:	CFPF
Lead Agency/Department Responsible:	PlanRVA & Crater PDC, DCR, UVA, W&M, ODU, Chambers of Commerce, Economic Development departments
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CHARLES CITY COUNTY MITIGATION ACTION 1	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, with particular emphasis on floodprone areas.
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate in eastern half of the county
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Planning and Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Generators, in particular, are identified as a high priority need at: Roxbury Pumping Stations (generator failed); Kimages Well #1 (generator failed); Animal Shelter (no generator); Mt Zion Vacuum Station (no generator); and Ruthville Fire & EMS (no generator).	

CHARLES CITY COUNTY MITIGATION ACTION 2	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Conduct annual preparedness days for hazards to include floods, wind, and earthquakes.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases, Shoreline Erosion
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CHARLES CITY COUNTY MITIGATION ACTION 3	
Work with private utilities to keep right-of-way clear.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, with particular emphasis on evacuation routes
Benefit Cost:	Right of ways must remain clear of debris that clogs drains and trees that block roads so that drainageways and roads continue to operate as designed.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CHARLES CITY COUNTY MITIGATION ACTION 4	
Reduce rural wildfire risk by increasing resources used to fight wildfires. Equipment needs may include, but are not limited to: dry hydrants, drafting equipment, personnel and tankers.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Rural wildfire risk and raze risk to rurally-located structures can be reduced by strategically locating and maintaining dry hydrants, and having sufficient personnel, drafting equipment and tanker trucks available to deploy quickly.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4: Goal 4: Objectives 4.1, 4.2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	Existing budgets; DHS: HMGP;ARPA
Lead Agency/Department Responsible:	Administration
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Dry hydrants are currently located in just 3 areas of the county: the Industrial Park area, near Kimages Road and Wayside Road (State Route 607) in the southwest part of the county, and in the southeast along Wilcox Neck Road. The Charles City County Fire Department has identified the following needs: 2 engines with 1000 gallons of water on each side; 1 tanker (2200 gallons); 12 firefighters working 24/7, 3 shifts; and, 3 ambulances (1 ALS, 2 BLS). The Charles City County Volunteer Fire Department has identified the following needs: 1 engine with 1000 gallons of water; 2 ambulances BLS; and, 1 rescue truck.	

CHARLES CITY COUNTY MITIGATION ACTION 5	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Examples include the *Virginia Hurricane Evacuation Guide* and data collected through VDEM's Crisis Track after a disaster.	

CHESTERFIELD COUNTY MITIGATION ACTION 1	
Conduct regular review of repetitive loss and severe repetitive loss NFIP data. Continue to work with VDEM and FEMA to mitigate repetitive and SRL properties as owners demonstrate interest in participation. Projects may include acquisition, relocation, elevation or retrofits.	
BACKGROUND INFORMATION	
Site and Location:	Repetitively flooded areas in the county
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the county who have to pay for flood insurance. Helping these owners, in particular, will have a positive impact on the flood vulnerability of the county.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Moderate – 2 rep loss areas along Falling Creek, near Newby's Bridge Rd, 1 rep loss area near Screamersville, and1 rep loss area near Mt Blanco Low – all other rep loss areas
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Environmental Engineering – Floodplain Manager
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CHESTERFIELD COUNTY MITIGATION ACTION 2	
Enhance and centralize use of GIS to gather damage assessment information by all county agencies including establishing naming conventions and data categories.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objectives 4.1 and 4.3
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time and associated software
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	GIS, Risk Management, Building Inspections
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CHESTERFIELD COUNTY MITIGATION ACTION 3	
Protect critical facility infrastructure through quick connects for generator power, wind and snow retrofits, and other protective measures, which may include permanent generators, elevation, or relocation. This action may include minor flood control structures and stormwater system modifications.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Radon Exposure
Goal(s) Addressed:	Goal 3, Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC, FMA; ARPA; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
The county's new COOP will aid in the process of identifying needs.	

CHESTERFIELD COUNTY MITIGATION ACTION 4	
Provide training opportunities to educate all county staff with a role in disaster recovery regarding mitigation principles and long term recovery best practices, particularly related to housing options.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Preparing all county staff to assist citizens and themselves in the event of a disaster reduces damages and allows faster recovery. If staff are also able to incorporate mitigation principles during recovery/rebuilding, future damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3: Objective 3.2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Annually/Ongoing
ADDITIONAL COMMENTS	
Introduction to EM provided to all interested county staff, annually. EM is revising recovery training and developing new best practices, restructuring the EOC and developing new training techniques/priorities.	

CHESTERFIELD COUNTY MITIGATION ACTION 5	
Encourage whole community preparedness through education regarding hazards affecting the community and steps to reduce vulnerability.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Sharing mitigation priorities with a broad group of stakeholders encourages multiple small steps that reduce vulnerability to individual businesses, homes and families.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	$12,000/yr for materials plus staff costs
Potential Funding Sources:	DHS: HMGP; ARPA; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Annually/Ongoing
ADDITIONAL COMMENTS	
County has expanded public outreach to focus on the whole community, including seniors, populations with medical, functional, and access needs, lesser served populations, civic associations, youth, and faith-based organizations.	

CHESTERFIELD COUNTY MITIGATION ACTION 6	
Use abandoned mines mapping to guide zoning, development, and building inspection decisions. Work with Virginia Department of Energy to continue to refine the Locations of Abandoned Mines in the Greater Richmond Area maps.	
BACKGROUND INFORMATION	
Site and Location:	See maps in Section 5
Benefit Cost:	Measures that discourage or prohibit new development in areas over or near abandoned minds reduce vulnerability to dangerous sinkholes or other land movements that may affect structural stability, especially to underground components.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Sinkholes, Landslides, Earthquakes
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 3: Objective 3.2; Goal 4: Objectives 4.1, 4.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Inspections; Environmental Engineering; Planning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Mapping is part of development review process. Both the physical hazard and historical significance are considered.	

CHESTERFIELD COUNTY MITIGATION ACTION 7	
Enhance processes and procedures in building permit application system within Enterprise Land Management System (ELM) to comprehensively capture damage assessment data.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 3: Objective 3.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	GIS; Inspections
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CHESTERFIELD COUNTY MITIGATION ACTION 8	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes. Consider development of a standalone floodplain ordinance.	
BACKGROUND INFORMATION	
Site and Location:	Flood prone areas countywide
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Inspections, Planning, Environmental Engineering
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CHESTERFIELD COUNTY MITIGATION ACTION 9	
Maintain StormReady certification (last certification 2020).	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	StormReady helps arm communities with the communication and safety skills needed to save lives and property--before, during and after the event. StormReady helps community leaders and emergency managers strengthen local safety programs.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Severe Winter Weather, Thunderstorms, Extreme Heat
Goal(s) Addressed:	Goal 1; Goal 2
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

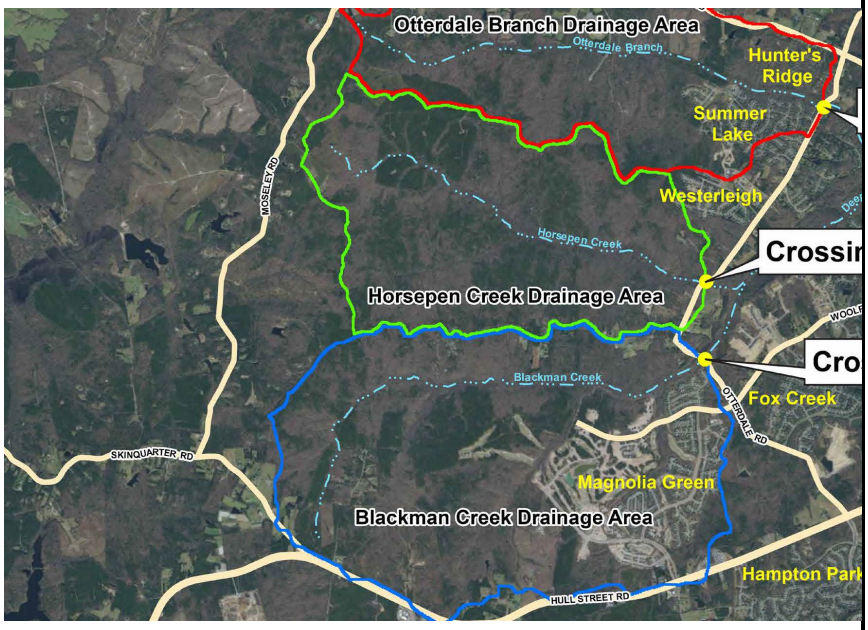
CHESTERFIELD COUNTY MITIGATION ACTION 10	
Incorporate hazard mitigation potential in decision making for acquiring new park land and open space easements.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Strategic acquisition of land by Parks and Recreation can reduce vulnerability to a variety of hazards.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Wildfires, Droughts and Extreme Heat, Landslides, Shoreline Erosion, Sinkholes
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3: Objective 3.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC, FMA; ARPA; Virginia CFPF
Lead Agency/Department Responsible:	Parks and Recreation; FOLAR
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CHESTERFIELD COUNTY MITIGATION ACTION 11	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, with particular emphasis on floodprone areas.
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Community Development; Planning; Environmental Engineering
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CHESTERFIELD COUNTY MITIGATION ACTION 12	
Apply hazard mitigation concepts across development project review, capital improvement planning and all other community planning efforts.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Hazard mitigation is forward-thinking, and thus requires application across disciplines in order to reduce damages.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Community Development; Planning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CHESTERFIELD COUNTY MITIGATION ACTION 13	
Install new monitoring systems for county-owned dams.	
BACKGROUND INFORMATION	
Site and Location:	County-owned dams, high and significant hazard potential, countywide
Benefit Cost:	Real-time monitoring is necessary for early notification of dam/impoundment problems, information that can be used to notify the public to take protective action. Public information helps arm citizens with the communication and safety skills needed to save lives and property--before, during and after a flood event.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	>$330,000
Potential Funding Sources:	DHS: HHPD; CIP
Lead Agency/Department Responsible:	Department of Utilities
Implementation Schedule:	Within 3 years of funding
ADDITIONAL COMMENTS	

CHESTERFIELD COUNTY MITIGATION ACTION 14	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in the event of a hazard event. Acquire additional resources to build components of a flood warning system and local evacuation plan.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE; USGS
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Incorporate any manufactured home park evacuation plans promulgated in response to the floodplain management ordinance at Sec. 19.1-503(10).	

CHESTERFIELD COUNTY MITIGATION ACTION 15	
Improve stormwater management system to reduce flooding, particularly in neighborhoods. Projects may include raising roads and regrading to eliminate 100-year flood hazard, redesign and installation of infrastructure to more properly handle current and future flows.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, but with particular emphasis on Otterdale Road improvements at Otterdale Branch, Horsepen Creek and Blackman Creek. 
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses. In some cases, the risk of flooding is so great that relocation, demolition or elevation is the only cost effective and safe solution.

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	Moderate

Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	$25,000,000
Potential Funding Sources:	100% county funded
Lead Agency/Department Responsible:	Environmental Engineering
Implementation Schedule:	Ongoing; Construction of all Otterdale Road crossings expected complete by 2024.
ADDITIONAL COMMENTS	
County funding has been identified to address existing drainage issues on Otterdale Road between Woolridge Road and Genito Road. Preliminary engineering to address the Blackman Creek, Horsepen Creek, and Otterdale Branch crossings is underway. Project brochure available online at: https://www.chesterfield.gov/DocumentCenter/View/21384/Otterdale-Rd-Drainage-CIM---Project-Brochure-PDF	

CHESTERFIELD COUNTY MITIGATION ACTION 16	
Develop and expand use of mass notification tool. Final system should have four audiences for messaging: 1) residents; 2) employees; 3) IPAWS all hazard notifications; and 4) a community engagement tool. Include notification system for dam inundation area dwellers, as identified on recorded plats.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Severe Winter Weather, Thunderstorms, Droughts and Extreme heat, Earthquakes, Infectious Diseases
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.2, 1.4; Goal 4: Objectives 4.1, 4.3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	$71,000/year plus staff time
Potential Funding Sources:	USGS; USACE; DHS: HMGP; Virginia CFPF; ARPA; existing budget
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	
Investigate the possibility of using NWS weather radio for non-weather related messaging, as well.	

CHESTERFIELD COUNTY MITIGATION ACTION 17	
Finalize and implement county COOP. Coordinate implementation across all county departments.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	An effective COOP helps identify and reduce vulnerabilities in the county's operational procedures. The plan requires continuous refinement and updating.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate (it keeps critical human services going)
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	within 2 years of plan adoption
ADDITIONAL COMMENTS	
COOP is substantially complete.	

CITY OF COLONIAL HEIGHTS MITIGATION ACTION 1	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes.	
BACKGROUND INFORMATION	
Site and Location:	Floodprone areas throughout the city
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objective 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate to High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing budgets and staff
Lead Agency/Department Responsible:	Building Inspection Department
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF COLONIAL HEIGHTS MITIGATION ACTION 2	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Citywide, but with particular emphasis on Newcastle Apartments in the Old Town Creek floodway and floodplain. Safe evacuation of these buildings during flood events is problematic. *Source: Virginia Flood Risk Information System*
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses. In some cases, the risk of flooding is so great that relocation, demolition or elevation is the only cost effective and safe solution.

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High – Newcastle Apartments rep loss area Moderate – 2 rep loss areas along Swift Creek west of Jefferson Davis Highway Low – rep loss area east of I-95 and north of Temple Ave, along Old Town Creek
Estimated Cost:	Depends on method selected to address the problem.
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Fire and EMS; Planning and Community Development; Economic Development; PDC
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	
Additional projects include projects to repair/replace/retrofit aging infrastructure, such as: shelter retrofits; protection for Lakeview Elementary which is in the SFHA; repairs to flood-damaged stormwater components; protection for sewer pump stations; and aging sewer and water lines and components (Conjure's Neck and Boulevard north of Temple).	

CITY OF COLONIAL HEIGHTS MITIGATION ACTION 3	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Conduct annual preparedness days for hazards to include floods, wind, earthquakes, and tornado. Customize messaging to address: repetitive flood loss areas, importance of flood insurance coverage, and the high vulnerability of certain populations.	
BACKGROUND INFORMATION	
Site and Location:	Citywide, with particular emphasis on repetitive flood loss areas.
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	~$5,000
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 1 year of plan adoption

ADDITIONAL COMMENTS
The current messaging/outreach the City is deploying is not reaching the targeted populations. Officials are optimistic about reworking the current system to address more people and measuring the number of people reached.

CITY OF COLONIAL HEIGHTS MITIGATION ACTION 4	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Repetitively flooded areas in the city
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the county who have to pay for flood insurance, and for targeting flood risk messaging per action #4 above.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Fire and EMS, PDC and VDEM
Implementation Schedule:	Within 2 years of plan adoption and regularly thereafter as new data are provided
ADDITIONAL COMMENTS	

CITY OF COLONIAL HEIGHTS MITIGATION ACTION 5	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to build components of a flood warning system and local evacuation plan, including: new IFLOWS gauges (especially, Swift Creek, Swift Creek dam and Old Town Creek), road crossing elevations for county, city and state-owned roads, a flood alert system, and an additional tornado siren for the north end of the City near Tussing Elementary and Conjure's Neck.	
BACKGROUND INFORMATION	
Site and Location:	Citywide, with particular emphasis on the Swift Creek floodplain, Sherwood Hills, and Conjure's Neck, as described above
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Fire and EMS
Implementation Schedule:	Within 4 years of plan adoption

CITY OF COLONIAL HEIGHTS MITIGATION ACTION 6	
Repair flood gates on Lakeview Dam, as identified in after action report from the last flood event that impacted the dam.	
BACKGROUND INFORMATION	
Site and Location:	Lakeview Dam is located in a meander bend of Swift Creek in the northwest portion of the City.
Benefit Cost:	Critical infrastructure requires regular upkeep, maintenance and repairs to operate at design capacity. Repairs to the dam are far less expensive than the potential flooding that could result should the flood gates fail.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HHPD, HMGP; USACE
Lead Agency/Department Responsible:	Emergency Management, VaDCR
Implementation Schedule:	Immediately; identify funding source within 1 year of
ADDITIONAL COMMENTS	
Lakeview Dam is privately-owned and was built in 1920; it is considered a high hazard potential dam. Although no structures are listed as potential impact structures on the Dam Safety Data Sheet, the dam impounds water above the Sherwood Hills neighborhood and access/egress to that neighborhood during flood events on Swift Creek is very limited.	

CITY OF COLONIAL HEIGHTS MITIGATION ACTION 7	
Include additional reviewers on Design Review Committee for new development, specifically to review projects for hazard-related vulnerabilities. Include staff training for decision making tools, such as those developed by VIMS Center for Coastal Resources Management for shoreline development and the Certified Floodplain Manager program from the Association of State Floodplain Managers.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Early review of projects to reduce existing and future hazard vulnerabilities reduce future damages.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Wildfires, Landslides, Shoreline Erosion, Sinkholes
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development, Emergency Management
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	
This action includes elements from the Comprehensive Plan Environment Policies section.	

DINWIDDIE COUNTY MITIGATION ACTION 1	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Floodprone areas of the county
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the county who have to pay for flood insurance, and for targeting flood risk messaging.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Moderate – Single rep loss area east of Namozine Creek, north of New Cox Road
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning/Zoning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Dinwiddie County currently has 1 repetitive loss area identified in Section 5.	

DINWIDDIE COUNTY MITIGATION ACTION 2	
Address road flooding in the county. Appropriate measures may include elevation of bridges, maintenance of roadside ditches, and improvements to BMPs.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Road flooding impacts safety and welfare of citizens and travelers. Impassable roads present a dangerous hazard for drivers, and for first responders.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate to High
Estimated Cost:	TBD
Potential Funding Sources:	VDOT; county CIP
Lead Agency/Department Responsible:	Emergency Management, VDOT
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

DINWIDDIE COUNTY MITIGATION ACTION 3	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Conduct annual preparedness days for hazards to include floods, wind, tornados and earthquakes.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Minimal
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

DINWIDDIE COUNTY MITIGATION ACTION 4	
Continue to refine and update Continuity of Operations Plan (COOP) with lessons learned from COVID-19 pandemic.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	An effective COOP helps identify and reduce vulnerabilities in the county's operational procedures. The plan requires continuous refinement and updating, especially post-disaster when memories are fresh regarding how the plan can be improved.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Services
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

DINWIDDIE COUNTY MITIGATION ACTION 5	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes. Ensure easy access to FEMA floodplain maps by citizens and property owners.	
BACKGROUND INFORMATION	
Site and Location:	Floodprone areas throughout the county
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objective 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate to High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning/Zoning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

DINWIDDIE COUNTY MITIGATION ACTION 6	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities, and stormwater management system improvements. Conduct countywide facilities assessment, including schools, to determine vulnerability to multiple hazards, continuous power availability and utility redundancies.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Critical facilities operated by the wastewater authority and the Dinwiddie County Water Authority are of particular concern.	

DINWIDDIE COUNTY MITIGATION ACTION 7	
Increase water/wastewater treatment systems resiliency with County, McKenney and two private subdivisions with their own water systems. Measures may include generators and additional wells.	
BACKGROUND INFORMATION	
Site and Location:	Stony Springs and Lew Jones Village are the private subdivisions.
Benefit Cost:	Safe drinking water in post-disaster scenarios is a basic necessity both for recovery and for safety of citizens.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Wildfires, Severe Winter Weather, Droughts and Extreme Heat, Earthquakes
Goal(s) Addressed:	Goal 4: Objectives 4.1 and 4.2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP
Lead Agency/Department Responsible:	Dinwiddie County Water Authority, wastewater authority
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

DINWIDDIE COUNTY MITIGATION ACTION 8	
Integrate mitigation plan goals and actions into other appropriate planning mechanisms such as comprehensive plans and capital improvement plans.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Mitigation actions that are represented in various plans, budgets and programming are more likely to be funded sufficiently and implemented because the number of people engaged in making the actions happen increases.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Planning; Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

DINWIDDIE COUNTY MITIGATION ACTION 9	
Integrate Health Department and Emergency Management operations in the event of a health-related event, such as pandemic. Address Incident Command Services at both departments; coordinate with the PDC and other regional entities, and prepare post-incident review of COVID response.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Aligning agency goals within county government helps ensure a better-coordinated response process.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Infectious Diseases, Radon Exposure
Goal(s) Addressed:	Goal 2; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate to High
Estimated Cost:	Staff time
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Emergency Management, Health Department, PDC
Implementation Schedule:	Within 1 year of plan adoption
ADDITIONAL COMMENTS	

DINWIDDIE COUNTY MITIGATION ACTION 10	
Fill and train GIS/addressing staff and planner level position. Expand the Planning Department staff to more effectively and efficiently address short-term and long-term planning needs.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP; ARPA
Lead Agency/Department Responsible:	Emergency Management, Planning/Zoning
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

DINWIDDIE COUNTY MITIGATION ACTION 11	
Design any new county schools to current shelter standards.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	New schools that can also serve as shelters benefit the county in numerous ways because stringent design requirements ensure protection from a variety of hazards.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts & Extreme Heat, Earthquakes
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Design costs
Potential Funding Sources:	CIP
Lead Agency/Department Responsible:	Emergency Management, County Administration
Implementation Schedule:	Long-term
ADDITIONAL COMMENTS	

DINWIDDIE COUNTY MITIGATION ACTION 12	
Develop methods for encouraging private property owners to properly maintain BMPs.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, several locations
Benefit Cost:	Ill-maintained BMPs can contribute to flooding problems and disturb valuable ecosystem.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Winter Weather, Shoreline Erosion, Landslides, Sinkholes
Goal(s) Addressed:	Goal 1, Goal 2, Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Methodology development requires staff time, but maintenance will cost landowners.
Potential Funding Sources:	TBD
Lead Agency/Department Responsible:	Environmental
Implementation Schedule:	Within 4 years of plan adoption
ADDITIONAL COMMENTS	

DINWIDDIE COUNTY MITIGATION ACTION 13	
Study capacity of existing stormwater system components, including culverts and other structures, to determine if sizing is sufficient for current and future flooding and precipitation conditions. Identify and replace vulnerable or undersized structures with bridges, larger culverts or other measures to reduce flood hazards. Implement program for regular inspections and maintenance of roadside ditches and stream channels.	
BACKGROUND INFORMATION	
Site and Location:	Countywide study
Benefit Cost:	Stormwater conveyances are necessary in urbanized areas to alleviate flooding. Improvements over time are necessary to retrofit incorrectly sized systems, and to accommodate changes in precipitation rates and frequency.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate to High
Estimated Cost:	TBD
Potential Funding Sources:	Virginia CFPF
Lead Agency/Department Responsible:	Environmental, VDOT
Implementation Schedule:	Within 1 year of plan adoption
ADDITIONAL COMMENTS	
The county plans to build these measures into the county resilience plan in order to become eligible for CFPF money for planning and implementation.	

TOWN OF MCKENNEY MITIGATION ACTION 1	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA, if any.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	Although the town does not have a mapped SFHA through FEMA, they do participate in the NFIP and flood insurance is available. Town officials should monitor the flood insurance loss list for any claims to determine if reconsideration of flood hazard areas is or may become advisable.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Mayor and Administration
Implementation Schedule:	
ADDITIONAL COMMENTS	

TOWN OF MCKENNEY MITIGATION ACTION 2	
Continue to work with VDOT to evaluate and mitigate at-risk roads.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	Roads are critical infrastructure in this town.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Earthquakes, Landslides
Goal(s) Addressed:	Goal 4: Objectives 4.1, 4.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	Dinwiddie County, VDOT
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF MCKENNEY MITIGATION ACTION 3	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Conduct annual preparedness days for hazards to include floods, wind, tornado, and earthquakes.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases, Shoreline Erosion
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF MCKENNEY MITIGATION ACTION 4	
Increase water/wastewater treatment systems resiliency between Dinwiddie County, the Town of McKenney and two private water systems.	
BACKGROUND INFORMATION	
Site and Location:	Town and surrounding county
Benefit Cost:	Critical infrastructure resiliency can be a low-cost way to supplement existing systems and help ensure the utilities stay online during a disaster.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Wildfires, Severe Winter Weather, Droughts and Extreme Heat, Earthquakes
Goal(s) Addressed:	Goal 4: Objectives 4.1 and 4.2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP; ARPA
Lead Agency/Department Responsible:	Town officials, Dinwiddie County Water Authority, private system owners
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

TOWN OF MCKENNEY MITIGATION ACTION 5	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities, mapping to determine detailed flood hazards, and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Town Administration
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF MCKENNEY MITIGATION ACTION 6	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Town Administration
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF EMPORIA MITIGATION ACTION 1	
Investigate all public utility lines to evaluate their resistance to flood, wind, and winter storm hazards.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Provision of public utilities during and after disasters is critical to public safety.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes
Goal(s) Addressed:	Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	$75,000 for inspection & report; retrofit costs TBD
Potential Funding Sources:	DHS: HMGP, BRIC; ARPA
Lead Agency/Department Responsible:	Public Utilities
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF EMPORIA MITIGATION ACTION 2	
Complete replacement of Halifax Street Bridge.	
BACKGROUND INFORMATION	
Site and Location:	Halifax Street crosses Metcalf Branch southeast of the intersection of Routes 58 and 301. Area is identified as Zone A on the FIRM.
Benefit Cost:	The bridge is aging and in disrepair and may be a culprit in the repetitive flooding reported in the area.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	$150,000 (2016/17)
Potential Funding Sources:	CIP
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Within 10 years of plan adoption
ADDITIONAL COMMENTS	
Building adjacent to the bridge (north side) is in SFHA and contains numerous hazardous materials.	

CITY OF EMPORIA MITIGATION ACTION 3	
Continue to review and make recommendations for improvements to the stormwater system.	
BACKGROUND INFORMATION	
Site and Location:	Citywide; improvements at industrial park and Emporia Shopping Center were budgeted to 2020/2021.
Benefit Cost:	Stormwater conveyances are necessary in urbanized areas to alleviate flooding. Improvements over time are necessary to retrofit incorrectly sized systems, and to accommodate changes in precipitation rates and frequency.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	$400,000 budgeted 2020/21
Potential Funding Sources:	ARPA; DHS: HMGP, BRIC
Lead Agency/Department Responsible:	Emergency Services, Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF EMPORIA MITIGATION ACTION 4	
Finalize Continuity of Operations Plan.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Plans that reduce the impacts of ongoing disasters save taxpayer dollars by bringing businesses back online sooner and providing normal services to citizens in need.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources, CIP; VDEM
Lead Agency/Department Responsible:	Administration; Emergency Services
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF EMPORIA MITIGATION ACTION 5	
Improve gauging and warning system. Install additional flood gauges on the Meherrin River. Integrate data from all new flood gauges into citizen notification system, including a siren system. Use gauging and warning system data and existing flood depth data to begin developing targeted evacuation plan for flood-prone areas.	
BACKGROUND INFORMATION	
Site and Location:	Flood-prone areas Citywide, particularly Falling Run and the Meherrin River
Benefit Cost:	The state hurricane evacuation plan does not take all local factors into account and may not be sufficient for some residents of Emporia, especially if flooding isn't caused by hurricane. Local planning will facilitate evacuation when needed and better focus evacuation messaging to reduce confusion, speed evacuation and reduce the number of people in danger.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	$50,000 - $125,000
Potential Funding Sources:	DHS: HMGP, FMA; USACE: FPMS; ARPA
Lead Agency/Department Responsible:	Emergency Services
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF EMPORIA MITIGATION ACTION 6	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Hazard prone areas Citywide, especially repetitive flood loss areas as discussed in Section 5
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Services
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF EMPORIA MITIGATION ACTION 7	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objective 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Zoning Administrator
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF EMPORIA MITIGATION ACTION 8	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Conduct annual preparedness days for hazards to include floods, wind, and earthquakes.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases, Shoreline Erosion
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Services
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF EMPORIA MITIGATION ACTION 9	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the city who have to pay for flood insurance.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Zoning Administrator
Implementation Schedule:	Every 2 years
ADDITIONAL COMMENTS	

GOOCHLAND COUNTY MITIGATION ACTION 1	
Continue coordination with VDEM on incoming evacuee issues.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, particularly along the I-64 corridor along the northern edge of the county.
Benefit Cost:	Evacuees from the Washington DC and Hampton Roads metropolitan areas place a burden on local infrastructure. Coordination with VDEM keeps local officials informed and aware of potential impacts.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Earthquakes
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GOOCHLAND COUNTY MITIGATION ACTION 2	
Continue to coordinate with City of Richmond and Department of Corrections to address wastewater capacity issues.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, but particularly near Goochland Courthouse
Benefit Cost:	There are critical capacity issues with wastewater that impact the ability of the utility to continue operating throughout a disaster event.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Sinkholes
Goal(s) Addressed:	Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Coordination costs are minimal; future costs for infrastructure retrofits TBD
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Utilities
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GOOCHLAND COUNTY MITIGATION ACTION 3	
Continue to provide training opportunities to county staff. Hazard-related topics may include: floodplain management training, conferences and certification through VaDCR and the Association of Floodplain Managers; conferences and training for emergency managers regarding wildfire mitigation and other hazards; conferences and training for county officials regarding mitigation grant availability and processes.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Funds to provide county official with training can reduce damages from hazard events in the future by helping to reduce exposure of new development and identify grant opportunities for retrofitting existing structures and infrastructure.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.3; Goal 2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	$2500/year
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Emergency Management & Community Development
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GOOCHLAND COUNTY MITIGATION ACTION 4	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Customize approach to provide outreach to large group of citizens with regard to broad spectrum of hazards, including flood, radon and wildfire. Continue the floodplain map-related outreach to support county's new FEMA FIRMs.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases, Shoreline Erosion
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GOOCHLAND COUNTY MITIGATION ACTION 5	
Strengthen system of coordinating, collecting, storing and transmitting damage assessment data for each natural hazard event which causes death, injury, and/or property damage.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Sinkholes
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 2; Goal 3: Objective 3.2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time and data storage costs
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management/ IT
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
VDEM has Crisis Track system for this purpose, as well, which meet community needs for post-disaster data collection.	

GOOCHLAND COUNTY MITIGATION ACTION 6	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes.	
BACKGROUND INFORMATION	
Site and Location:	Flood-prone areas Countywide
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objective 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Community Development
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GOOCHLAND COUNTY MITIGATION ACTION 7	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities, mapping to determine detailed flood hazards, and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, particularly in the repetitive flood loss area identified in Section 5 of this plan and the existing Fire Training Center.
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Services, Community Development
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
County has outgrown existing Fire Training Center and is examining locations and designs for a new building.	

GOOCHLAND COUNTY MITIGATION ACTION 8	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to build components of a flood warning system and local evacuation plan, including: new IFLOWS gauges, high hazard water crossing elevations for county and state-owned roads, and a flood alert system.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, particularly flood-prone areas and the repetitive flood loss area just south of Westview on the James River.
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP; ARPA; USACE: FPMS
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

GOOCHLAND COUNTY MITIGATION ACTION 9	
Hire full time Environmental Planner to support stormwater management, PlanRVA coordination, environmental planning, conservation easements, community outreach and awareness of various hazards. Add a second Environmental Inspector.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	These positions support the policies and regulations already in place in the County. Administration of existing policies and providing assistance to citizens are important components in the mitigation process.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2: Objective 2.2; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	$175,000 per year
Potential Funding Sources:	ARPA; Virginia CFPF
Lead Agency/Department Responsible:	Environmental and Land Development
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

GOOCHLAND COUNTY MITIGATION ACTION 10	
Support Virginia DCR in its efforts to bring all regulated dams into compliance with the Dam Safety Regulations Implement projects and assign responsibility to ensure maintenance/retrofit needs are addressed.	
BACKGROUND INFORMATION	
Site and Location:	Dams throughout the county
Benefit Cost:	Local engineering expertise and regional knowledge may prove effective in supplementing existing, limited state resources for inspecting and rating dams.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1; Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Contracted cost for inspections TBD.
Potential Funding Sources:	DHS: HHPD, HMGP; ARPA; USACE
Lead Agency/Department Responsible:	Community Development and Public Safety
Implementation Schedule:	Within 5 years of plan adoption
ADDITIONAL COMMENTS	

GREENSVILLE COUNTY MITIGATION ACTION 1	
Complete development of Continuity of Operations plan.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Plans that reduce the impacts of ongoing disasters save taxpayer dollars by bringing businesses back online sooner and providing normal services to citizens in need.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	CIP; DHS; VDEM
Lead Agency/Department Responsible:	Public Safety
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GREENSVILLE COUNTY MITIGATION ACTION 2	
Complete implementation of citizen notification system.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Other methods of notifying citizens require massive amounts of staff time which exceeds budgetary restraints. Reverse 911 quickly and efficiently uses existing infrastructure to notify property owners of appropriate pre- and post-disaster mitigation actions.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Infectious Disease
Goal(s) Addressed:	Goal 1; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Safety
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GREENSVILLE COUNTY MITIGATION ACTION 3	
Consider participating in "Turn Around, Don't Drown" public education campaign.	
BACKGROUND INFORMATION	
Site and Location:	Flood-prone road crossings throughout the county
Benefit Cost:	Public information helps arm citizens with the communication and safety skills needed to save lives and property--before, during and after a flood event. Reminders via social media are free of charge and require only staff time.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.3; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Safety
Implementation Schedule:	Immediately upon plan adoption
ADDITIONAL COMMENTS	

GREENSVILLE COUNTY MITIGATION ACTION 4	
Improve GIS layers and track storm damages.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Landslides, Shoreline Erosion, Sinkholes
Goal(s) Addressed:	Goal 3: Objective 3.1; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	DHS: HMGP; ARPA
Lead Agency/Department Responsible:	Public Safety
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
VDEM Crisis Track can be used by localities to obtain, record and share storm damages from the field immediately following disaster events.	

GREENSVILLE COUNTY MITIGATION ACTION 5	
Install high water mark signage along bridges and other structures to indicate dangerous water levels along creeks and rivers in flood-prone areas.	
BACKGROUND INFORMATION	
Site and Location:	Floodprone stream crossings throughout the county
Benefit Cost:	Signage that notifies drivers about how high the water is helps reduce water rescues and save lives. Combined with a "Turn Around, Don't Drown" campaign, this action could be very effective at minimizing dangerous water rescues.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.2; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	$15,000
Potential Funding Sources:	DHS: HMGP, FMA; USACE: FPMS; ARPA
Lead Agency/Department Responsible:	Public Safety, with VDOT
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

GREENSVILLE COUNTY MITIGATION ACTION 6	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes.	
BACKGROUND INFORMATION	
Site and Location:	Throughout floodprone areas of the county
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objective 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Zoning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GREENSVILLE COUNTY MITIGATION ACTION 7	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Conduct annual preparedness days for hazards to include floods, wind, and earthquakes.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases, Shoreline Erosion
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Safety
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GREENSVILLE COUNTY MITIGATION ACTION 8	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Repetitively flooded areas in the county
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the county who have to pay for flood insurance.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Zoning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GREENSVILLE COUNTY MITIGATION ACTION 9	
Work with state partners and neighboring localities to monitor and implement Next Generation 911 GIS data standards. Explore 911 consolidation with Emporia.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP; existing resources
Lead Agency/Department Responsible:	GIS Manager, PDC
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GREENSVILLE COUNTY MITIGATION ACTION 10	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, with particular emphasis on floodprone areas.
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Services, Planning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

GREENSVILLE COUNTY MITIGATION ACTION 11	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Emergency Services, Planning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF JARRATT MITIGATION ACTION 1	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Zoning and Planning; Fire Department
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF JARRATT MITIGATION ACTION 2	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Zoning and Planning; Fire Department
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Examples include the Virginia Hurricane Evacuation Guide and data collected via VDEM's Crisis Track post-disaster.	

HANOVER COUNTY MITIGATION ACTION 1	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event: • **Develop a more advanced flood warning system to increase the ability to locally and specifically forecast flood events and flood depths. Partner with other organizations including the NWS, U.S. Geological Survey (USGS), and local watershed organizations.** • **Acquire additional resources to build components of a local evacuation plan, including: new IFLOWS gauges, high hazard water crossing elevations for county and state-owned roads, and a flood alert system (using GIS, CodeRed and reverse 911).** • **Create more targeted flood messages and planning that can be conveyed to citizens. Include dam owners and downstream property owners.**	
BACKGROUND INFORMATION	
Site and Location:	Countywide, especially in floodprone areas and communities downstream of the dam
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced and lives are saved.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD

Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

HANOVER COUNTY MITIGATION ACTION 2	
Promote the "Turn Around, Don't Drown" public education campaign.	
BACKGROUND INFORMATION	
Site and Location:	Floodprone road crossings countywide
Benefit Cost:	Public information helps arm citizens with the communication and safety skills needed to save lives and property--before, during and after a flood event. Reminders via social media are free of charge and require only staff time.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.2; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Public Safety and National Weather Service
Implementation Schedule:	Ongoing and frequently
ADDITIONAL COMMENTS	

HANOVER COUNTY MITIGATION ACTION 3	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes. Develop plan to improve flood insurance coverage in the county, similar to the CRS Plan for Public Involvement. Consider updating flood ordinance from 2008.	
BACKGROUND INFORMATION	
Site and Location:	Throughout floodprone areas of the county
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.2, 1.4; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development
Implementation Schedule:	Within 4 years of plan adoption
ADDITIONAL COMMENTS	

HANOVER COUNTY MITIGATION ACTION 4	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Conduct annual preparedness days for hazards to include floods, wind, tornado, and earthquakes.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases, Shoreline Erosion
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
This is an ongoing action. The county's CERT and Medical Reserve Corps (MRC) distribute literature at multiple public events and work with Emergency Management on general preparedness training program that includes hazard information, at least twice per year.	

HANOVER COUNTY MITIGATION ACTION 5	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Repetitive flooded areas in the county, particularly the area identified in Section 5 near Pegway Lane and Route 642 (Bell Creek Road)
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the county who have to pay for flood insurance.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development
Implementation Schedule:	Ongoing as data are provided
ADDITIONAL COMMENTS	
IMPORTANT: Officials noted that they need to determine if the repetitive flood loss area identified in Section 5 is included on the new preliminary FEMA SFHA maps.	

HANOVER COUNTY MITIGATION ACTION 6	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, with particular emphasis on floodprone areas and repetitive flood loss area.
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Management, Public Works, Planning and Community Development
Implementation Schedule:	Ongoing

ADDITIONAL COMMENTS
Action may include stormwater management conveyance improvements, stream cleanouts with VDOT, storage management and communications with dam owners, and coordination with Va Department of Forestry regarding the hydrologic impacts of mass timber clearing. County has made and continues to make significant progress addressing generators for critical facilities, including switching from diesel to natural gas generators at fire stations, replacing the Wickham Building generator, adding a generator at Town Hall and the new terminal in the airport, and replacing units at the Police Department, and Fire Training Center.

HANOVER COUNTY MITIGATION ACTION 7	
Improve community interoperability when cell services are interrupted. Work with cell service providers and electric utility to ensure power redundancies at cell towers.	
BACKGROUND INFORMATION	
Site and Location:	All regional cell towers that affect county communications
Benefit Cost:	Cell service is critical to management of emergencies and for communicating messages to the public.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS, Dominion Energy
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	

HANOVER COUNTY MITIGATION ACTION 8	
Assemble pre-approved messaging plans for various hazard events. Include focus audience, message, and plan for dissemination. Assemble resources required to execute plans for each hazard.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Time is precious in post disaster scenarios, and having the tools available and pre-approved messaging agreed upon can help save lives and reduce damage.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.2, 1.3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	<$25,000; electronic messaging boards range from $13,000 - $35,000 each
Potential Funding Sources:	DHS: HMGP; ARPA
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	
Messaging will address a variety of hazard events and identify conflicts in messaging, such as from online apps (e.g., Waze) that send information to residents and visitors. Methods of dissemination may vary, but may include electronic messaging boards and door stickers or door hangers.	

TOWN OF ASHLAND MITIGATION ACTION 1	
Continue to identify areas of existing development where drainage is of significant concern, and implement a drainage improvement program, where feasible. Evaluate and make improvements, as needed, to stormwater system to ensure adequacy to handle major rain events.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	Ashland is generally flat and has poorly drained soils. Much of the town was developed prior to current standards for stormwater quantity control. Drainage studies can identify sites where undersized structures contribute to flooding and propose projects to reduce flooding now and in the future.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate (in southern portion of town) to Low
Estimated Cost:	TBD
Potential Funding Sources:	CIP; DHS: HMGP; ARPA
Lead Agency/Department Responsible:	Planning & Utilities
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
This action is also in the town's comprehensive plan, as policy recommendation E.14.	

TOWN OF ASHLAND MITIGATION ACTION 2	
Continue NFIP Community Rating System activities to reduce flood risk. Consider development of a Plan for Public Involvement per *CRS User's Manual* that is coordinated with other community outreach programs.	
BACKGROUND INFORMATION	
Site and Location:	Floodprone areas throughout the town
Benefit Cost:	Currently rated as a Class 8 in the CRS, property owners in the town's SFHA receive a 10% discount on premiums.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1; Goal 2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate (in southern portion of town) to Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF ASHLAND MITIGATION ACTION 3	
Finalize Continuity of Operations plan. New County/Town THIRA, COOP, and EOP are being completed together. Each department will have their own operational plans.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town, and coordinated with Hanover County
Benefit Cost:	All of these plans help identify and reduce vulnerabilities in the town's operational procedures.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Costs of implementation are TBD.
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Police
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
These plans are substantially complete. COOP is awaiting approval.	

TOWN OF ASHLAND MITIGATION ACTION 4	
Continue to enhance capabilities to use GIS for emergency management.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the Town
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF ASHLAND MITIGATION ACTION 5	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town, with particular emphasis on floodprone areas
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Planning and Community Development; Department of Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Potential projects include stream restorations, debris cleanup and the equipment necessary to assist, identification and removal of hazardous trees before wind and winter weather events.	

TOWN OF ASHLAND MITIGATION ACTION 6	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes.	
BACKGROUND INFORMATION	
Site and Location:	Throughout floodprone areas of the town
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate (in southern portion of town) to Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF ASHLAND MITIGATION ACTION 7	
Distribute brochures and use other means (e.g., local media) to educate the public regarding preparedness and mitigation. Conduct annual preparedness days for hazards to include floods, tornados, wind, and earthquakes.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Police
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Activities focus on flooding, stormwater management, hurricanes, winter weather and other “stay safe” messaging.	

TOWN OF ASHLAND MITIGATION ACTION 8	
Coordinate emergency management plans and practices with Hanover County and Randolph-Macon College, including plans for debris management.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	Coordinated responses and pre-event planning reduce impacts and damages.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1, Goal 2, Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	

TOWN OF ASHLAND MITIGATION ACTION 9	
Integrate mitigation plan goals and actions into other appropriate planning mechanisms for the town and county, such as comprehensive plans and capital improvement plans. Add hazard mitigation discussion to the town's comprehensive plan, and include pertinent mitigation actions.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	Mitigation actions that are represented in various plans, budgets and programming are more likely to be funded sufficiently and implemented because the number of people engaged in making the actions happen increases.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF ASHLAND MITIGATION ACTION 10	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Police, Planning and Community Development
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF ASHLAND MITIGATION ACTION 11	
Continue coordination between Planning and Community Development and County Building Services to ensure no structures are constructed in the SFHA without proper permitting.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	Code compliant designs are proven to reduce damage from flood, wind, snow and earthquake. The NFIP requires that all development in the SFHA is compliant with local floodplain management requirements implemented specifically to reduce flood damages.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate (in southern portion of town) to Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development, Hanover County
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

HENRICO COUNTY MITIGATION ACTION 1	
Implement all-inclusive hazard mitigation planning for schools, to include: 1) continue annual site multi-hazard inspections of schools to identify areas for use as tornado safe rooms, assessment of structure vulnerability to earthquake and flood based on floor elevations; 2) prepare Emergency Action Plan for each school; 3) incorporate building plans into GIS to enable first responders entering the schools for any reason; and 4) ensure sheltering sites meet all national shelter standards, have generator power, and are protected from wind and flood. Fund and fulfill required retrofits upon identification.	
BACKGROUND INFORMATION	
Site and Location:	All county schools
Benefit Cost:	Schools house a large number of people everyday, which increases exposure to a variety of hazards. Pre-disaster planning and structural inspections, as well as detailed knowledge about the school layout and construction, enable first responders to quickly respond to events and minimize damage.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Sinkholes, Infectious Diseases
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4: Objectives 4.1, 4.3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	Existing budgets; DHS: HMGP, BRIC
Lead Agency/Department Responsible:	Emergency Management & Henrico County Public Schools

Implementation Schedule:	within 4 years of plan adoption, with ongoing annual inspections
ADDITIONAL COMMENTS	

HENRICO COUNTY MITIGATION ACTION 2	
Continue to implement drainage and stream channel maintenance program.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Conveyances that are kept clean and maintained appropriately are less likely to cause flooding during periods of extreme precipitation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 4: Objective 4.2
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
This program is currently complaint-based.	

HENRICO COUNTY MITIGATION ACTION 3	
Expand existing comprehensive Public Outreach program through coordination of several ongoing efforts related to hazards: 1) operationalize Community Emergency Resource Team resources to enhance training availability to targeted populations; 2) continue participating in Great Shakeout (workplace safety drills) and other wide-scale disaster drills; 3) continue participation in the StormReady program; 4) continue outreach through brochure distribution and other means (e.g., utility bill messaging, local media, social media) to educate the public regarding preparedness and mitigation; 5) coordinate all messaging with CRS Plan for Public Information (PPI), which focuses on increasing flood insurance countywide; and 6) rebrand Dept. of Public Works outreach for flood and dam safety and tie into other EM initiatives.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Severe Winter Weather, Thunderstorms, Extreme Heat
Goal(s) Addressed:	Goal 1; Goal 2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	$10,000/year, plus staff time
Potential Funding Sources:	Existing resources, CERT
Lead Agency/Department Responsible:	Emergency Management, Finance, Public Works, Public Utilities, Public Relations
Implementation Schedule:	Ongoing

ADDITIONAL COMMENTS
Consider addition of Public Information Officer on staff of DPW to manage outreach on flood and dam safety. With proper training, CERT members can be used to help administer vaccine clinics, lead volunteer efforts, conduct damage assessments, provide information dissemination, canvas communities, prepare IEPs, serve as radio team leaders.

HENRICO COUNTY MITIGATION ACTION 4	
Upgrade/retrofit existing EOC and identify viable temporary EOCs that would suit the county's purposes. Expand options for public facilities that can receive generator backup and be used as temporary emergency shelters.	
BACKGROUND INFORMATION	
Site and Location:	Existing EOC and potential county-owned facilities countywide
Benefit Cost:	EOCs require sufficient protection from weather and manmade hazards to provide a safe operational platform for executing emergency response. Temporary EOCs for particular events may provide a lower cost way to address the vulnerabilities of the existing facility.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 4: Objective 4.2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	Existing resources; DHS, VDEM
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 10 years of plan adoption
ADDITIONAL COMMENTS	
Second floor of existing EOC building is vulnerable to wind damage and is located near major road and hospital with potential for hazardous materials exposure. Existing EOC is not a dedicated facility.	

HENRICO COUNTY MITIGATION ACTION 5	
Install electrical hook-ups, wiring, and switches to allow quick connects at county-owned critical facilities, including for example, shelters and pump stations.	
BACKGROUND INFORMATION	
Site and Location:	Critical facilities throughout the county
Benefit Cost:	Shelters and pump stations can stay operational throughout disaster events with provision of dependable generator power.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	Existing resources; DHS: HMGP, UASI; ARPA
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

HENRICO COUNTY MITIGATION ACTION 6	
Provide continuous, ongoing training on hazard mitigation and the county's related initiatives to all county staff. Training will enhance ability to integrate mitigation objectives in all county programs.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Available materials for training are readily available from state and Federal agencies free of charge. The benefits of hazard-focused training may be realized in small ways over a long period of time as mindsets change to think about the impact of everyday actions on long-term vulnerability.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 2: Objective 2.2; Goal 3: Objective 3.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Works, Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

HENRICO COUNTY MITIGATION ACTION 7	
Expand existing local, regional, and county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, including: 1) build a comprehensive stream gauge network that includes data on water elevation, water quality, precipitation measurement, and dam impoundment levels; 2) updated Emergency Action Plans based on rain gauge data; 3) warning system(s) that alert citizens; and 4) detailed evacuation planning tied to warning system and based on critical road elevations or other road obstructions.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, with particular emphasis on county- and FEMA-identified flood hazard areas
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1, Goal 2
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE; USGS
Lead Agency/Department Responsible:	Public Utilities, Public Works, and Emergency Management, USGS
Implementation Schedule:	
ADDITIONAL COMMENTS	
USGS rain gauges have been installed at 5 of the county-owned dams, and USACE/NWS have completed inundation mapping on the James River.	

HENRICO COUNTY MITIGATION ACTION 8	
Maintain relationships with Dominion Energy, Comcast, Verizon (and other utility service providers), and VDOT to ensure swift removal of debris and continued maintenance of lines to minimize future debris.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	The critical element in maintaining these relationships is keeping contacts and contact information current and up to date on the county's actions. Cooperation with utility providers in post-disaster scenarios protects consumers and reduces damages.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Dominion Energy, DPW, DPU, Fire and Police
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

HENRICO COUNTY MITIGATION ACTION 9	
Conduct annual review of repetitive loss, severe repetitive loss and all NFIP claims and policy coverage data from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Data analysis will inform other community mitigation efforts.	
BACKGROUND INFORMATION	
Site and Location:	Floodprone areas countywide
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the county who have to pay for flood insurance. Data analysis will inform PPI which targets underinsured, flood-prone areas of the county in an effort to increase flood insurance coverage.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low to Moderate; Rep loss areas on Horsepen Branch, Rocky Branch, North Run, Trumpet Branch and along West Nine Mile Road near Highland Springs have highest relative NRI risk for flood in the county and should be prioritized to increase impacts of mitigation on socially vulnerable populations.
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Works, FEMA Region III

Implementation Schedule:	Annual, or as data are provided
ADDITIONAL COMMENTS	
Each rep loss and severe rep loss structure will be assigned a flood risk score (using social vulnerability info) and ranked in order to prioritize areas for flood mitigation	

HENRICO COUNTY MITIGATION ACTION 10	
Continue participating in the National Flood Insurance Program and Community Rating System, including enforcement of zoning and building codes.	
BACKGROUND INFORMATION	
Site and Location:	Throughout floodprone areas of the county
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation. CRS participation reduces flood insurance premiums for property owners in the SFHA.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

HENRICO COUNTY MITIGATION ACTION 11	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities, and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, with particular emphasis on floodprone areas.
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate to Low for flood: Each rep loss and severe rep loss structure will be assigned a flood risk score (using social vulnerability info) and ranked in order to prioritize areas for flood mitigation
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Management, Public Utilities, Public Works, Planning, Permit Center, Building Inspections, Police, Schools, Rec & Parks

Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Acquisition of floodprone structures is the county's current priority for mitigation. Strategic acquisition of properties on the open market or available through trustee's sale is a long-term tactic.	

HENRICO COUNTY MITIGATION ACTION 12	
Prepare countywide hazard-related communications plan. Include general outreach regarding risk, county programs and dam safety. Provide information on regulations and permitting requirements. Tie messaging into the PPI focusing on flood insurance coverage. Prepare an annex to the Emergency Operations Plan that includes prescribed messages for pre- and post-disaster scenarios.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Pre-prepared and pre-approved messages save precious moments in post-disaster scenarios when citizens need answers and officials need to disseminate information. The costs of preparing communications methodology and messaging ahead of time are minimal.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management, Public Works, Public Relations
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

HENRICO COUNTY MITIGATION ACTION 13	
Provide training to realtors, insurance agents, builders, and surveyors, who operate in the county regarding floodplain management policies and procedures. Provide business resilience training to business owners, especially SWaM businesses. Tie messaging into the PPI.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Effective floodplain management reduces future damages in floodprone areas but only if regulations are enforced. There are many measures businesses can implement to reduce damage from a variety of hazards.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundments
Goal(s) Addressed:	Goal 1, Objectives 1.2, 1.3, 1.4; Goal 2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources; DHS: HMGP, FMA;
Lead Agency/Department Responsible:	DPW
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

HENRICO COUNTY MITIGATION ACTION 14	
Provide infrastructure upgrades (roads, water supply, sanitary sewer service) to improve emergency services response times in the county's east end. Ensure water supply is sufficient to meet firefighting needs, and water quality remains safe for residents.	
BACKGROUND INFORMATION	
Site and Location:	Eastern portion of the county, east and south of Richmond
Benefit Cost:	Response times for wildfire and other hazard events can reduce damage by removing people from harm's way.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfires, Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Severe Winter Weather, Earthquakes
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	Capital budgeting
Lead Agency/Department Responsible:	DPW, Public Utilities, Fire
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 1	
Integrate mitigation goals into future capital improvement plans to ensure that new city facilities are located out of identified hazard areas. Relocate Fire Station 1/EOC/Headquarters outside of 0.5 mile evacuation zone for industrial plans and as far as possible from train yards/tracks.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	The vulnerability of public safety buildings and the location of the city's operational facilities in areas outside of high hazardous risk zones is a key element in reducing risk and increasing operational capabilities.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hazardous materials release secondary to surrounding facilities impacted by natural disasters, i.e. tornado, hurricane, high winds.
Goal(s) Addressed:	Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 2 years of plan adoption and then ongoing
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 2	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building ordinances. Update Article XV, Floodplain District, ordinance. Research joining the NFIP Community Rating System.	
BACKGROUND INFORMATION	
Site and Location:	Floodprone areas Citywide
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Development
Implementation Schedule:	Ongoing. Update floodplain ordinance within 2 years of plan adoption.
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 3	
Target FEMA's repetitive loss property, and those in the surrounding repetitive loss area, for specialized outreach and mitigation activities.	
BACKGROUND INFORMATION	
Site and Location:	Structures are in an area outside the detailed-study 100-year floodplain and floodway of Bailey Creek, a tributary of the James River. Bailey Creek, in general, has a relatively flat watershed; the lower reaches are swampy, and flow is very sluggish.
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring structures designated as repetitive loss have flood insurance is important for protecting citizens occupying those structures.

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1; Goal 3: Objective 3.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing

ADDITIONAL COMMENTS
As of 2021, there is only 1 confirmed repetitive loss in Hopewell.

CITY OF HOPEWELL MITIGATION ACTION 4	
Inspect and clear debris from stormwater drainage system. Increase capacity of Cabin Creek drainage system, including: 1) debris clearing and revetment, and 2) if necessary, re-alignment of channel. Increase capacity of Cattail Creek channel and culverts crossing CSX and Norfolk Southern Railroad to address repeated flooding and damage to infrastructure.	
BACKGROUND INFORMATION	
Site and Location:	Cabin Creek, and Cattail Creek at railroad crossing
Benefit Cost:	Benefits of improving the stormwater conveyances accrue to infrastructure and homes in the area flooded by undersized bridges and culverts. Ensuring culverts are sized appropriately for current and future conditions will help address climate change and increased precipitation in the future, as well.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP; ARPA; Virginia CFPF
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Cattail Creek improvements have been funded (partially by grant funding) and are substantially complete. Additional improvements to stabilize the stream channel and road embankment of the city's primary emergency route, Winston Churchill Dr, between High Ave & Arlington Rd, and to protect adjacent residences, is also substantially complete.	

CITY OF HOPEWELL MITIGATION ACTION 5	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, and an engineering study to identify retrofits to address critical infrastructure vulnerabilities such as the need for generators, and quick-connects at the schools.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Management, Public Works
Implementation Schedule:	
ADDITIONAL COMMENTS	
City Hall generator is under-sized to fulfill radio & other needs during disaster.	

CITY OF HOPEWELL MITIGATION ACTION 6	
Engage owners of the city's industrial businesses to discuss opportunities for retrofitting/hardening their facilities against flooding and severe weather, and developing business resilience plans.	
BACKGROUND INFORMATION	
Site and Location:	The City's floodprone industrial waterfront
Benefit Cost:	Targeted mitigation opportunities in this area can help dramatically reduce vulnerability by reducing damage to structures and infrastructure, and prepare businesses for managing disaster events.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Severe Winter Weather, Shoreline Erosion, Earthquakes
Goal(s) Addressed:	Goal 1: Objectives 1.3, 1.4; Goal 2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal planning costs; project/retrofit costs TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; ARPA; USEDA: DMTA
Lead Agency/Department Responsible:	Emergency Management, private owners
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 7	
Develop a debris removal plan.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Both pre- and post-disaster debris removal is a key component in managing recovery and getting infrastructure (such as roads) back online.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Shoreline Erosion
Goal(s) Addressed:	Goal 1: Objectives 1.1; Goal 3: Objective 3.1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Planning costs minimal; fees associated with on call contractors to perform services
Potential Funding Sources:	DHS; VDEM
Lead Agency/Department Responsible:	Public Works, Emergency Management
Implementation Schedule:	Within 1 year of plan adoption
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 8	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
City distributed FEMA brochures during COVID disaster.	

CITY OF HOPEWELL MITIGATION ACTION 9	
Install NWS-grade tide gauge at confluence of James and Appomattox Rivers. Include acoustic water-level sensor, protective well components, data collection platform, GOES satellite telemetry, enclosure, stand, batteries, antenna, and solar panels. Integrate IPAWS sensors with CodeRed alert system.	
BACKGROUND INFORMATION	
Site and Location:	Confluence of James and Appomattox Rivers
Benefit Cost:	The gauge data will be used to increase predictive capability, to build historical data to use for more reliable future predictions for industrial area and marina that will increase protective measures taken and aid evacuation efforts.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP; NWS; USACE; ARPA; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 4 years of plan adoption
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 10	
Implement continuity of operations plan.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	COOP helps identify and reduce vulnerabilities in the city's operational procedures.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 1 year of plan adoption
ADDITIONAL COMMENTS	
Since previous plan, City has completed the COOP.	

CITY OF HOPEWELL MITIGATION ACTION 11	
Integrate VDEM Crisis Track software (for post-disaster damage assessment) into local GIS platforms for data collection, storage and sharing. Add building plans from critical facilities into GIS to benefit first responders.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Development
Implementation Schedule:	Within 1 year of plan adoption
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 12	
Retrofit Hopewell Marina infrastructure to minimize potential impacts from flooding and shoreline erosion, to include: power equipment, pumpout facility, and docks. Develop plan for debris management at the site. Ensure marina rules and regulations require boats to be operational and regularly-maintained, with insurance policies up to date.	
BACKGROUND INFORMATION	
Site and Location:	Hopewell Marina, on the south bank of the Appomattox River, just west of the Route 10 bridge
Benefit Cost:	Marina is vulnerable to flooding and shoreline erosion; retrofitting components and infrastructure will reduce future flood damages.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Shoreline Erosion, Severe Wind Events
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	ARPA; DHS: HMGP
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 13	
Formalize process for tax sale properties, with special focus on those in hazardous locations (SFHA, 500-year floodplain, hazardous materials, etc.).	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Determining best practices for divesting the city of hazardous properties and minimizing future private investment in those properties can reduce damages in the long-term.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Shoreline Erosion, Earthquakes, Severe Wind Events
Goal(s) Addressed:	Goal 1; Goal 3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal cost for planning; future acquisition/disposal/demolition costs TBD. Demolition/rebuild may allow future, protected development.
Potential Funding Sources:	DHS: HMGP, BRIC, FMA, RFC
Lead Agency/Department Responsible:	Commissioner of Revenue, Emergency Management, Risk Management
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 14	
Develop local stormwater management resilience plan and incorporate identified upgrades into the State's Coastal Resilience Plan.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	A broad review and study of the city's stormwater conveyances is needed to identify upgrades/maintenance/retrofits necessary to ensure the system can perform as designed to handle existing and future precipitation conditions.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	Virginia CFPF
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Within 1 year of plan adoption
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 15	
Implement State Code requirement to adopt Capital Improvement Budget. As outlined in the Comprehensive Plan, a CIP would identify and prioritize projects for environmental protection, including funding for: critical RPA maintenance, mitigation and remediation; stormwater retrofits on City-owned properties; development of Small Area Plans in key areas of environmental vulnerability, and grant and investment support for high priority pollutant reduction projects.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	CIP is needed in order to determine City priorities for mitigation and to outline what local funds are available to support the most cost beneficial initiatives.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure; Shoreline Erosion, Severe Wind Events, Earthquakes
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	City Manager, Finance, Public Works
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

CITY OF HOPEWELL MITIGATION ACTION 16	
Enact additional regulations to govern shoreline development, to include: require vegetation as an alternative to manmade structures; require all new shoreline development applications are accompanied by a Shoreline Protective Plan, in accordance with the *Virginia Department of Conservation and Recreation Chesapeake Bay Local Assistance Riparian Buffers Modification and Mitigation Guidance Manual*; ensure all newly delineated wetlands (resulting from review of development proposals) are added to the city's wetland resource inventory.	
BACKGROUND INFORMATION	
Site and Location:	Shorelines citywide
Benefit Cost:	Shoreline erosion is caused by a variety of forces in Hopewell, but controlling new development is an important element in reducing future damages.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Shoreline Erosion
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Development
Implementation Schedule:	Within 5 years of plan adoption
ADDITIONAL COMMENTS	
This action is also recommended in the comprehensive plan.	

CITY OF HOPEWELL MITIGATION ACTION 17	
Install comprehensive atmospheric monitoring equipment, including but not limited to: air temperature, road temperature, wind speed & direction, rainfall, lightning strike, humidity, road surface and bridge surfaces conditions. This comprehensive weather monitoring system includes remote monitoring of these sensors and conditions, and receives data from all monitors as well as cameras. Remote and automatic activation of automatic early warning system must also be included.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Improved situational awareness of atmospheric conditions which allows for improved preparation, response and recovery before during and after inclement weather conditions. This allows City officials to make accurate informed decisions for the planning preparation and response to natural disasters, early warning and notification, orders of emergency evacuation/shelter in place.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Severe Winter Weather, Droughts and Extreme Heat, Thunderstorms
Goal(s) Addressed:	Goal 1: Objective 1.1, 1.2,1.4; Goal 2: Objective 2.1, 2.2, 2.3; Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP; NWS; USACE; ARPA; Virginia CFPF
Lead Agency/Department Responsible:	Public Works, Emergency Management
Implementation Schedule:	Within 2 years of adoption
ADDITIONAL COMMENTS	
As a waterfront community we must monitor the conditions of roadways, bridges, the shoreline as well as current air temperatures, surface temperatures, wind and tidal activity. The City	

maintains over 276 miles of roadways; cost savings and waste reductions would be secondary benefits of implementing this program. Accurate atmospheric monitoring or air and road surface temperature information allows the personnel responsible for surface pre-treatment, treatment, repairs, and maintenance to respond appropriately to the current conditions, monitor trends, and respond accordingly. This prevents waste and the misapplication of treatment products.

CITY OF HOPEWELL MITIGATION ACTION 18	
Implement the projects identified in the local stormwater resilience plan. Projects are categorized from short range to long range based on size, cost, complexity and risk area.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	This effort will address potential climate hazards that are not only felt today but also will affect every aspect of life over the coming decades. Project implementation will mitigate risk areas identified in stormwater resilience plan, reducing the occurrence of flood damage to public infrastructure and private property.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	VDOT Revenue Sharing Program, Virginia DCR CFPF, Virginia DEQ Stormwater Local Assistance Fund
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Within 5 Years of plan adoption
ADDITIONAL COMMENTS	
The local stormwater resilience plan is a living document that will be updated each year to account for completed projects and new projects added as categorized.	

NEW KENT COUNTY MITIGATION ACTION 1	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Repetitively flooded areas in the county
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the county who have to pay for flood insurance.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Moderate – 2 rep loss areas in the southeastern part of county along the Chickahominy River
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

NEW KENT COUNTY MITIGATION ACTION 2	
Maintain floodplain protection ordinances and policies that allow the county to fully participate in the National Flood Insurance Program..	
BACKGROUND INFORMATION	
Site and Location:	Throughout floodprone areas of the county
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3, Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Inspections
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Floodplain management ordinance was updated in September 2021. A floodplain manager position was created and staffed in Environmental in 2019. This action is also expressed in the county's comprehensive plan.	

NEW KENT COUNTY MITIGATION ACTION 3

Distribute brochures and other literature to educate the public regarding preparedness and mitigation. Use a variety of means to disseminate hazard-related information, including social media and workshops. Prepare transferable lesson plans for delivery in schools and summer camps (Storm Camp). Incorporate the NWS "Turn Around, Don't Drown" campaign.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time + materials (~$2500/year printing costs)
Potential Funding Sources:	DHS: HMGP; NWS; ARPA
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
County currently distributes information at all special events, such as Grand Illumination, National Night Out, and the County Fair.	

NEW KENT COUNTY MITIGATION ACTION 4	
Encourage new community support facilities, such as banks, gas stations, and pharmacies, to have back-up generators, cell phone charging stations, and electric vehicle charging stations as they are developed.	
BACKGROUND INFORMATION	
Site and Location:	Countywide population centers
Benefit Cost:	Long-term power outages can have impacts beyond climate control. Emergency Management disseminates post-disaster messaging via social media, which requires cell service. Citizens need urgent access to money, gas and medicines.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD. If mandated, cost is minimal. If incentives are provided, county could cover part of the cost.
Potential Funding Sources:	DHS; Dominion Energy
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

NEW KENT COUNTY MITIGATION ACTION 5	
Identify and replace vulnerable or undersized structures with bridges, larger culverts or other measures to reduce flood hazards.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Benefits of improving the stormwater conveyances accrue to infrastructure and homes in the area flooded by undersized bridges and culverts.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	~$175,000-$250,000 for single stormwater master plan
Potential Funding Sources:	DHS: HMGP; ARPA; USDA: WPFP
Lead Agency/Department Responsible:	Planning, Environmental, General Services
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

NEW KENT COUNTY MITIGATION ACTION 6

Pursue opportunities and funding to harden local utilities and infrastructure to improve recovery time, including fulfilling any equipment and heavy machinery needs to accomplish this, and retrofitting critical facilities and systems.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Infrastructure can often be retrofitted at low to moderate cost to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Landslides, Shoreline Erosion, Sinkholes, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4: Objectives 4.1 and 4.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Public Utilities, Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

NEW KENT COUNTY MITIGATION ACTION 7

Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects.

BACKGROUND INFORMATION	
Site and Location:	Countywide, with particular emphasis on floodprone areas and repetitive loss areas as identified in Section 5
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing

ADDITIONAL COMMENTS

NEW KENT COUNTY MITIGATION ACTION 8

Identify additional shelter mass care locations.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Sheltering requirements are evolving and communities must adjust to meet the needs of citizens for a variety of short- and longer-term disaster duration events in order to minimize adverse impacts when evacuation is necessary.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS; VDEM
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Annual needs assessment
ADDITIONAL COMMENTS	
Shelter demand, availability and options are reviewed annually. COVID impacted mass care options requiring Federal and state agencies to adopt interim strategies including non-congregate shelter options.	

NEW KENT COUNTY MITIGATION ACTION 9

Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required. Consider countywide flood warning system and evacuation plan.

BACKGROUND INFORMATION	
Site and Location:	Countywide; I-Flow gauges particularly needed for Colonies and campground areas near Chickahominy River
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE; USGS
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing

ADDITIONAL COMMENTS

NEW KENT COUNTY MITIGATION ACTION 10

Create a culture within New Kent County government focused on hazard mitigation objectives: 1) integrate mitigation plan goals and actions into other appropriate planning mechanisms, such as the comprehensive plan and capital improvement plan; 2) review processes and procedures across all functions to ensure objectives are met (Development Review Committee hazard reviews, for example); and 3) regularly brief elected officials on mitigation plan status and priorities. Within Emergency Management, conduct and receive training to stay current on grant opportunities and identify new opportunities for data sharing within the county, region and state. Work to focus mitigation actions on specific structures, neighborhoods and problem areas. Incorporate mitigation objectives into recovery planning and regular exercises.

BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Mitigation actions require integration with other county functions to be implemented effectively.

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal; some training costs may be incurred
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing

ADDITIONAL COMMENTS

NEW KENT COUNTY MITIGATION ACTION 11	
Periodically inventory existing dams in the county, assess their hazard potential, and seek funding for preparation of dam inundation zone maps. Ensure Emergency Action Plans (EAPs) are up to date, identify necessary maintenance or retrofits, and conduct exercises to reinforce EAP procedures.	
BACKGROUND INFORMATION	
Site and Location:	All dams countywide
Benefit Cost:	Local engineering expertise and regional knowledge may prove effective in supplementing existing, limited state resources for inspecting and rating dams. Dam inundation planning is similarly impacted.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HHPD; USACE; VaDCR
Lead Agency/Department Responsible:	Environmental; Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
This action is also expressed in the county's comprehensive plan. There are no high hazard potential dams in New Kent County.	

NEW KENT COUNTY MITIGATION ACTION 12	
Promote native and drought-tolerant grass species and landscaping as an alternative to traditional fescue-based lawns.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	This measure provides protection from a variety of hazards; reduced runoff and erosion, and more cooling on high temperature days are advantages of these alternatives.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Shoreline Erosion, Extreme Heat
Goal(s) Addressed:	Goal 3
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management and County Extension Services
Implementation Schedule:	Within 4 years of plan adoption
ADDITIONAL COMMENTS	
This action is also expressed in the county's comprehensive plan.	

CITY OF PETERSBURG MITIGATION ACTION 1	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes.	
BACKGROUND INFORMATION	
Site and Location:	Throughout floodprone areas of the city
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Building Department
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 2	
Partner with parent-teacher associations and local schools to implement existing curriculum related to natural hazards (e.g., Masters of Disaster, Risk Watch).	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Children and parents that are informed and know what actions to take in the event of hazard events can help reduce damages and save lives.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 3	
Complete application for StormReady Program.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	StormReady helps arm communities with the communication and safety skills needed to save lives and property--before, during and after the event. StormReady helps community leaders and emergency managers strengthen local safety programs.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Severe Winter Weather, Thunderstorms, Extreme Heat
Goal(s) Addressed:	Goal 1; Goal 2
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	
City is not certified StormReady as of January 2022.	

CITY OF PETERSBURG MITIGATION ACTION 4	
Consider participating in FEMA's Community Rating System.	
BACKGROUND INFORMATION	
Site and Location:	Citywide, with particular benefits to flood prone areas
Benefit Cost:	CRS actions help reenforce existing floodplain management initiatives, including the floodplain zoning overlay ordinance. These measures reduce average annual damages from flooding in the future, and participation in the CRS results in premium savings that stay in homeowners' pockets.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Considerable staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 5	
Inspect and clear debris from stormwater drainage system. Partner with VDOT to ensure non-City owned ROWs are also clear.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Clear drainage systems help to alleviate local or urban flooding and associated damage resulting from severe precipitation events.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	$20,000/year
Potential Funding Sources:	Existing CIP; DHS: BRIC, HMGP; VDOT
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 6	
Finish implementation of Reverse 911 system.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Other methods of notifying citizens require massive amounts of staff time which exceeds budgetary restraints. Reverse 911 quickly and efficiently uses existing infrastructure to notify property owners of appropriate pre- and post-disaster mitigation actions.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.2, 1.4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 7	
Install high water mark signage along bridges and other structures to indicate dangerous water levels along creeks and rivers in flood-prone areas.	
BACKGROUND INFORMATION	
Site and Location:	Flood-prone crossings Citywide
Benefit Cost:	Signage that notifies drivers about how high the water is helps reduce water rescues and save lives.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding; Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.2, 1.4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	$15,000
Potential Funding Sources:	DHS: HMGP, FMA; USACE: FPMS; ARPA; FOLAR
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 8	
Investigate all public utility lines to evaluate their resistance to flood, wind, and winter storm hazards. Retrofit or relocate lines, as necessary, to reduce vulnerabilities.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Provision of public utilities during and after disasters is critical to public safety.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Shoreline Erosion, Sinkholes
Goal(s) Addressed:	Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	$75,000 for inspection & report; retrofit costs TBD
Potential Funding Sources:	DHS: HMGP, BRIC; ARPA
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 9	
Work with VDOT, private utilities, and/or private homeowners to trim or remove trees that could down power lines.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Provision of utilities during and after disasters is critical to public safety.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Shoreline Erosion, Sinkholes
Goal(s) Addressed:	Goal 2; Goal 4
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	$25,000
Potential Funding Sources:	ARPA; DHS: HMGP;
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 10	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal
Potential Funding Sources:	DHS: HMGP
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 11	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Repetitive flood loss areas throughout the City as discussed in Section 5 of this plan
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the City who have to pay for flood insurance.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning Department, Tax Assessor
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 12	
Install quick connects for generators at critical facilities. Ensure existing generators are working at all times with regular maintenance and inspections. Replace generators, as necessary.	
BACKGROUND INFORMATION	
Site and Location:	Citywide facilities
Benefit Cost:	Continuity of operations after a hazard event is dependent upon operational utilities, shelters, communications and medical services.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	$8000/year
Potential Funding Sources:	DHS: HMGP; Existing CIP budgets
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 13	
Work with state partners and neighboring localities to monitor and implement Next Generation 911 GIS data standards.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP; existing resources
Lead Agency/Department Responsible:	GIS Manager, Crater PDC
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 14	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Citywide, with particular emphasis on the city's repetitive flood loss areas as identified in Section 5
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Fire-Rescue
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF PETERSBURG MITIGATION ACTION 15	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Fire-Rescue
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

POWHATAN COUNTY MITIGATION ACTION 1	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities, mapping to determine detailed flood hazards, and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Quick connects for all permanently-installed generators on critical facilities are needed.	

POWHATAN COUNTY MITIGATION ACTION 2	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes. Continue to require minimum non-disturbance (vegetated) buffers from the edge of all wetlands and streams.	
BACKGROUND INFORMATION	
Site and Location:	Throughout floodprone areas of the county
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low, to Moderate in the eastern two-thirds of the county
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
County does not allow new development in the SFHA. The buffer continuance is also expressed in the existing comprehensive plan, which is currently being updated.	

POWHATAN COUNTY MITIGATION ACTION 3	
Maximize use of VDEM's Crisis Track system to collect and transmit damage assessment information post-disaster.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	

POWHATAN COUNTY MITIGATION ACTION 4	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Increase situational awareness on behalf of citizens and maximize use of social media, Yammer, county employees, CodeRed/R911 to communicate important hazard-related messages.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases, Shoreline Erosion
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management, County Public Information Officer
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

POWHATAN COUNTY MITIGATION ACTION 5	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA, if any arise. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Repetitively flooded areas in the county
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the county who have to pay for flood insurance.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
There are currently no properties on the NFIP list of repetitive flood losses for Powhatan County.	

POWHATAN COUNTY MITIGATION ACTION 6	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required.	
BACKGROUND INFORMATION	
Site and Location:	Floodprone areas countywide
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

POWHATAN COUNTY MITIGATION ACTION 7	
Implement measures to reduce wildfire damages, including: 1) mandate Fire Department review for defensible space and wildfire interface in development review process; 2) provide wildfire mitigation training to landowners and other county staff.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Damage from wildfire can be reduced by ensuring new development has protective measures in place. The VDOF has several tools available for training measures, free of charge.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Goal(s) Addressed:	Goal 1; Goal 3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Community Development, VDOF
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	

POWHATAN COUNTY MITIGATION ACTION 8	
Finalize Post-Disaster Redevelopment plan that documents plans and procedures for recovery, including development/designation of a Recovery Operations Center.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Covering a broad array of hazard events, this plan lays out a plan for recovery that will help align redevelopment efforts with current standards for hazard mitigation, thereby reducing future vulnerability.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 3: Objective 3.2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 1 year of plan adoption
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 1	
Continue participating in the National Flood Insurance Program, including enforcement of zoning and building codes.	
BACKGROUND INFORMATION	
Site and Location:	Throughout floodprone areas of the county
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Building Department
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 2	
In future updates to the 2018 comprehensive plan, include hazard vulnerability summary and include mitigation actions in the plan.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Repetition of mitigation actions and consistency throughout county plans helps ensure implementation of the plan and subsequent reduction in vulnerability.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Planning Department
Implementation Schedule:	Within 1 year of plan adoption
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 3	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, with particular emphasis on floodprone areas.
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Planning and Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 4	
Develop stormwater master plan to study capacity of existing culverts and other structures to determine if sizing is sufficient for current conditions. Identify and replace vulnerable or undersized culvert stream crossings with bridges or larger culverts to reduce flood hazards, where feasible. Implement program for regular inspections and maintenance of roadside ditches and stream channels.	
BACKGROUND INFORMATION	
Site and Location:	Countywide; however, certain areas along Rte 460 and Rte10 (near Deep Bottom)
Benefit Cost:	Benefits of improving the stormwater conveyances accrue to infrastructure and homes in the area flooded by undersized bridges and culverts. Ensuring culverts are sized appropriately for flooding conditions will help address climate change and increased precipitation in the future, as well.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, FMA, BRIC; ARPA
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Within 4 years of plan adoption
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 5	
Maximize use of VDEM's Crisis Track system to collect and transmit damage assessment information post-disaster.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 6	
Coordinate drought contingency plans with County Extension Office.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Maintaining contingency plans for predicting and addressing drought conditions can help reduce losses, especially in the agricultural sectors.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Droughts and Extreme Heat
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 7	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Target FEMA's repetitive flood loss properties for specialized outreach and mitigation activities to encourage purchase of flood insurance and flood preparedness measures.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
County has active Survivor Day programming, outreach tables at events, and CERT programs, all of which will continue.	

PRINCE GEORGE COUNTY MITIGATION ACTION 8	
Hire appropriately-trained personnel for Emergency Management Office, Building Inspections Office, and Zoning Office to ensure adequate levels of staffing to administer county programs.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Staff who are well-versed in administration of county requirements related to hazard mitigation help make sure that existing standards are enforced and new standards do not increase the impacts of hazards.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objective 1.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	~$150,000/year (salaries) + ~$2000/year (training)
Potential Funding Sources:	DHS; Existing budgets
Lead Agency/Department Responsible:	County Administration and Agency Heads
Implementation Schedule:	Within 4 years of plan adoption
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 9	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Repetitively flooded areas in the county
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the county who have to pay for flood insurance.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 10	
Build new Fire Department burn building.	
BACKGROUND INFORMATION	
Site and Location:	Benefits accrue regionally; proposed site is off of Wells Station Road close to Route 460
Benefit Cost:	This project is critical for maintaining a competently-trained and coordinated fire and EMS system.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfires
Goal(s) Addressed:	Goal 1: Objective 1.1
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	$718,306
Potential Funding Sources:	Capitol funds; Virginia Department of Fire Programs; regional partners (tri-cities, Fort Lee)
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 11	
Continue implementation of automatic aid agreement with the City of Hopewell.	
BACKGROUND INFORMATION	
Site and Location:	Countywide, including Hopewell
Benefit Cost:	Mutual aid agreements expand the capabilities of both jurisdictions to respond to and manage hazard events.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal; some costs accrue if agreement is enacted for an event
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

PRINCE GEORGE COUNTY MITIGATION ACTION 12	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Emergency Services, Planning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

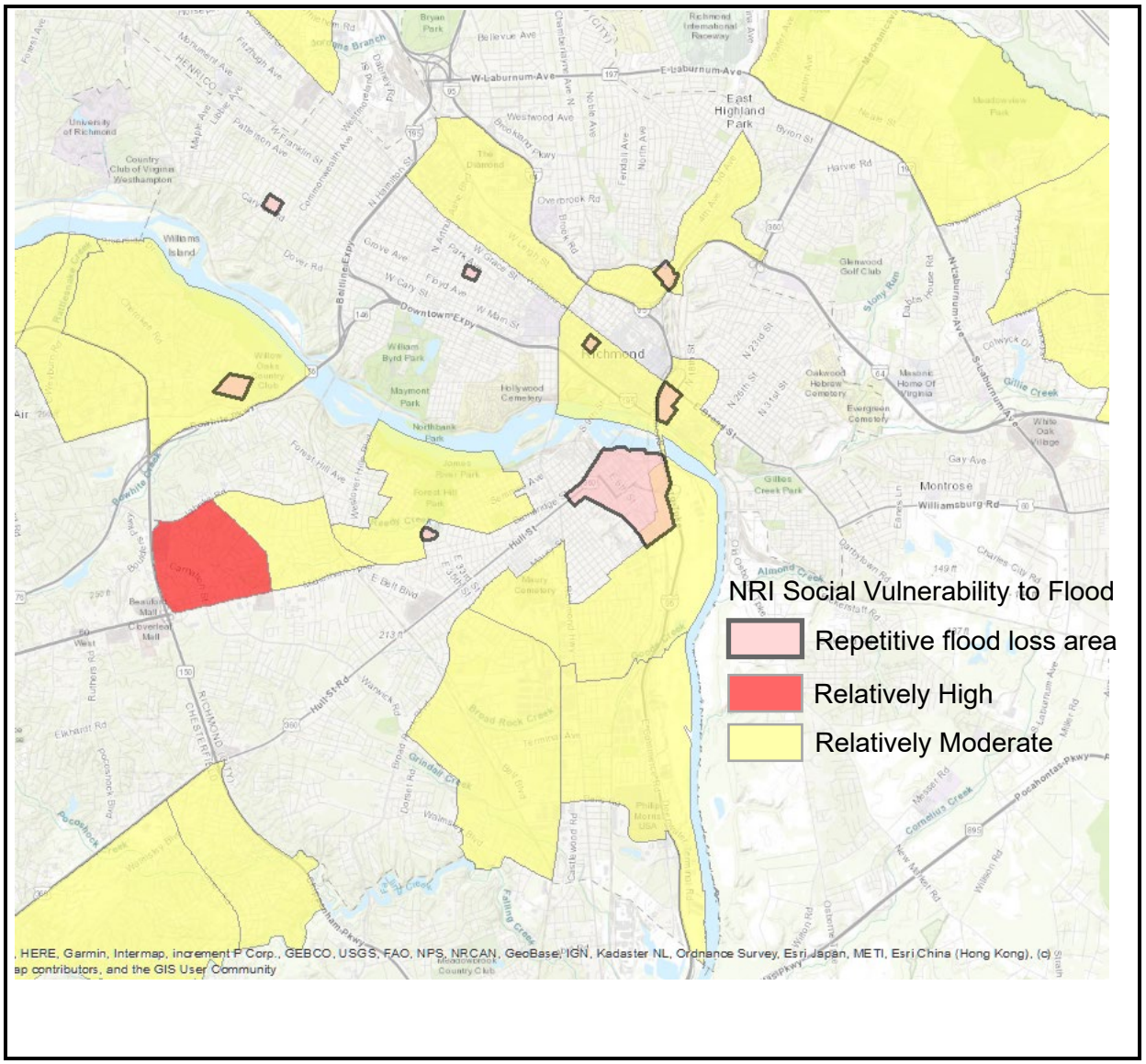
CITY OF RICHMOND MITIGATION ACTION 1	
Re-establish independent Office of Emergency Management.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Make the existing Office of Emergency Management an independent entity within the City of Richmond's governance structure to support and enhance staff's ability to implement citywide priority actions and exercises.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	CIP & General Fund Budget
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	within 2 years of plan adoption
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 2	
Establish a dedicated, independent EOC to fully support response and recovery efforts, and new technology for Emergency Management.	
BACKGROUND INFORMATION	
Site and Location:	Downtown Richmond
Benefit Cost:	The city's existing EOC is a shared space which inhibits timely coordination and response.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	CIP
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Within 4 years of plan adoption
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 3	
Continue to update emergency response plan and educate the public on hazard resiliency and emergency preparedness. Conduct emergency planning, climate, and resiliency engagement and outreach, particularly in communities with high vulnerability to hazards that have been traditionally underrepresented in city planning processes: Black and African American, Hispanic and Latino, lower-income, and those with limited English proficiency.	
BACKGROUND INFORMATION	
Site and Location:	Citywide, with emphasis on areas with high social vulnerability
Benefit Cost:	By purposefully engaging specific communities, equity in city services is more fully realized.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.3, 1.4; Goal 2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Minimal; estimated <$15,000/year
Potential Funding Sources:	DHS: HMGP; Virginia CFPF; HUD: CDBG
Lead Agency/Department Responsible:	Office of Sustainability, Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Includes conducting annual preparedness days for hazards to include floods, wind, and earthquakes.	

CITY OF RICHMOND MITIGATION ACTION 4	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Repetitively flooded areas in the city
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the city who have to pay for flood insurance.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	Moderate – 5 rep loss areas near downtown Low – 3 rep loss areas near downtown
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Utilities
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 5	
Continue participating in the NFIP and identify additional Community Rating System activities to reduce flood risk.	
BACKGROUND INFORMATION	
Site and Location:	Throughout flood-prone areas of the city
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding; Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1; Goal 2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	NRI flood risk ranges from Low to Moderate to High. See figure in comments below for additional information.
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Utilities
Implementation Schedule:	Long-term
ADDITIONAL COMMENTS	


NRI Social Vulnerability to Flood
Repetitive flood loss area
Relatively High
Relatively Moderate
Richmond
East Highland Park
Montrose
Williamsburg Rd
Hull St
Hull St Rd
Downtown Expy
Belle Isle
Williams Island
Maymont Park
Hollywood Cemetery
Northbank Park
Forest Hill Park
Carnation St
Broad Rock Creek
Gillies Creek Park
Gillie Creek
Almond Creek
Pocahontas Pkwy
, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c)
ap contributors, and the GIS User Community

CITY OF RICHMOND MITIGATION ACTION 6	
Improve existing flood warning system to increase the ability to forecast flood events and flood depths. Acquire additional resources to build components of a local evacuation plan, including: improved IFLOWS gauges, high hazard water crossing elevations for city and state-owned roads, and a flood alert system (using GIS and the City's public warning system).	
BACKGROUND INFORMATION	
Site and Location:	Floodprone areas citywide
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding; Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	NRI flood risk ranges from Low to Moderate to High.
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE; USGS
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Long-term
ADDITIONAL COMMENTS	
Partner with other organizations including the NWS, USGS, local watershed organizations and the Flood Wall Manager.	

CITY OF RICHMOND MITIGATION ACTION 7	
Distribute NOAA weather radios to residents.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	By alerting the public to impending threats, weather radios reduce injuries and damage during disasters.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.2, 1.4; Goal 4: Objectives 4.1, 4.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Radios are $35 to $80 each
Potential Funding Sources:	DHS; Existing budgets
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 8	
Enhance use of GIS for urgent emergency needs.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP; Virginia CFPF; General Fund Budget
Lead Agency/Department Responsible:	Emergency Management, DPW, DIT
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 9	
Expand facility assessment inventory of all City-owned facilities, including primary and secondary schools, to evaluate their resistance to all natural hazards. Identify and implement necessary retrofits or relocations to increase facility hardening, including addressing backup power needs through generators or micro-grids. Invest in data management system to allow local GIS/CAD storage archive of building plans for first responders and emergency planners.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Hazard response needs are evolving: an up-to-date inventory of City buildings and capabilities will add needed flexibility to response and recovery. Temporary response and recovery structures operating near a contained disaster site can make response management easier and more cost effective.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	Existing budgets, CIP
Lead Agency/Department Responsible:	Emergency Management and DPW
Implementation Schedule:	Long-term
ADDITIONAL COMMENTS	
City has conducted wind study on many City-owned facilities. An assessment inventory of City-owned facilities is identified in Richmond 300. This HMA would include collection of structural and elevation data, as well.	

CITY OF RICHMOND MITIGATION ACTION 10	
Perform hazard prevention activities to increase the protection of public and private structures from natural hazard damage, such as maintenance of floodwall, acquiring, relocating, retrofitting or elevating flood prone property, upgrading public infrastructure near hazard prone areas or other flood control projects.	
BACKGROUND INFORMATION	
Site and Location:	Citywide, with particular emphasis on flood-prone areas.
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	DPU (floodwall) Emergency Management (other)
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 11	
Provide targeted outreach to business owners (particularly those with hazardous materials stored on site) to discuss hazards and mitigation alternatives.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Businesses are a key element in resiliency as they provide services that allow residents to acquire necessary items during recovery. Showing businesses how to plan for recovery and reduce future damages contributes to a shorter recovery period for the whole community.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	<$8000/year
Potential Funding Sources:	DHS: HMGP; EDA: DMTA; ARPA; Virginia CFPF
Lead Agency/Department Responsible:	Richmond Fire and Emergency Services, Economics Portfolio
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 12	
Continue to maintain existing Continuity of Operations Plans with emphasis on redundant power needs for specific critical facilities, and mitigation actions to address the water supply system.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Effective COOPs help identify and reduce vulnerabilities in the city's operational procedures. These plans require continuous refinement and updating, especially post-disaster when memories are fresh regarding how the plan can be improved.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.2; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Staff time
Potential Funding Sources:	Existing budgets; DHS
Lead Agency/Department Responsible:	Emergency Management; Citywide
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 13	
Develop plan for community resilience hubs to serve as "one stop shops" for information on hazard and climate resilience and services before, during, and after hazard-related events. Services provided after hazard-related events may include device charging, shower and clothes washing facilities, and cooling/heating refuge.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Multiple hubs for promoting community resilience post disaster are less costly and more efficient than activating full-fledged shelters. These hubs can be spread strategically throughout a disaster area.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS; VDEM
Lead Agency/Department Responsible:	Emergency Management; Office of Sustainability
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 14	
Integrate equity-centered hazard and climate change planning into all city plans, to include special event planning, operational exercises, and disaster management planning.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Mitigation actions require integration with other city functions and planning efforts to be implemented effectively.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Staff time
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Citywide
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 15	
Conduct detailed climate change vulnerability and risk assessments for Richmond's population, natural resources, built assets, and municipal facilities and operations.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	While the hazard mitigation plan has a vulnerability and risk assessment for the entire study area, a more detailed and thorough development of data specifically for Richmond would provide better tools for analyzing the costs and benefits of specific projects.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	~$75,000
Potential Funding Sources:	CIP; Virginia CFPF; DHS
Lead Agency/Department Responsible:	Office of Sustainability
Implementation Schedule:	Within 4 years of adoption
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 16	
Increase staffing levels for hazard mitigation planning and implementation in Emergency Management, Public Utilities, Office of Sustainability, and/or other relevant departments. Establish as part of this a cross-departmental team for coordinating citywide hazard and resilience planning and service delivery.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Establishing mitigation actions, prioritizing and then implementing them requires input from various departments in the city. Staff dedicated to this process are required in more than one department to realize the benefits of mitigation projects in the near term.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objective 1.1
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	CIP; Virginia CFPF
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Within 3 years of plan adoption
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 17	
Adopt and implement the RVAgreen 2050 equitable climate action and resilience plan. Implement strategies to reduce vulnerability and increase resilience to the impacts of climate change (extreme heat, extreme precipitation, and flooding).	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Since 2017, Richmond has invested significantly in understanding the impacts of climate change and the actions needed to reduce vulnerability. Formally adopting the RVAgreen plan commits city officials to implementing actions to fulfill plan objectives.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Droughts and Extreme Heat, Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1; Goal 3; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Strategy costs vary
Potential Funding Sources:	Funding sources vary by action.
Lead Agency/Department Responsible:	Office of Sustainability
Implementation Schedule:	Adopt and implement in 2022
ADDITIONAL COMMENTS	
RVAgreen 2050 builds on the foundation set by Richmond 300, the city's master planning process that engaged thousands of Richmonders in identifying objectives.	

CITY OF RICHMOND MITIGATION ACTION 18	
Upon completion, implement the RVAH2O Green Infrastructure Master Plan to expand green infrastructure on public lands and rights-of-way to improve stormwater quality and reduce runoff through City projects and community partnerships, including public engagement and education programs.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	The city has invested considerably in identifying opportunities to improve existing stormwater systems with green infrastructure. Implementation of individual projects will provide reduce flood damages into the future.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	NRI flood risk ranges from Low to Moderate to High.
Estimated Cost:	Multiple projects identified; costs vary
Potential Funding Sources:	Funding sources vary; many funded by CIP; Virginia CFPF
Lead Agency/Department Responsible:	Public Utilities
Implementation Schedule:	Plan currently in draft format; due mid/late 2023. Implementation thereafter.
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 19	
Develop, fund, and implement an urban heat island reduction plan and program with a focus on vulnerable populations and ecosystems as part of implementation of the RVAgreen 2050 equity-centered climate action and resilience plan. Include depaving initiatives and other actions to reduce impervious surface.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Urban heat islands contribute to the city's vulnerability for extreme heat. Addressing the types and expanse of impervious surface can provide benefits for reducing flooding and the impacts of extreme heat and drought.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Droughts and Extreme Heat
Goal(s) Addressed:	Goal 1; Goal 3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low to Moderate
Estimated Cost:	TBD
Potential Funding Sources:	DHS; Virginia CFPF; CIP
Lead Agency/Department Responsible:	Office of Sustainability
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 20	
Expand the Community Emergency Response Team (CERT). Hire a full-time coordinator for the CERT program.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	The city's CERT members contribute to response and recovery and could benefit implementation of mitigation actions, as well. Focused coordination of the team is necessary to maximize benefits.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	~$75,000/year
Potential Funding Sources:	General Fund Budget
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Within 4 years of adoption
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 21	
Increase the proportion of Richmonders within a 10-minute walk of a public green space with amenities such as shade structures and tree canopy, public water fountains, and community garden space.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Public green spaces and their amenities benefit residents during times of extreme heat, and if co-located with floodplains, may provide flood reduction benefits, as well.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1, Goal 3: Objective 3.1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	NRI flood risk ranges from Low to Moderate to High.
Estimated Cost:	TBD – studies underway
Potential Funding Sources:	DHS; ARPA; Virginia CFPF; DOI; EPA
Lead Agency/Department Responsible:	Parks, Recreation, and Community Facilities
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
This recommendation is a result of community surveys and is included in several community plans.	

CITY OF RICHMOND MITIGATION ACTION 22	
Increase and enhance the resilience and health of Richmond's urban forest. Increase tree canopy.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Increased tree canopy can achieve co-benefits of improved stormwater management, improved air quality, and reduced urban heat island impacts.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Droughts and Extreme Heat
Goal(s) Addressed:	Goal 1; Goal 3; Goal 4: Objectives 4.1 and 4.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS; ARPA; Virginia CFPF; DOI; EPA
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Long-term
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 23	
Adopt an ordinance to require the city to use the Institute for Sustainable Infrastructure Envision framework to assess sustainability, resiliency, and equity in all new infrastructure projects.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Envision is a decision-making guide that provides industry-wide sustainability metrics for all types and sizes of infrastructure to help users assess and measure the extent to which their project contributes to conditions of sustainability across the full range of social, economic, and environmental indicators. Furthermore, the Envision framework recognizes that these sustainability factors are variable across a project's life cycle. Envision helps users optimize project resilience for both short-term and long-term impacts.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Office of Sustainability; Public Works
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 24	
Develop Resilient Design Guidelines and require builders to incorporate design measures to reflect a changing climate, increased precipitation and flooding in concert with a public education campaign to convey the benefits of adaptive and resilient buildings.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	Resilient design guidelines help ensure that future construction is resilient and provides benefits for managing multiple issues, including hazards such as flooding.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Severe Winter Weather, Droughts and Extreme Heat, Earthquakes, Radon Exposure
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.3, 1.4; Goal 3
Priority (High, Moderate, Low):	Low
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	CIP; Virginia CFPF
Lead Agency/Department Responsible:	Office of Sustainability; Planning and Development Review
Implementation Schedule:	Within 4 years of adoption
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 25	
Increase resilience of transit systems as part of implementation of the RVAgreen 2050 equity-centered climate action and resilience plan. Integrate and connect street trees with public transit and biking infrastructure.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	These actions would increase shade to mitigate extreme heat, and improve storm water management to mitigate flooding.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Droughts and Extreme Heat
Goal(s) Addressed:	Goal 1; Goal 3; Goal 4: Objectives 4.1 and 4.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	Virginia CFPF; ARPA
Lead Agency/Department Responsible:	Public Works, Office of Sustainability, GRTC, Office of Equitable Transit and Mobility
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 26	
Continue to manage industrial processes and waste streams to protect the community and natural resources from hazardous and other materials.	
BACKGROUND INFORMATION	
Site and Location:	Citywide industrial areas, particularly those intersecting with the city's floodplains
Benefit Cost:	Ensuring industrial waste is managed appropriately is critical to protecting river components, including floodplains.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Earthquakes, Landslides, Shoreline Erosion
Goal(s) Addressed:	Goal 1, Goal 2; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	EPA; DHS; ARPA; Virginia CFPF
Lead Agency/Department Responsible:	DPW, DPU, Fire and Emergency Services
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

CITY OF RICHMOND MITIGATION ACTION 27	
Establish a community response fund for direct and immediate assistance to community organizations that provide services to residents to enhance resilience to climate change hazards as part of implementation of the RVAgreen 2050 equity-centered climate action and resilience plan.	
BACKGROUND INFORMATION	
Site and Location:	Citywide
Benefit Cost:	This action would benefit residents directly by connecting them with organizations that provide services.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Droughts and Extreme Heat, Landslides, Shoreline Erosion, Infectious Diseases
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	CIP
Lead Agency/Department Responsible:	Office of Sustainability
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

TOWN OF SURRY MITIGATION ACTION 1	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities, mapping to determine detailed flood hazards, and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the Town
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Services/Safety, Utilities
Implementation Schedule:	Immediately upon adoption
ADDITIONAL COMMENTS	

TOWN OF SURRY MITIGATION ACTION 2	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the Town
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Existing budgets
Potential Funding Sources:	DHS: HMGP, BRIC; USACE
Lead Agency/Department Responsible:	Emergency Services/Safety, Utilities
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

SUSSEX COUNTY MITIGATION ACTION 1	
Add trained staff to Emergency Management, Building Inspections, and Planning and Zoning, to include a Certified Floodplain Manager in Planning & Zoning.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Staff who are well-versed in administration of county requirements related to hazard mitigation help make sure that existing standards are enforced and new standards do not increase the impacts of hazards.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 3
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	3 annual salaries (~$180,000/year) + training (~$2000/year)
Potential Funding Sources:	DHS
Lead Agency/Department Responsible:	Public Safety
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
While some staff changes have occurred, additional personnel are still required.	

SUSSEX COUNTY MITIGATION ACTION 2	
Continue participating in the National Flood Insurance Program through: 1) enforce of zoning and building codes; 2) pursue memorandum of agreement between towns and the county to provide flood ordinance administration, as necessary; and, 3) review and update 2009 flood ordinance.	
BACKGROUND INFORMATION	
Site and Location:	Throughout floodprone areas of the county
Benefit Cost:	NFIP regulations reduce flood damage by requiring elevation to the base flood elevation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High – western part of the county, and Stony Creek Moderate – middle part of the county Low – far eastern part of the county
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Zoning, Building Inspections, USACE, Va DCR, Wakefield and Waverly Administration
Implementation Schedule:	
ADDITIONAL COMMENTS	
This action is also a comprehensive plan recommended action.	

SUSSEX COUNTY MITIGATION ACTION 3	
Develop stormwater master plan to study capacity of existing culverts and other structures to determine if sizing is sufficient for future conditions. Identify and replace vulnerable or undersized culvert stream crossings with bridges or larger culverts to reduce flood hazards, where feasible. Implement program for regular inspections and maintenance of roadside ditches and stream channels.	
BACKGROUND INFORMATION	
Site and Location:	Countywide; however, areas in and near the towns of Wakefield and Stony Creek are of particular concern.
Benefit Cost:	Benefits of improving the stormwater conveyances accrue to infrastructure and homes in the area flooded by undersized bridges and culverts. Ensuring culverts are sized for future flooding will help address climate change and increased precipitation.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High – western part of the county, and Stony Creek Moderate – middle part of the county Low – far eastern part of the county
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, FMA, BRIC; ARPA
Lead Agency/Department Responsible:	Public Safety, VDOT
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

SUSSEX COUNTY MITIGATION ACTION 4	
Advocate for a Federal/state project to elevate I-95 bridge and widen channel at Stony Creek.	
BACKGROUND INFORMATION	
Site and Location:	I-95 bridge over Stony Creek, just north of Rte 40 outside of Stony Creek
Benefit Cost:	Bridge is older and appears to constrict the floodway at the crossing during the base flood. SFHA impacts large portion of Stony Creek.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1, Goal 2, Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	PDC, VDOT, USDOT
Lead Agency/Department Responsible:	Public Safety, County Administration
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

SUSSEX COUNTY MITIGATION ACTION 5	
Expand GIS capabilities. Acquisition of detailed floodplain BFEs and roadway crossing elevations are particular areas of interest for evacuation and emergency access planning.	
BACKGROUND INFORMATION	
Site and Location:	Countywide; however, area outside of Stony Creek along the Nottaway River are of particular interest.
Benefit Cost:	Emergency Management and hazard response functionality are improved with high level data integration and geographic/spatial data.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 2; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Public Safety, VDOT, USACE, VaDCR
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

SUSSEX COUNTY MITIGATION ACTION 6	
Increase capacity of stormwater system in conjunction with towns of Wakefield and Waverly.	
BACKGROUND INFORMATION	
Site and Location:	Wakefield and Waverly
Benefit Cost:	Properly sized and maintained culverts and other stormwater structures can help alleviate flooding and minimize damages to nearby infrastructure and buildings.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1: Objective 1.1; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; ARPA; VDOT
Lead Agency/Department Responsible:	Public Safety
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

SUSSEX COUNTY MITIGATION ACTION 7	
Increase outreach to citizens regarding preparation and response to hazard events, to include: promote the "Turn Around, Don't Drown" public education campaign; install high water marks at key crossings; social media information ahead of rain/wind/winter storms; temporary digital signage on critical roadways; and other permanent signage to warn of known driving hazards.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Severe Wind Events, Severe Winter Weather
Goal(s) Addressed:	Goal 1
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time; digital signage cost is $15,000 - $30,000 per sign
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Emergency Management, NWS
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

SUSSEX COUNTY MITIGATION ACTION 8	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities, mapping to determine detailed flood hazards, and stormwater management system improvements. Target repetitive flood loss areas identified in Section 5, two of which have high risk and social vulnerability.	
BACKGROUND INFORMATION	
Site and Location:	Repetitive flood loss areas, particularly the two near Stony Creek Stony Creek Wastewater Treatment Plant Generators for county evacuation shelters
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Public Safety
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

SUSSEX COUNTY MITIGATION ACTION 9	
Distribute brochures and use other means to educate the public regarding preparedness and mitigation. Conduct annual preparedness days for hazards to include floods, wind, tornado, and earthquakes.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	FEMA, VDEM and other agencies maintain a large library of free paper and online materials to support this action. Social media is free for communities and has potential to reach large number of citizens in a short period of time, and at little cost.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Tornadoes, Wildfires, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes, Radon Exposure, Infectious Diseases
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 2: Objective 2.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Minimal
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Public Safety
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

SUSSEX COUNTY MITIGATION ACTION 10	
Conduct regular review of repetitive loss and severe repetitive flood loss properties from FEMA. Review will include verification of the geographic location of each property and determination if mitigated and by what means. Corrections can be made to FEMA by filing form FEMA AW-501.	
BACKGROUND INFORMATION	
Site and Location:	Repetitively flooded areas in the county
Benefit Cost:	Structures designated as repetitive flood losses are treated differently under NFIP rating procedures. Ensuring the list is correct is important for property owners in the county who have to pay for flood insurance.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objectives 1.1, 1.4; Goal 3; Goal 4: Objective 4.1
Priority (High, Moderate, Low):	
Impact on Socially Vulnerable Populations:	High – 2 rep loss areas along I-95 Low – 1 rep loss area in northeast corner of county
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Zoning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

SUSSEX COUNTY MITIGATION ACTION 11	
Develop and implement detailed tornado response and recovery plan, to include safe rooms for manufactured home parks, and post-event housing considerations for impacted residents (with HUD).	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	This targeted mitigation action will help reduce impacts to citizens in a post disaster scenario. Safe rooms can save lives, particularly in highly vulnerable manufactured home parks.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Tornado
Goal(s) Addressed:	Goal 1: Objectives 1.2, 1.4; Goal 3: Objective 3.2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP; HUD: CDBG (see 2003 Tornado Shelters Act)
Lead Agency/Department Responsible:	Sussex County/Towns
Implementation Schedule:	

ADDITIONAL COMMENTS
On December 3, 2003, the President signed into law the Tornado Shelters Act (Public Law 108-146), which amends the Housing and Community Development Act of 1974, authorizing communities to use community development block grant funds to construct tornado-safe shelters in manufactured home parks. It allows construction or improvement of tornado-safe shelters for manufactured housing including loans and grants to non-profit or for-profit entities. Shelters built under the auspices of the Act must be located in a neighborhood or park that contains at least 20 units, consists predominately of low- and moderate-income households, and is in a state where a tornado has occurred within the current or last 3 years. Further, each constructed shelter must comply with the Department of Housing and Urban Development's (HUD's) standards for construction and safety, and be large enough to accommodate all members of the park/neighborhood, and be located in a park/neighborhood that has a warning siren.

SUSSEX COUNTY MITIGATION ACTION 12	
Develop/update county capital improvements plan to include timelines and appropriations for projects identified under this hazard mitigation planning effort.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Several mitigation actions identified in the plan cannot be implemented without grant funding and/or county appropriations.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All hazards
Goal(s) Addressed:	Goal 1, Goal 3
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	Staff time
Potential Funding Sources:	Existing budgets
Lead Agency/Department Responsible:	Unknown, no response
Implementation Schedule:	Within 1 year of plan adoption
ADDITIONAL COMMENTS	
This action is also a comprehensive plan recommended action.	

SUSSEX COUNTY MITIGATION ACTION 13	
Reduce physical vulnerability of County staff with offices currently in temporary modular units from wind, snow and rain. Provide freestanding building with structural protections that meet or exceed current building code standards.	
BACKGROUND INFORMATION	
Site and Location:	County complex in Sussex
Benefit Cost:	Some county staff currently have offices in manufactured buildings outside of the main building. These structures are temporary in nature and may be more vulnerable to damage during weather extremes.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Severe Wind Events, Tornadoes, Severe Winter Weather, Thunderstorms, Droughts and Extreme Heat, Earthquakes
Goal(s) Addressed:	Goal 1; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD – new building is more expensive than reconfiguring existing space
Potential Funding Sources:	Existing county revenues
Lead Agency/Department Responsible:	County Administration
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

SUSSEX COUNTY MITIGATION ACTION 14	
Establish development criteria and requirements to include density and intensity criteria, cluster subdivision design, stream buffers, impervious surface limits and innovative stormwater management alternatives.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Existing design and development criteria for subdivisions are minimal. Beneficial design that accounts for existing and future hazards reduces damage from disasters in the future.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High – western part of the county, and Stony Creek Moderate – middle part of the county Low – far eastern part of the county
Estimated Cost:	Staff time
Potential Funding Sources:	Existing resources
Lead Agency/Department Responsible:	Planning and Zoning
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
This action is also a comprehensive plan recommended action.	

SUSSEX COUNTY MITIGATION ACTION 15	
Provide improved healthcare facilities for county residents, to include services before during and after all types of hazard events, to ensure continuity of operations. Options may include coordination and consolidation of existing health facilities and other county functions.	
BACKGROUND INFORMATION	
Site and Location:	Countywide
Benefit Cost:	Maintaining functionality of county resources during and after the pandemic proved challenging.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Infectious Diseases, Radon Exposure, Tornadoes, Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Droughts and Extreme Heat, Earthquakes
Goal(s) Addressed:	Goal 1; Goal 2; Goal 3: Objective 3.2
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	Low
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, other; ARPA
Lead Agency/Department Responsible:	Health Department, Public Safety
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	
This action is also a comprehensive plan recommended action.	

TOWN OF STONY CREEK MITIGATION ACTION 1	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Repetitive loss area along south bank of creek and Halifax Road; floodway area north of the intersection of Rte 301 and Halifax Road (restaurant); structures at the intersection of Main Street and Halifax Road, just south of the Main Street bridge over Stony Creek
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Mayor, with assistance from Crater PDC
Implementation Schedule:	Ongoing

ADDITIONAL COMMENTS
Small flood control structure (*e.g.,* kneewall) may be cost-beneficial along Halifax Road, outside of floodway. Elevation of residential structures, or floodproofing of commercial structures may be feasible options at the east and west ends of town. Request assistance from USACE, Norfolk District. FPMS division could conduct study to determine feasibility of various alternatives in the town to alleviate repetitive flooding.

TOWN OF STONY CREEK MITIGATION ACTION 2	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Mayor & Town Clerk
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF STONY CREEK MITIGATION ACTION 3	
Advocate for a Federal/state project to elevate I-95 bridge and widen channel at Stony Creek.	
BACKGROUND INFORMATION	
Site and Location:	I-95 bridge over Stony Creek, just north of Rte 40 outside of Stony Creek
Benefit Cost:	Bridge is older and appears to constrict the floodway at the crossing during the base flood. SFHA impacts large portion of the Town of Stony Creek.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1, Goal 2, Goal 4
Priority (High, Moderate, Low):	Moderate
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	PDC, VDOT, USDOT
Lead Agency/Department Responsible:	Mayor
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

TOWN OF STONY CREEK MITIGATION ACTION 4	
Install high water signage to warn drivers and pedestrians of dangerous crossing during flooding. Use Turn Around, Don't Drown campaign materials to further warn drivers of hazards.	
BACKGROUND INFORMATION	
Site and Location:	Main Street bridge over Stony Creek, Halifax Road and Route 301 near I-95.
Benefit Cost:	Signage warning drivers helps prevent water rescues and saves lives.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding
Goal(s) Addressed:	Goal 1, Goal 2
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	~$5000
Potential Funding Sources:	PDC, USACE, ARPA, FEMA: HMGP
Lead Agency/Department Responsible:	Mayor
Implementation Schedule:	Within 2 years of plan adoption
ADDITIONAL COMMENTS	

TOWN OF WAKEFIELD MITIGATION ACTION 1	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities, mapping to determine detailed flood hazards, and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the Town, particularly in flood-prone areas that have flooded recently along Route 460 near the Virginia Diner.
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Emergency Services/Safety, Utilities
Implementation Schedule:	Immediately upon adoption
ADDITIONAL COMMENTS	

TOWN OF WAKEFIELD MITIGATION ACTION 2	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the Town, particularly in flood-prone areas that have flooded recently along Route 460 near the Virginia Diner.
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	Existing budgets
Potential Funding Sources:	DHS: HMGP, BRIC; USACE
Lead Agency/Department Responsible:	Emergency Services/Safety, Utilities
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	
Examples include the *Virginia Hurricane Evacuation Guide* and data from VDEM's Crisis Track collected post-disaster.	

TOWN OF WAVERLY MITIGATION ACTION 1	
Protect public and private structures from natural hazard damage, including acquiring, relocating, retrofitting or elevating floodprone property. This action may include minor structural flood control projects, retrofits to address critical infrastructure and facilities and stormwater management system improvements.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	Structures and infrastructure can often be retrofitted to provide additional protection from hazards such as flood, thereby reducing average annual losses.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Severe Wind Events, Wildfires, Severe Winter Weather, Thunderstorms, Earthquakes, Landslides, Radon Exposure
Goal(s) Addressed:	Goal 1: Objective 1.4; Goal 3; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: BRIC, HMGP, FMA, RFC; ARPA; USACE: SFCP, FPMS; HUD: CDBG; Virginia CFPF
Lead Agency/Department Responsible:	Mayor and Town Administration
Implementation Schedule:	
ADDITIONAL COMMENTS	

TOWN OF WAVERLY MITIGATION ACTION 2	
Use available statewide, regional, or county advanced warning systems, weather gauging systems, evacuation planning tools, and public information resources to prepare community officials and residents in case of a hazard event. Acquire additional resources to supplement these systems, as required.	
BACKGROUND INFORMATION	
Site and Location:	Throughout the town
Benefit Cost:	When people have adequate time to prepare for a hazard event and know what actions to take ahead of time, damages are reduced.
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Flooding due to Impoundment Failure, Tornadoes, Severe Wind Events, Thunderstorms, Earthquakes, Severe Winter Weather
Goal(s) Addressed:	Goal 1; Goal 2; Goal 4
Priority (High, Moderate, Low):	High
Impact on Socially Vulnerable Populations:	High
Estimated Cost:	TBD
Potential Funding Sources:	DHS: HMGP, BRIC; Virginia CFPF; USACE
Lead Agency/Department Responsible:	Mayor and Town Administration
Implementation Schedule:	Ongoing
ADDITIONAL COMMENTS	

8.0 Plan Maintenance Procedures

8.1 Updates for 2022

Section 8 was updated to modify the wording and scope, clarify the planning and updating requirements, and to amend the communities participating in this planning process.

8.2 Introduction

This section discusses how the Mitigation Strategy will be implemented by the communities and how the overall Hazard Mitigation Plan will be evaluated and enhanced over time. This section also discusses how the public and participating stakeholders will continue to be involved in the hazard mitigation planning process in the future.

8.3 Implementation

44 CFR Requirement

Part 201.6(c)(4)(i): The plan will include a plan maintenance process that includes a section describing the method and schedule of monitoring, evaluating and updating the mitigation plan within a five-year cycle.

In addition to the assignment of a lead department or agency, an implementation time period has been established for each mitigation action in order to assess whether actions are being implemented in a timely fashion. Each community will seek funding sources to implement mitigation projects in both the pre-disaster and post-disaster environments. When applicable, potential funding sources have been identified for proposed actions listed in each MAP.

44 CFR Requirement

Part 201.6(c)(4)(ii): The plan maintenance process will include a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

Emergency Management officials in each community will be responsible for determining additional implementation procedures beyond those listed within the Mitigation Action Plan. This includes further integrating the Hazard Mitigation Plan into other local planning documents such as comprehensive or capital improvement plans, when appropriate. The members of the planning committees for each community remain charged with ensuring that the goals and strategies of new and updated local planning documents

(such as Comprehensive Plans and Zoning Ordinances) are consistent with the goals and actions of the Hazard Mitigation Plan, and that those planning documents will not contribute to an increased level of hazard vulnerability in the region.

Opportunities to integrate the requirements of this Plan into other local planning mechanisms will continue to be identified through future meetings of each community's mitigation planning committee and through the five-year review process described in this section.

Each community will integrate the tenets of this mitigation plan into relevant local government decision making processes or mechanisms. The primary means for integrating mitigation strategies into other local planning documents will be accomplished through the revision, update, and implementation of the Mitigation Action Plan that requires specific planning and administrative tasks (i.e., plan amendments, ordinance revisions, capital improvement projects). In addition, each community will incorporate existing planning processes and programs addressing the impacts of climate change, resiliency programs, and flooding mitigation into this document by reference.

8.4 Monitoring, Evaluation and Enhancement

Periodic revisions and updates to the Plan are required to ensure that the goals of the Plan are kept current, taking into account potential changes in hazard vulnerability and mitigation priorities. In addition, revisions may be necessary to ensure that the Plan is in full compliance with changing Federal, state and local regulations. Periodic evaluation of the Plan will also ensure that specific mitigation actions are being reviewed and carried out according to the Mitigation Action Plan.

The Hazard Mitigation Planning Working Group will continue to meet at least annually and following any disaster events warranting a re-examination of the mitigation actions, thus continuously updating the Plan to reflect changing conditions and needs within the communities. An annual report on the Plan will be developed and presented to elected officials through PlanRVA and Crater PDC in order to report progress on the actions identified in the Plan and to provide information on the latest legislative requirements. The report may also highlight proposed additions or improvements to the Plan. The report will be released to the media and made available to the public via appropriate methods, such as the PDCs' web sites.

Each community has designated a lead person and agency responsible for the monitoring, evaluation and enhancements to the plan. Those position titles and agencies are shown in Tables 3.2a and 3.2b as rows marked with an asterisk. These individuals are the primary contacts moving forward with plan implementation.

8.4.1 Annual Progress Reports

Each community's hazard mitigation planning committee will be responsible for producing an annual progress report to evaluate the Plan's overall effectiveness. As part of the contract for preparing this plan, the contractor is providing a mitigation action plan spreadsheet in Appendix G that lists all mitigation actions for each community and the

region. Updating this spreadsheet with status information will allow periodic progress checkups that can feed into the annual progress reports.

8.4.2 Five-Year Plan Review

At a minimum, the Plan will be reviewed and must be updated every five years by the hazard mitigation planning committees as required by DMA 2000. The purpose of the review and update is to determine whether there have been any significant changes that may, in turn, necessitate changes in the types of mitigation actions proposed. New development in identified hazard areas, an increased exposure to hazards, the increase or decrease in capability to address hazards, and changes to federal or state legislation are examples of factors that may affect the content of the Plan.

The plan review provides community officials with an opportunity to evaluate those actions that have been successful and to explore the possibility of documenting potential losses avoided due to the implementation of specific mitigation measures. The plan review also provides the opportunity to address mitigation actions that may not have been successfully implemented. Each community will be responsible for reconvening and conducting the five-year review, although it is expected that the PDCs will again lead the effort to update the plan in five years. During the five-year plan review process, the following questions will be considered as criteria for assessing the effectiveness and appropriateness of the Plan:

- Do the goals and actions address current and expected conditions?
- Has the nature or magnitude of hazard risk changed?
- Are current resources adequate to implement the Plan?
- Should additional local resources be committed to address identified hazard threats?
- Are there any issues that have limited the current implementation schedule?
- Has the implementation of identified mitigation actions resulted in expected outcomes?
- Has the committee measured the effectiveness of completed hazard mitigation projects in terms of specific dollar losses avoided?
- Did the community, agencies and other partners participate in the plan implementation process as proposed?

Following the five-year review, any revisions deemed necessary will be summarized and implemented according to the reporting procedures and plan amendment process outlined in this section. Upon completion of the review and update process, the Plan will be submitted to VDEM for review and approval. Upon final approval, VDEM will submit the Plan amendments to FEMA for final review as required by DMA 2000.

8.4.3 Disaster Declaration

Following a state or federal disaster declaration, the hazard mitigation planning committee will reconvene and the Plan will be revised as necessary to reflect lessons learned or to address specific circumstances arising from the event. Community committees may find it necessary to convene following localized emergencies and disasters, or when pursuing funding for a specific mitigation project, in order to determine if administrative changes to the Plan are warranted.

8.4.4. Reporting Procedures

The results of the five-year review will be summarized by the committee in a report that will include an evaluation of the effectiveness of the Plan and any required or recommended changes or amendments. The report will also include a brief progress report for each mitigation action, including the identification of delays or obstacles to their completion along with recommended strategies to overcome them. Any necessary revisions to the Plan must follow the plan amendment process outlined herein.

8.4.5 Plan Amendment Process

Upon initiation of the amendment process, the community(ies) will forward information on the proposed change(s) to interested parties, including affected municipal departments. Information will also be forwarded to the VDEM. This information will be disseminated in order to seek input on the proposed amendment(s) for not less than a 5-day review and comment period.

At the end of the 5-day review and comment period, the proposed amendment(s) and all comments will be forwarded to the PDCs for final consideration. The committee will review the proposed amendments along with the comments received from other parties, and if acceptable, the committee will submit a recommendation for the approval and adoption of changes to the Plan.

Minor revisions to the plan may be approved by each community's Chief Administrative Officer, while substantial amendments and addendums must be approved by the community's elected governing body.

In determining whether to recommend approval or denial of a Plan amendment request, the following factors will be considered by the committee:

- There are errors, inaccuracies or omissions made in the identification of issues/needs in the Plan;
- New issues/needs have been identified which are not adequately addressed in the Plan;
- There has been a change in data or assumptions from those upon which the Plan is based.

Upon receiving the recommendation from the committee and prior to adoption of the Plan, each community's governing body will hold a public hearing. The governing body will review the recommendation from the committee (including the factors listed above) and any oral or written comments received at public hearing(s). Following that review, the governing body will take one of the following actions:

- Adopt the proposed amendments as presented;
- Adopt the proposed amendments with modifications;
- Refer the amendments request back to the committee for further revision; or
- Defer the amendment request back to the committee for further consideration and/or additional hearings.

8.5 Continued Public Involvement

44 CFR Requirement

Part 201.6(c)(4)(iii): The plan maintenance process will include a discussion on how the community will continue public participation in the plan maintenance process.

Public participation is an integral component of the mitigation planning process. As described above, significant changes or amendments to the Plan will require a public hearing prior to any adoption procedures.

Other efforts to involve the public in the maintenance, evaluation and revision process will be made. These efforts differ by community based on each community's individual needs, public response and whether the community has been recently affected by a hazard event. Examples of how communities in the Richmond-Crater region already engage the public during the interim planning period, or of how they may choose to approach this task in the future, include:

- Advertise meetings of the committee in local newspapers, public bulletin boards, web sites, social media and community public buildings. Designating a diverse community mitigation committee through official resolution of the governing board, and then scheduling regular meetings of the committee and advertising those meetings aggressively has worked well for some communities.

- Designate willing residents and private sector representatives as official members of the planning committee. While real estate, financial and construction industry leaders are natural partners in mitigation planning, look beyond these to include business leaders, large employers, and representatives of local military installations and transportation hubs, such as the Port of Virginia. Cultural institutions are an important component in the regional economy and their collections may be vulnerable to many of the hazards discussed

in the plan. Neighborhood groups, civic leagues and other citizen groups are a valuable source of mitigation ideas for specific areas.

- Engage elected officials and planning commission members in the process, beyond simply providing updates or reports. Elected officials have a responsibility to protect the health, safety and welfare of their constituents and their support is critical to successful implementation of the Mitigation Action Plan in every Richmond-Crater community.

- Use local media to update the public about any maintenance or periodic review activities taking place. The media have moved beyond traditional print and televised formats and their online presence can be valuable in disseminating information about upcoming meetings or activities. Local non-profits can also be invaluable in spreading the word about mitigation planning meetings open to the public.

- Use questionnaires, open houses, fairs and other community events to obtain ongoing public comments on the Plan and its implementation. Many local emergency managers effectively use community events to inform and advise the public on preparedness and evacuation, but the venues can also be valuable for informing the citizenry about the components of effective mitigation, how their community is implementing their Mitigation Action Plan and gathering information from the public to inform the next plan revision.

- Use community web sites, social media and list-servs to advertise any maintenance or periodic review activities taking place. Periodic surveys on social media can be a fun way to raise awareness.

- Hold area-specific meetings on a regular basis to solicit feedback from neighbors. Such meetings, held in public venues, can be used to distribute literature, educate residents on mitigation actions they can implement on their own, and solicit input on how the mitigation process can be more effective for their area or neighborhood.

- Integrate mitigation action plans, goals and objectives, and other plan elements into other community planning objectives. When a community's comprehensive or resiliency planning process includes similar team members and incorporates or references pieces of the hazard mitigation plan, the public gains familiarity with the links between the plans and the ways in which the efforts complement each other.

- Maintain hard copies of the Plan in public libraries, on the web, or other appropriate venues. While many residents are engaged in community affairs through computer technology, keeping hard copies of the plan in public venues with a business card or other contact information for providing feedback or answering questions is an old-fashioned but necessary way of reaching a much larger segment of residents.

Table 8.1 provides summary feedback from individual community's committee leaders indicating how they anticipate their community will include the public in the 5-year period following adoption.

Table 8.1: Including the Public During Plan Implementation Period						
Community	**Advertise committee meetings**	**Designate residents, private sector reps as members of committee**	**Use local media to update public on maintenance activities**	**Use questionnaires, open houses to obtain public comment**	**Use web sites to advertise maintenance activities**	**Maintain copies of the plan in libraries, on the web, or other venues**
Charles City County	✓	✓	✓	✓	✓	✓
Chesterfield County	✓	✓	✓	✓	✓	✓
City of Colonial Heights	✓		✓		✓	✓
Dinwiddie County	✓	✓	✓		✓	✓
Town of McKenney	✓					
City of Emporia	✓		✓		✓	✓
Goochland County	✓	✓	✓		✓	✓
Greensville County	✓		✓		✓	✓
Town of Jarratt	✓					
Hanover County	✓	✓	✓	✓	✓	✓
Town of Ashland	✓	✓	✓	✓	✓	✓
Henrico County	✓	✓	✓	✓	✓	✓
City of Hopewell	✓		✓		✓	✓
New Kent County	✓	✓	✓	✓	✓	✓
City of Petersburg	✓		✓		✓	✓
Powhatan County	✓		✓		✓	✓
Prince George County	✓		✓		✓	✓
City of Richmond	✓	✓	✓	✓	✓	✓
Town of Surry	✓		✓			
Sussex County	✓		✓		✓	✓

Table 8.1: Including the Public During Plan Implementation Period						
Community	Advertise committee meetings	Designate residents, private sector reps as members of committee	Use local media to update public on maintenance activities	Use questionnaires, open houses to obtain public comment	Use web sites to advertise maintenance activities	Maintain copies of the plan in libraries, on the web, or other venues
Town of Stony Creek	✓					✓
Town of Wakefield	✓					✓
Town of Waverly	✓					✓

8.6 Opportunities for Improvement

Several opportunities for improving the plan and planning process are outlined below in **Table 8.2**, primarily as suggestions or strategies that may enhance the planning process effectiveness for either individual communities in the coming 5-year period of implementation, or for future updates of the entire plan.

Table 8.2: Opportunities for Improvement	
Mitigation Planning Step	**Opportunities**
Phase I: Organize Resources **Step 1. Get Organized** **Step 2. Plan for Public Involvement** **Step 3. Coordinate with Other Departments & Agencies**	• Continue to distribute Memorandum of Intent to Participate for all communities in the early stages of the planning process. • Engage public information officers, resiliency officers, equity officers, web site managers and other community communications specialists from each community throughout the process. • The regional planning authority should continue to ask and rely on communities to reach out to large businesses, military installations, educational and medical institutions, neighborhood associations, non-profits, utilities and other groups to spur their involvement in the process, but communities need to provide documentation of these "asks" that is then included in the plan. • Rural town engagement in the planning process was limited. Continue to educate town staff about importance of their input.
Phase II: Assess Risk **Step 4. Identify the Hazards** **Step 5. Assess the Risks**	• Virtual meetings limited the feedback received after presentation of HIRA to the committee. Distributing small elements of the assessment to the committee for review may increase participation and feedback. • Difficulty obtaining repetitive loss data from FEMA and assessor data from some communities delayed completion of the HIRA.
Phase III: Develop Mitigation Plan **Step 6: Review Mitigation Alternatives** **Step 7: Draft an Action Plan** **Step 8: Set Planning Goals**	• Provide a review form for each community to document their review and approval of each plan section. • "Office Hours" with consultant worked well for developing each community MAP but did not include all stakeholders. Reassess this approach once COVID-19 restrictions are lifted.

EXECUTIVE SUMMARY

The *Henrico County Vision 2026 Comprehensive Plan* (the Plan) is an over-arching guide for the future development of Henrico County. It is a long-range vision, with goals and objectives to reflect the community's values and needs. The Plan combines assessments and recommendations on a broad spectrum of topics and functions of the county that are essential to the continued health and vitality of the community.

The county's previous comprehensive plan included the *2010 Land Use Plan*, the *2010 Major Thoroughfare Plan* (transportation), and the *2015 Parks, Recreation and Open Space Plan*. With the *Henrico County Vision 2026 Comprehensive Plan* these components, as well as chapters addressing public facilities, natural resources and community character, have been updated simultaneously and coordinated into an inclusive and unified document.

THE PROCESS

The *Henrico County Vision 2026 Comprehensive Plan* represents the culmination of a multi-year effort by the Henrico County Planning Department with assistance from the consulting firm McBride Dale Clarion, along with sub-consultants Kimley-Horn, TischlerBise, Greeley and Hansen and the Survey Evaluation and Research Laboratory at Virginia Commonwealth University. In addition, a Technical Advisory Committee, made up of representatives from several different county agencies, assisted in developing and reviewing the many components of the Plan.

Public participation was an important component of the *Henrico County Vision 2026 Comprehensive Plan* process. The Planning Department made a concerted effort to provide multiple opportunities to solicit citizen input. A dedicated website was established early in the process, allowing users to review available information and provide feedback directly to the Planning Department. A statistically valid community survey was developed and sent to a random sample of property owners to explore opinions and preferences of county residents regarding a variety of Comprehensive Plan issues and topics. Through a series of community open houses and town hall style meetings, major components of the Draft Plan were introduced and discussed. Joint work sessions between the Planning Commission and Board of Supervisors were held throughout the planning process and members of the public were invited to attend. Prior to official public hearings, full-size, color copies of the Draft Future Land Use Map were inserted into 45,000 copies of the Richmond Times-Dispatch. Over 600 interested citizens attended the various meetings and provided more than 765 comments, including 81 requests for changes to the Future Land Use and Major Thoroughfare Plans.

THE CHAPTERS

The document is organized into twelve (12) chapters. Chapter 1 (Introduction to the County) provides a brief history of the county and its development while Chapter 2 (Overview of the Plan) establishes the purpose and legal basis of the Plan. Chapter 3 (Henrico Today) offers a brief overview of the existing conditions within the county as

well as forecasts used to drive Plan recommendations. Chapter 4 (Vision, Goals and Objectives) presents the vision, goals and objectives, creating a framework or over-arching vision for the Plan. Chapter 5 (Land Use) introduces the future land use designations for the county as well as development policies and density recommendations. The chapter also presents Keystone Policies, which identify the desired development character for the land use designations and function as guiding policies for development. Chapter 6 (Community Character) describes the appropriate character for a range of development types, from rural, low-intensity conservation to suburban and urban. Chapter 7 (Planning and Economic Focus Areas) identifies areas of the county requiring additional planning attention. The chapter also discusses the county's Enterprise Zone and identifies Prime Economic Development sites. Guidance on protecting, preserving and conserving the county's environmental resources is provided in Chapter 8 (Natural Resources). Chapter 9 (Parks, Recreation, Open Space, & Cultural Resources) contains an update of the 2015 Recreation and Parks Plan and includes a summary of the existing facilities and policies guiding their development. The chapter also addresses the county's efforts toward historic and cultural resource protection. Existing transportation facilities and service levels are identified in Chapter 10 (Transportation). The need for future network improvements coordinated with the Future Land Use Map recommendations are identified on the 2026 Major Thoroughfare Plan Map. Chapter 11 (Public Facilities and Utilities) identifies criteria for the assessment of potential future locations for public facilities and utilities including schools, police, fire/rescue, libraries and water and sewer. Finally, Chapter 12 (Implementation) identifies the various actions necessary to carry out the recommendations of the Plan. This includes a matrix where responsible parties and the timeframe for completion are identified.

MAPS

This document contains a series of maps, which are a vital part of the *Henrico County Vision 2026 Comprehensive Plan*. These visual images provide supplemental information that may otherwise be difficult to describe in written text. Due to the scale at which they are printed, the maps are for general planning purposes only. Specific questions regarding the information contained in the maps should be directed to the Henrico County Planning Department.

APPENDICES

In addition to the text and maps, the Plan also contains several appendices, which provide supplemental information about the background and process involved in developing the Plan. Included in the Appendices are the results of research performed on demographics and housing affordability, as well as specialized information on the transportation network. Although the Appendices was not adopted as part of the official *Henrico County Vision 2026 Comprehensive Plan*, they contain important information that may be of interest to the reader of the document in helping to understand and interpret the Plan.

COMMONWEALTH OF VIRGINIA
Department of Emergency Management

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TEL 804.267.7600 TDD 804.674.2417 FAX 804.272.2046

JOHN J. SCRIVANI
Acting State Coordinator

January 24, 2025

Division of Dam Safety and Floodplain Management
Virginia Department of Conservation and Recreation
600 East Main Street, 24th Floor
Richmond, Virginia 23219

Re: Virginia Community Flood Preparedness Fund – Henrico County Stream Gauge Network

To whom it may concern:
Please accept this letter of support for the Henrico County Stream Gauge Network grant application, submitted in response to the Virginia Community Flood Preparedness Fund (CFPF) Round 5 funding opportunity.

The Virginia Department of Emergency Management's (VDEM) mission is to save lives through effective emergency management and homeland security programs by coordinating a whole of Commonwealth approach to any complex event or disaster. VDEM has a strong working relationship with Henrico County on flood preparedness, including the development of the Richmond-Crater Hazard Mitigation Plan (HMP) and a recent Flood Mitigation Assistance (FMA) grant in the neighborhood of Lakeside.

We support Henrico County in developing a comprehensive county-wide hydrologic monitoring network, which is a crucial tool to properly assess changing climate patterns and more frequent extreme weather events. This network will provide critical data collection that benefits a range of the County's resiliency and emergency management initiatives, including future precipitation studies, local and regional planning efforts, and flood warning systems. Additionally, this system of precipitation and stream gauges will address a significant gap in hydrologic monitoring within Central Virginia that will be incorporated into the statewide network utilized by VDEM, contributing to a larger body of knowledge that will aid in the region's overall flood resilience.

VDEM continues to work with the federal, state, and local partners to develop a statewide network of hydrological monitoring sites, and this project will increase our capacity to promote effective, long-range emergency management planning throughout the Commonwealth. As such, we strongly endorse Henrico County's application. If I can provide any further assistance, please do not hesitate to contact me at Steven.PyleJr@vdem.virginia.gov or (540) 490-0380.

Sincerely,

Steven Pyle

Steven Pyle Jr., CFM
Team Lead – Flood Intel Unit
Virginia Department of Emergency Management