June 12, 2023

Southern Virginia Flood Resilience Plan Roadmap

- City of Martinsville
- Town of Halifax
- Town of South Boston
- Southside Planning District Commission

Prepared by the
University of Virginia

REPORT OVERVIEW

The work was conducted for the Southside Planning District Commission with specific focus on three localities: City of Martinsville, Town of Halifax, and Town of South Boston.

The project takes a whole community approach to assess what resources and elements of flood resilience plans this region has in hand already, to identify gaps that need to be addressed, and to develop initial roadmaps to fill those gaps.

SOUTHSIDE
PLANNING DISTRICT COMMISSION

South Boston
VIRGINIA

Martinsville
A CITY WITHOUT LIMITS

TOWN OF
Halifax
VIRGINIA

ACKNOWLEDGEMENTS

The Virginia Flood Resilience Initiative would like to thank the Southside Planning District Commission, City of Martinsville, Town of Halifax, Town of South Boston, and the many stakeholders and citizens who contributed to this important regional project to promote a more resilient Southern Virginia.

This research and report were developed by the Virginia Flood Resilience Initiative, an interdisciplinary effort at the University of Virginia consisting of researchers, professionals, and students from the Institute for Engagement and Negotiation, School of Architecture, School of Engineering, and Weldon Cooper Center for Public Service:

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EXECUTIVE SUMMARY

In December 2021, Virginia Department of Conservation and Recreation (DCR) awarded Southside Planning District Commission (SPDC) a Round Two Community Flood Preparedness Fund Capacity Building/Planning grant to conduct an initial scoping and benchmarking effort. This project takes a whole community approach to assess what resources and elements of flood resilience plans this region has in hand already, to identify gaps that need to be addressed, and to develop initial roadmaps to fill those gaps. The work was conducted for the Southside PDC with a focus on the following jurisdictions that volunteered to participate: Town of Halifax, Town of South Boston, and City of Martinsville (which is technically in the adjacent West Piedmont Planning District.)

On October 14, 2022, Southside PDC contracted with the University of Virginia's Weldon Cooper Center for Public Service, School of Engineering, School of Architecture, and Institute for Engagement and Negotiation to conduct research, stakeholder engagement, and develop this resulting report and accompanying flood hazard dashboard.

The deliverables required per the grant proposal and executed agreements include:

I. **Flood hazard inventory**
II. **Comprehensive inventory of resources**
III. **Stakeholder mapping and interviews**
IV. **Analysis of "soft" capacities**
V. **Baseline assessment process templates**

I. Flood hazard inventory was created through a series of high-resolution mapping and related analyses using a GIS-based Analytical Hierarchy Process (AHP) method to evaluate regular flood and flash flood scenarios. The results provide granular information about flood hazard levels in two watersheds that incorporate the three jurisdictions (i.e., Lower Smith River watershed that incorporates the City of Martinsville and Dan River-Birch Creek watershed that incorporates the Towns of Halifax and South Boston) at the 10-meter x 10-meter grid cell level as well as at land-parcel level. The flood hazard maps generated were validated using historical flood event data in the region and were then compared to FEMA Special Flood Hazard Areas (SFHA).

Between the two types of floods, hazard levels differ across the region. Whiles some areas are susceptible to both types of floods; upstream mountainous regions with steeper slopes and more developed areas are more susceptible to flash flooding. Additional comparison revealed that less than 50% of the areas identified as high or very high hazard for flash flood are within the FEMA SFHA. This was expected considering that while FEMA flood maps are generally good in locations where fluvial flooding is the dominant mechanism, they have been widely criticized for inaccuracy and being incomplete in areas dominated by pluvial flooding and in mountainous regions.

To make the flood hazard mapping more interpretable and usable for residents and decision makers, flood hazard maps were also generated at land parcel level for regular and flash food hazards. The results revealed that more than 40% of the land parcels in the City of Martinsville, 37% of the land parcels in the Town of Halifax, and more than 40% of the land parcels in the Town of South Boston are in high or very high flash flood hazard level.

A preliminary analysis was conducted to determine in which flood hazard levels the water and wastewater treatment plants are located. The results showed that the Halifax County Service Authority and Martinsville Water Purification are located in high flood hazard areas, while the Maple Ave wastewater treatment plant is located in an area under moderate flood hazard. We also analyzed how flooding can reduce accessibility to the hospitals and public schools. Using 15-minute service area as a proxy to measure accessibility, our results identified hot spot areas in the City of Martinsville and the Towns of Halifax and South Boston where access to these facilities could be significantly compromised if there is a flood.

Please see the full report for additional details, methodology, figures, and explanation of analysis and results.

II. Comprehensive inventory of resources: To assess what relevant land use planning, regulatory tools and resources the region and localities already have, comprehensive plans, floodplain ordinances, and zoning codes from the participating localities were evaluated. A set of indicators were developed based on the criteria established by DCR for evaluating Virginia Community Flood Preparedness Fund Grant Program proposals and a plan evaluation scoring system was used. Additional indicators were integrated based on themes and DCR's requirements for an approvable resilience plan, and, to ensure the evaluation of these resources would accurately document the resilience planning principles currently being met and those that may not be as clearly addressed at this time.

Several planning documents and ordinances were reviewed to determine whether various components of the document(s) addressed certain indicators, suggested/inferred/identified an indicator but not in detail, or more fully described and addressed an indicator. This included three local comprehensive plans, three local floodplain ordinances, two regional hazard mitigation plans, and two regional economic development strategy documents. The City of Martinsville's *Community Resilience Benchmarks* were also considered, but these are essentially performance indicators or guidelines rather than a regulatory tool like a plan or ordinance that carries legal authority. A summary of this evaluation is included in this report and the results of this evaluation are included in Appendix B, which also identifies specific areas where existing plans and ordinances could be strengthened and better aligned with DCR review criteria. This is particularly important given that **DCR will require individual localities to submit their own resilience plan** that combines local plans and ordinances with regional plans. Overall, trends that emerged from the plan and ordinance evaluations include:

- The local comprehensive plans reviewed all exhibit a ***strong fact base*** and presented information on the occurrence and impact of past flood events. However, these local comprehensive plans could be strengthened and better aligned with regulatory review criteria by integrating ***projections or estimates of future flood risk.***
- The two regional hazard mitigation plans both align very well with the DCR criterion stipulating that projects ***focus on flood control and resilience*** (i.e., a clear connection to flood control and resilience).
- All reviewed plans clearly ***rely on the best available science*** to make decisions and incorporate data, scientific analyses, and approaches to resilience in creating these plans and ordinances. This is the fifth criterion articulated by DCR in its "Resilience Plan Requirements" included as Appendix F of this report.
- Regulations like floodplain ordinances that are more specific tend to better align with the review criteria, particularly with respect to infrastructure designed to mitigate flooding.
- The plans reviewed articulated clear ***timelines for implementation*** and contained evidence of ***cross-jurisdiction coordination.***
- Zoning ordinances are the most flexible and widely available regulatory instrument for advancing flood resilience and each of the localities has a floodplain ordinance in place that is embedded within or integrated with its broader zoning ordinance.
- The third criterion articulated by DCR in its "Resilience Plan Requirements" (see Appendix F) focuses on equity and the existing plans could be strengthened by incorporating assessments of socially vulnerable populations in addition to risk-exposed property or infrastructure. Another strategy for bolstering this aspect of the plans reviewed might be to identify ways that ***past inequalities may have contributed to current patterns of flood risk*** and to discuss solutions to address these issues.
- While there was often evidence of public participation process with strong community engagement, more explicitly discussing efforts to ***bring the most vulnerable community members into planning processes*** could strengthen this particular criterion that DCR requires. More narrowly focused outreach efforts that specifically target flooding could help to achieve this goal, potentially ***reveal resident priorities*** for where and how to make flood resilience interventions and enhance alignment with DCR review criteria.

All of the plans reviewed were very strong in terms of ***incorporating nature-based infrastructure***, which is the second DCR criterion outlined in Appendix F. This is especially true in instances where the plans identify natural resources that are important for ecosystem health but that are at risk from flooding, as well as examples of how natural resources are being leveraged to defend against flood impacts. However, there are additional opportunities to ***educate residents about the benefits of natural resource protections*** and to ***add subdivision ordinances***

that address green infrastructure if local government leaders believe this aspect of the resilience planning requirements need further attention.

III. Stakeholder mapping and interviews: Stakeholders are defined as: (1) those who are affected by the decisions and actions that are taken and (2) those who have the power to influence their outcomes. Stakeholders can be individuals or organizations and are often grouped into three categories—public, private, and non-profit sectors. An initial inventory of stakeholders who are affected by flooding or that can influence flood impacts was developed by combining the results of two public surveys with insights gathered during two virtual engagement events and "desk research" involving web searches and document reviews.

The first online survey asked local government staff and elected officials who they believed were stakeholders that should be involved in flood resilience planning. Individuals and organizations with the most regulatory responsibilities (e.g., floodplain and zoning administrators), the greatest financial exposure (e.g., insurance companies), and with connections to agriculture (e.g., Farm Bureau) emerged as the most important constituencies.

A second online survey asked similar questions of residents who live in areas with a history of flood impacts. Their responses mirrored those responses offered by local government staff and elected officials. For the private sector, respondents unanimously indicated that small businesses and insurance companies should be part of the process, followed by commercial property owners, residential landlords, and Chambers of Commerce. Both residents and local officials identified agricultural and environmental non-profit organizations as important stakeholders for flood resilience. Public school officials and first responders were offered as stakeholders who should be involved but that were not among those listed in the survey question.

Six key informant interviews were conducted to supplement information gathered through the online surveys and the virtual focus group event held in November 2022. One of the main insights from these interviews is that flooding has been very localized in the past and the extent to which individuals or localities are deeply engaged with flood resilience depends on whether they have been directly affected. As a result, the perception of flood risk varies considerably depending on where one lives and works within the study region.

Please see the full report below for more details on stakeholder engagement and Appendix E for a summary of the online surveys conducted.

IV. Analysis of "soft" capacities: To effectively plan for flood resilience, localities must have adequate staffing, training, and other resources in place to support their work now and into the future. These "soft capacities" were identified and evaluated through a review of existing planning documents, an online survey of local government staff and elected officials conducted in the summer of 2022, and a virtual focus group meeting held in November 2022. Key findings are summarized below; please see the full report for additional details.

- Staffing levels in many localities within the study area are not adequate. Specifically, local government has seen **numerous retirements** but it has often been **a challenge to fill vacant positions.**
- A reduction in local government staffing levels has also meant an effective increase in workload for staff members that remain, which makes **training new hires difficult** from a time allocation perspective.
- The existence and adequacy of succession plans is not reflected in the planning documents reviewed and may be internal to each locality. However, local government staff from all three jurisdictions indicated during the November 2022 event that there is an awareness of their importance, but **succession plans are not widely available** in local government outside of the Standard Operating Procedures (SOPs) for police and fire personnel. When longtime employees retire, they often take **valuable institutional knowledge** with them that is difficult to capture.
- All participating jurisdictions **have a designated Floodplain Administrator** and two of these three individuals either participated in the November 2022 engagement event or completed the online survey.
- Respondents to the local government staff survey indicated that **funding was the most significant barrier to flood resilience** by a wide margin followed by the **demands on staff time** (e.g., police, public works) and **additional government expenses** (i.e., overtime pay) when floodwaters impact roads.
- When asked what flood risk information would be most useful, respondents said **more accurate flood maps** and **models that can predict flash flooding.**

V. Baseline assessment: The goal of the baseline assessment presented is to: (1) test the framework that has been developed over the past year through this project, and (2) identify areas of strength and gaps when the planning and regulatory assets are evaluated against DCR review criteria.

The information included in the full report explicitly provides evidence of the PDC and localities meeting criteria and resilience indicators that were established as part of the regulatory review process and represents a starting point for individual localities to create and submit a resilience plan to DCR for approval. Appendix C and the plan/ordinance evaluation template spreadsheet that accompanies this report can be used to help other under-resourced communities begin the process of resilience planning.

Per DCR guidance, each locality that intends to request future funding for resilience planning and project implementation will need its own approved resilience plan. However, many DCR requirements may be met by plans developed at the regional scale, such as the Southside PDC *Regional Hazard Mitigation Plan 2020* and the West Piedmont PDC *Multi-Jurisdictional Hazard Mitigation Plan*. Further, resilience plans submitted on a regional basis must meet the same

criteria as plans submitted for a single locality and because regional plans generally address larger scale planning issues, cross-jurisdictional considerations, and studies or projects that affect more than one locality, the most feasible model is for each Southern Virginia locality to reference regional plans as a means of supplementing local ordinances and plans.

Please see Appendix F for the most recent DCR guidance (dated January 2023) which reiterates core resilience plan requirements and discusses the difference between a standalone plan approach and a compilation plan approach.

Summary

The goal of this project is to provide resources and recommendations that will better position localities within the Southside PDC service region to satisfy the resilience planning requirements of the Virginia Department of Conservation and Recreation, which is a necessary first step in accessing funds to implement flood mitigation projects on the ground. In addition to the Community Flood Preparedness Fund Grant, developing a resilience plan that conforms to the DCR requirements will also facilitate efforts to secure funds from other sources (e.g., federal agencies) and to advance the flood resilience goals outlined in the Round Two Community Flood Preparedness Fund Capacity Building/Planning grant proposal and the numerous planning documents created and adopted by localities in the Southside PDC service region.

INTRODUCTION

This document provides an overview of existing strengths and areas that should be bolstered in preparation for submitting one or more resilience plans to the Virginia Department of Conservation and Recreation (VA DCR) for review and approval. The signed Capacity Building/Planning grant agreement from March 2022 identifies participating jurisdictions as the Southside Planning District Commission and three localities—the City of Martinsville, Town of Halifax, and Town of South Boston. The primary aim of this project has been to "conduct an initial scoping and benchmarking effort" which involves assessing "what resources and elements of flood resilience plans this region has in hand already to identify gaps that need to be addressed and to develop initial roadmaps to fill those gaps." The Round Two Community Flood Preparedness Fund Capacity Building/Planning Grant proposal contains an extensive Scope of Work beginning on page 9 that references:

- Assess capacity needs and assets
- Stakeholder identification, outreach, and education strategies
- Implementation plan and timelines for specific elements of completion, such as training, certifications, plan development, etc.
- Parties responsible for capacity building and/or plan development process
- Baseline assessment that identifies the gaps in hard and soft resources and capacities that localities will need to fill in order to develop a successful resilience plan

The expected outputs described in the original proposal are listed below and are each addressed in a section of this report:

> Performance Output: **Flood Hazard Inventory**
> Measure of Success: Identification of flood prone areas, mechanisms for flooding, and cascading impacts.
>
> Performance Output: **Comprehensive Inventory of Resources**
> Measure of Success: Identification of gaps in resources needed to develop a DCR-approvable resilience plan.
>
> Performance Output: **Stakeholder Mapping and Interviews**
> Measure of Success: Identification of diverse stakeholders, conducting of stakeholder interviews, and documentation of stakeholder perspectives and interests to inform future resilience planning efforts.
>
> Performance Output: **Analysis of "Soft" Capacities**
> Measure of Success: Identification of future staff training and capacity needs and outlining of steps necessary to address those needs in future roadmaps and plans.

Performance Output: **Baseline Assessment Process Templates**
Measure of Success: Successful testing and development of a baseline assessment process and creation of process templates that can be used to help other low-income, under-resourced communities begin the process of resilience planning.

FLOOD HAZARD INVENTORY

Flooding poses significant risk to the Commonwealth. While many efforts to address flood risk in Virginia are focused on coastal areas, flood risk in Virginia is not exclusive to the coastal zone, as illustrated by the extent of flood insurance claims over the last 20 years (Figure 1). Throughout the Commonwealth, flood insurance claims have totaled more than $744 million since 1976, with over $110 million occurring since 2015 (Virginia Department of Conservation and Recreation, 2021). Like in many communities and regions across Virginia, increasing flooding events are having devastating impacts on communities in the southern region of Virginia. Figure 2 shows the location of historical flood events as well as the FEMA's Special Flood Hazard Area (SFHA) in the two project sites, i.e., the Towns of Halifax and South Boston in the Southside PDC and the City of Martinsville in the West Piedmont PDC in Southern Virginia. The repercussions and cascading effects of flooding events in this region include local impacts on public safety and roads, reduced accessibility to critical facilities, community livability, and economic viability. Furthermore, flooding in the region also impacts vital regional and statewide economic and transportation corridors.

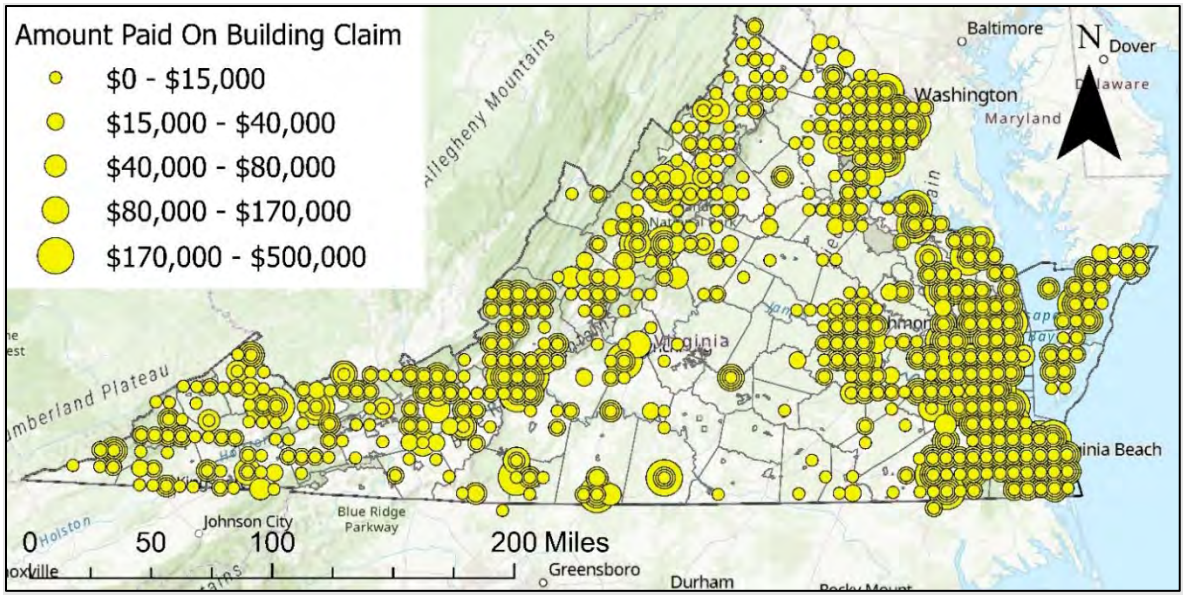

*Figure 1. National Flood Insurance Program flood insurance claims in Virginia from 2002-2021. Data obtained from FEMA (*https://nfipservices.floodsmart.gov/reports-flood-insurance-data*)*

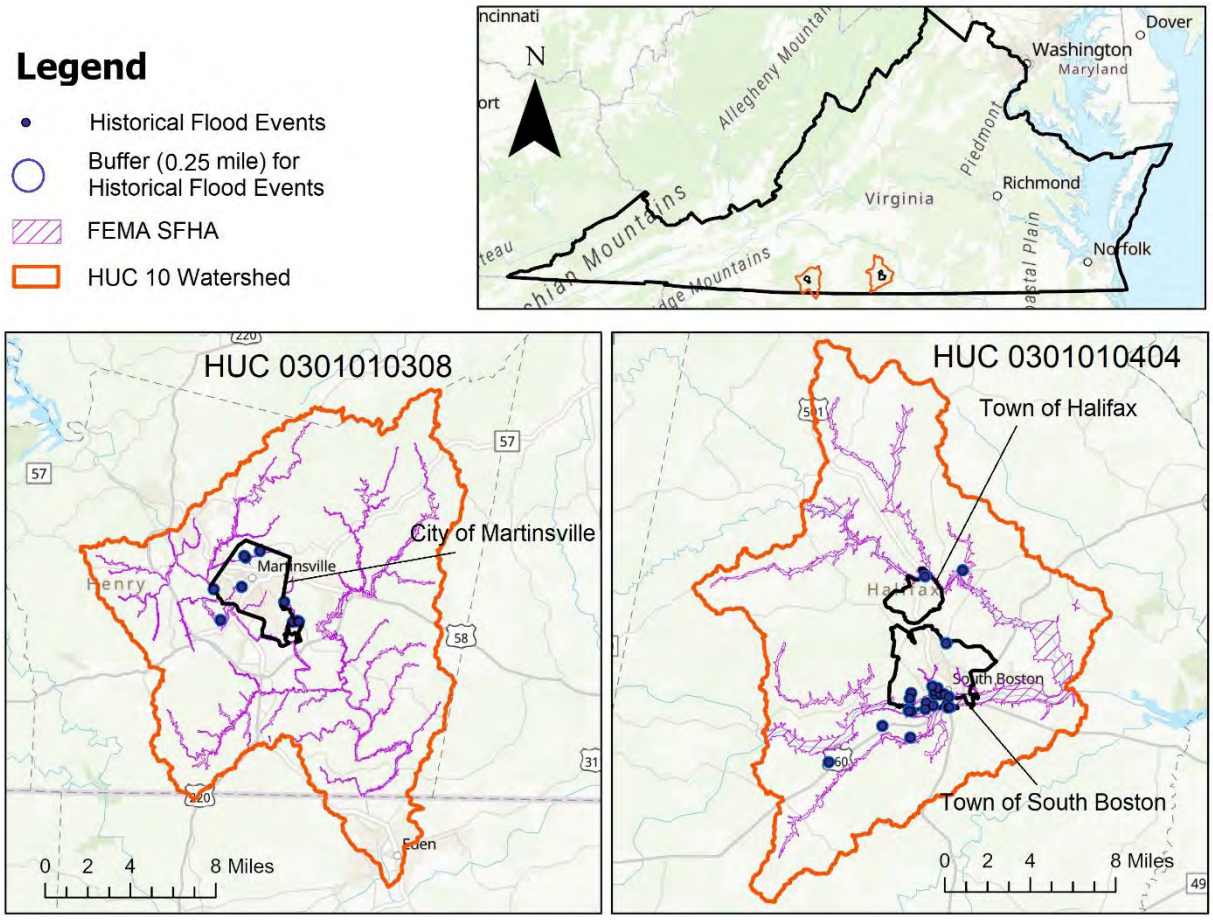

Figure 2. The location of the two HUC 10 watersheds covering the two project sites (i.e., Towns of Halifax and South Boston in the Southside PDC and the City of Martinsville in the West Piedmont PDC). The approximate location of historical flood events (with 0.25-mile radius buffer) and the FEMA SFHA are also shown. The historical flood events are obtained from NOAA's Storm Events Database (https://www.ncdc.noaa.gov/stormevents/) between 2006 and 2021.

Flood Hazard Mapping and Analysis

The flood hazard analysis in this project was conducted at the watershed level. To ensure that the entire area of each of the two project sites is covered by a watershed, the analysis was conducted at a Hydrologic Unit Code (HUC) 10 watershed level: the HUC 10 watershed used for the site including the City of Martinsville is *Lower Smith River* (HUC 0301010308) and the HUC 10 watershed used for the site including the Towns of Halifax and South Boston is *Dan River-Birch Creek* (HUC 0301010403) (*http://consapps.dcr.virginia.gov/htdocs/maps/huexplorer.htm*). To better understand the vulnerability of the project sites to floods at a high spatial resolution, the flood hazard analysis in this project was conducted using a GIS-based Analytical Hierarchy Process (AHP) method (see Appendix A for methodology). To conduct the AHP method, ten factors that contribute to flooding were considered: Elevation, Topographic Wetness Index, Stream Power Index, Vertical Distance to Drainage, Average Annual Precipitation, Maximum 5

Day Precipitation, Drainage Density, Land Use/Land Cover, Hydrologic Soil type, and Lithology. In each site, these factors were classified into 5 levels and then integrated using weighted average. Because the factors that contribute to fluvial flooding (hereafter referred to as *regular flood*) and pluvial flooding (hereafter referred to as *flash flood*) are different, we developed and used two sets of weights (refer to Appendix A and Table A.3 for more details). It is important to note that flood hazard identification based on the AHP method is specific to each watershed, and therefore, the flood hazard level in the two watersheds should not be directly compared with each other.

Flood Hazard Mapping at Grid Cell Level

We implemented the AHP method to generate and map flood hazard at 10-meter by 10-meter grid cells. For each grid cell and each flood type, first, a weighted average flood hazard value was calculated. These values were standardized and then classified into five flood hazard levels with break points of -1.5, -0.5, 0.5 and 1.5 corresponding to very low, low, moderate, high, and very high. Figure 3 and Figure 4 show the results of flood hazard mapping at grid-cell level for the City of Martinsville and for the Towns of Halifax and South Boston, respectively. Comparing the results under regular flood and flash flood, we find that the higher hazard level under regular flood occurs primarily along the rivers, while the higher levels of flash flood hazard are more concentrated in the developed areas in and surrounding the towns. Figure 3 shows that the downtown area in the City of Martinsville experiences higher hazard levels under flash flood, whereas southeast end of the City of Martinsville has higher regular flood hazard level. For the Towns of Halifax and South Boson, we find that the areas along the Toots Creek, Poplar Creek, and Dan River are under very high regular flood hazard level (Figure 4a). On the other hand, Figure 4b shows that the areas surrounding the constructed roads including U.S. Route 501 are in very high flash flood hazard levels. The flood hazard mapping results for the entire area of the HUC 10 watershed are presented in Appendix A.

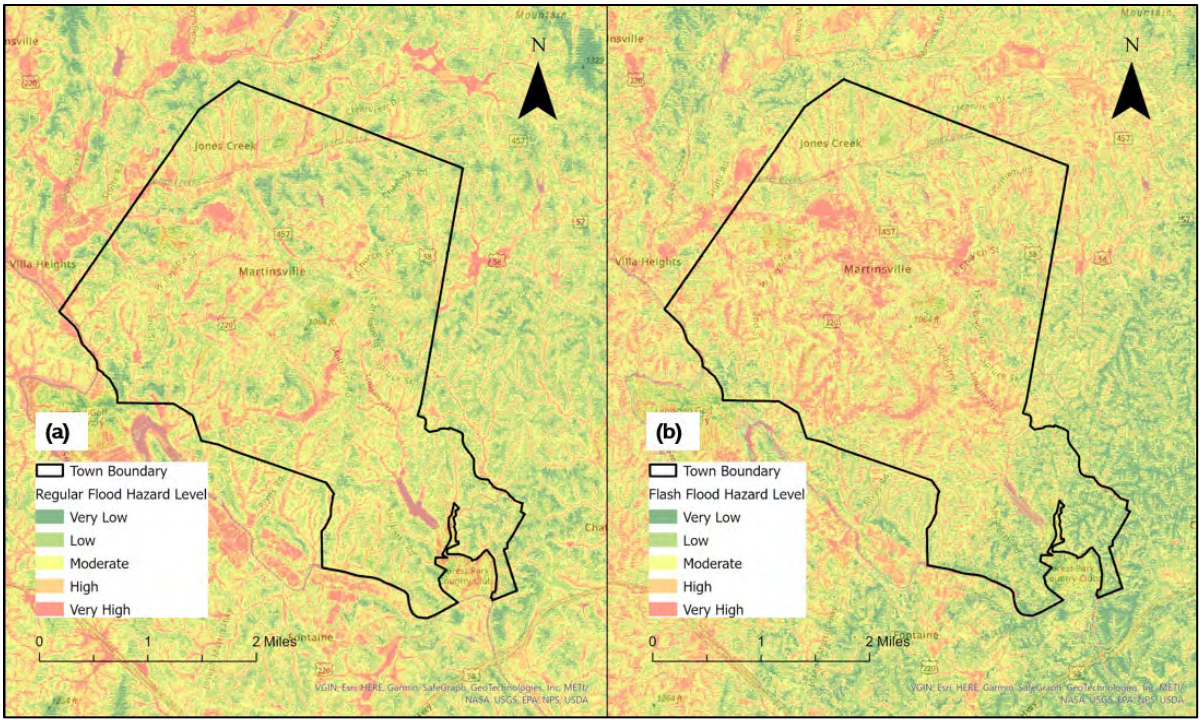

Figure 3. Flood hazard mapping at grid cell level using AHP method for the City of Martinsville for (a) regular flood and (b) flash flood.

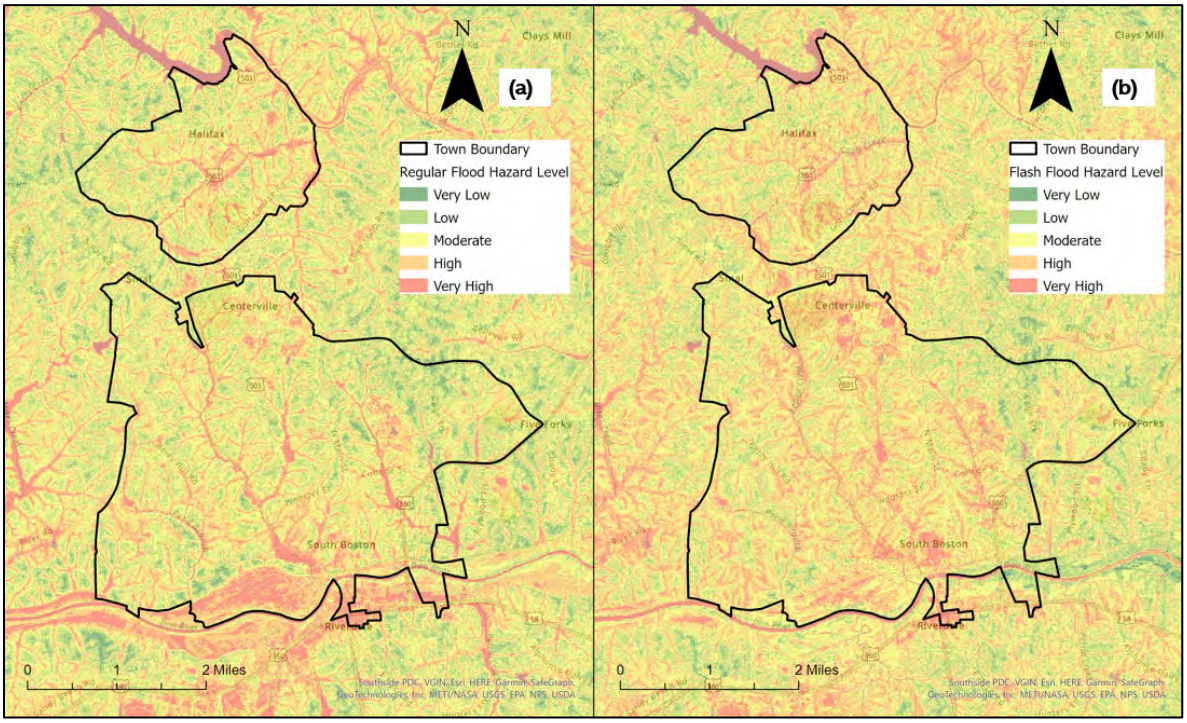

Figure 4. Flood hazard mapping at grid cell level using AHP method for the Towns of South Boston and Halifax for (a) regular flood and (b) flash flood.

The flood hazard maps generated were validated using historical flood events in the region. The historical flood events were obtained from NOAA's Storm Events Database between 2006 and 2021 (*https://www.ncdc.noaa.gov/stormevents/*). Given the limited accuracy of the latitude and longitude data associated with each record, the location of reported events were first manually inspected to see if they correspond to descriptions of the reported event. A buffer with a 0.25-mile radius was given to each event to represent the flooded region, though this buffer may not necessarily represent the entire flooded area. The validation results are shown in Figure 5 and Figure 6. To make the comparison easier, the grid-cell-level flood hazard levels shown in these figures represent the maximum of regular and flash flood hazard levels. Figure 5 shows the validation results for the City of Martinsville. Among the 10 reported events, 2 events were along the Smith River, 1 occurred near the intersection of Bridge Street and U.S Route 220 in downtown Martinsville, 3 events flooded sections of the Liberty Street and Royal Drive that are close to Jones River (Figure 5b), and the rest flooded the Spruce Street along the Mulberry Creek. Figure 6 shows the validation results for the Towns of Halifax and South Boston. 19 events were reported in the vicinity of the Dan River (Figure 6b), 2 events occurred along U.S. Route 360 (Figure 6c), and 2 events occurred in the northern part of Halifax. Despite the lack of sufficient accuracy regarding the extent of flooding in each historical event, the validation results show that all reported events occurred in very high hazard level regions. The events that occurred in the City of Martinsville all have intersections with or are close to the FEMA SFHA. However, at least four events have occurred in the Towns of South Boston Halifax that were outside of the FEMA SFHA.

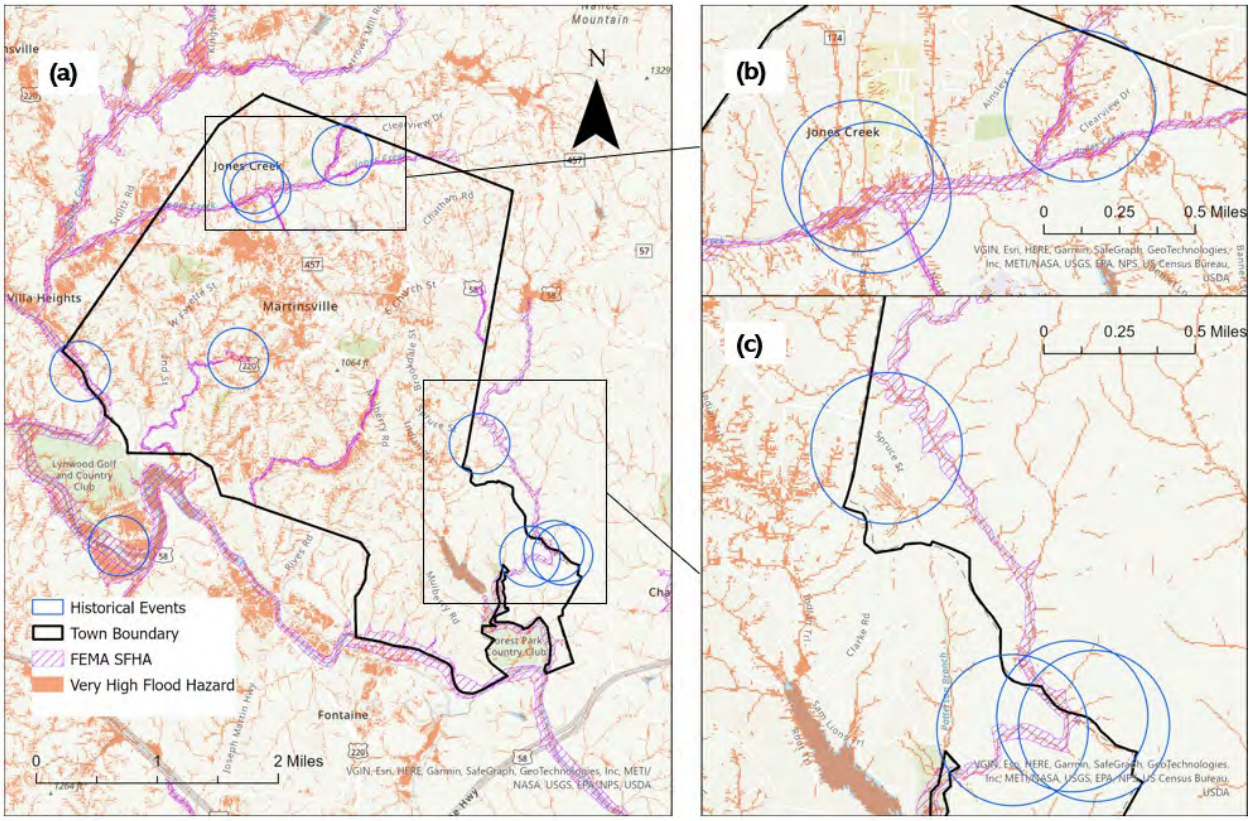

Figure 5. Comparing the identified very high flood hazard levels in the City of Martinsville with historical flood events.

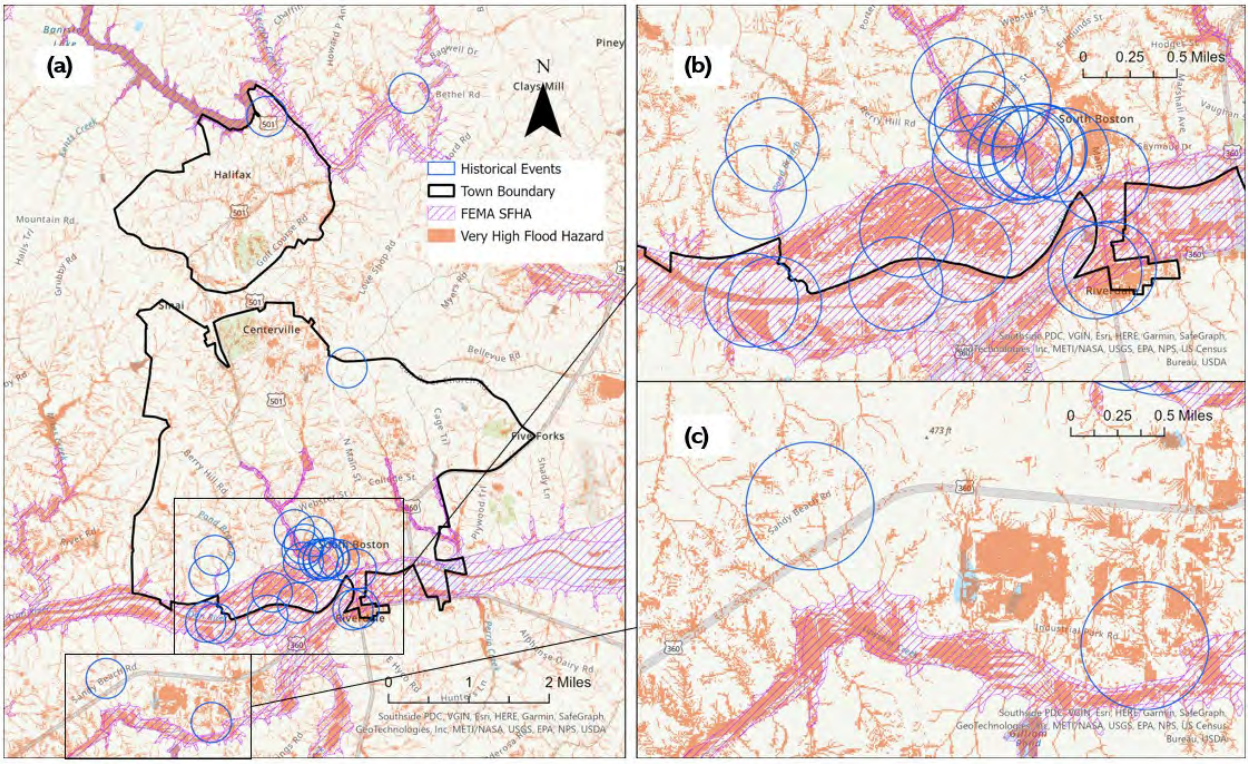

Figure 6. Comparing the identified very high flood hazard levels in the Towns of Halifax and South Boston with historical flood events.

The regular and flash flood hazard maps were also compared with the FEMA SFHA maps. Around 7.5% of the two HUC 10 watersheds incorporating the two project sites is under FEMA 100-year flood hazard. As shown in Table 1, around 73.4% of the FEMA SFHA area in the HUC 10 watershed incorporating the City of Martinsville and nearly 76.8% of the FEMA SFHA area in the HUC 10 watershed incorporating the Towns of South Boston and Halifax are identified as very high or high hazard level under regular flood. These numbers are lower for flash flood (39.6% and 45.5% in the two watersheds). In other words, in both watersheds, more than half of the SFHA area is identified as moderate or lower hazard level under flash flood. These areas are typically characterized by lower levels of land use/land cover, stream power index, and drainage density (see Appendix A for more details). These findings were expected given that FEMA flood maps are generally good in locations where fluvial flooding is the dominant mechanism but have been widely criticized for inaccuracy and being incomplete in areas dominated by pluvial flooding and in mountainous regions (Wing et al., 2021).

Table 1. Percentage of FEMA SFHA identified as different flood hazard levels under regular flood and flash flood cases in the two HUC 10 watersheds

	Identified Hazard Level	HUC 10 Watershed Incorporating the City of Martinsville	HUC 10 Watershed Incorporating the Towns of South Boston and Halifax
Regular Flood	Very High	39.0%	37.8%
	High	34.4%	39.0%
	Moderate	24.4%	20.4%
	Low or Very Low	2.2%	2.7%
Flash Flood	Very High	18.6%	17.5%
	High	21.0%	28.0%
	Moderate	34.1%	38.0%
	Low or Very Low	26.3%	16.5%

Flood Hazard Mapping at Land Parcel Level

To make the flood hazard mapping more interpretable and usable for residents and decision makers, flood hazard maps were also generated at land parcel level. Specifically, the flood hazard index values at grid cell level for both regular and flash flood maps were averaged within each land parcel, standardized, and classified with breakpoints of -2.0, -1.0, 0.0, and 1.0. The parcel-based flood hazard maps for the City of Martinsville and the Towns of Halifax and South Boston are shown in Figure 7 and Figure 8. Our results show that the City of Martinsville is more susceptible to flash flooding. Specifically, we find that nearly 41% of the land parcels in Martinsville are identified as high or very high flood hazard level under flash flood (Figure 9). Under regular flood, only 14.7% of the land parcels are in high or very high hazard level (Figure 9). Figure 7b shows the downtown area in Martinsville generally has higher hazard level of flash flood, especially those parcels closer to U.S. Route 220 and Virginia State Route 457. The difference between land parcels in high or very high hazard level under flash and regular floods is less significant in South Boston and Halifax (Figure 8). Our results show that land parcels along the Dan River are generally in high and very high hazard level of regular flood, whereas land parcels in high or very high level of flash flood are generally concentrated along the U.S. Route 501. Additionally, regions surrounding Willingham Avenue and Old Halifax Road are also more vulnerable to flash flooding. The distribution of land parcels flood hazard presented in Figure 10 shows that a higher percentage of land parcels in South Boston are more vulnerable to both regular and flash floods.

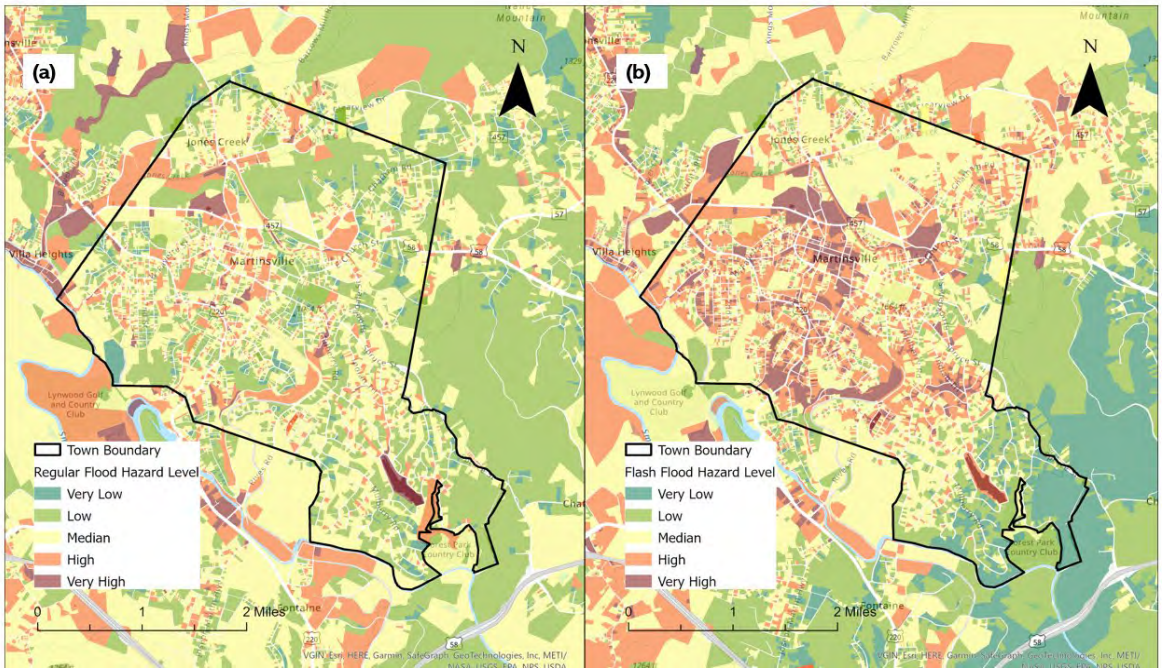

Figure 7. Flood hazard mapping at land parcel level in the City of Martinsville for (a) regular flood and (b) flash flood.

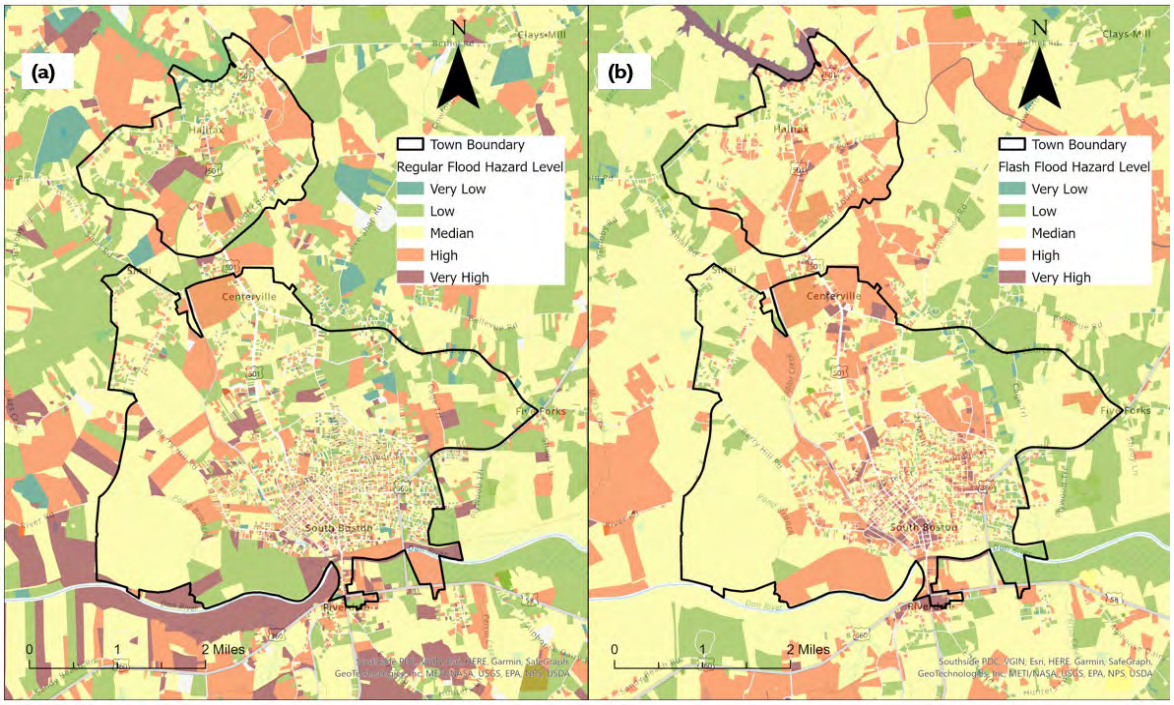

Figure 8. Flood hazard mapping at land parcel level in the Towns of Halifax and South Boston for (a) regular flood and (b) flash flood.

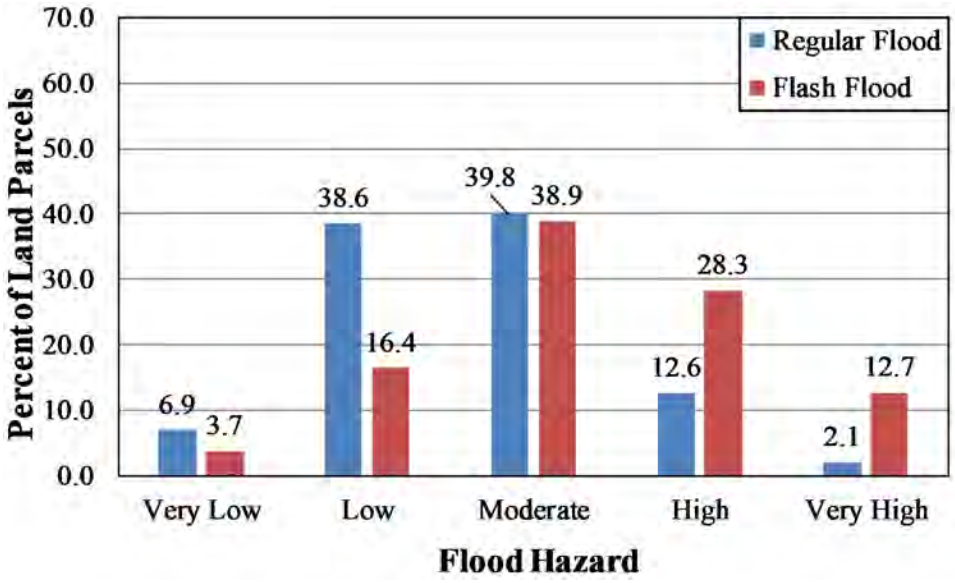

Figure 9. Distribution of flood hazard levels at parcel level in the area surrounded by the boundary of the City of Martinsville.

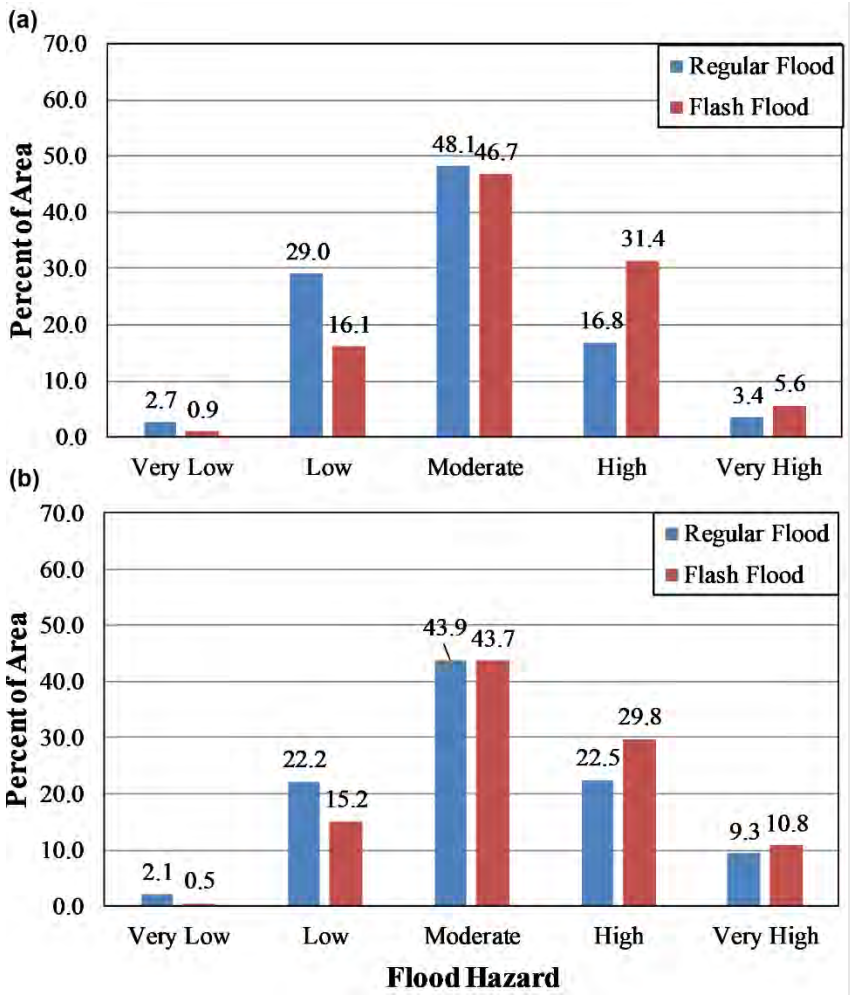

Figure 10. Distribution of flood hazard levels at parcel level in the area surrounded by the boundary of the (a) Town of Halifax and (b) Town of South Boston.

Figure 11 and Figure 12 compare the results of land-parcel-level flood hazard analysis with FEMA SFHA. Specifically, the figures show that which land parcels with very high hazard level fall inside or outside of the FEMA SFHA. In the City of Martinsville, we find that there are a few parcels outside of FEMA SFHA that are identified as very high hazard level under regular flood. However, there are many parcels at very high levels of flash flood hazard that are outside of FEMA SFHA. In the Towns of Halifax and South Boston, our results identified a large number of parcels outside of FEMA SFHA classified as very High hazard level for both regular and flash flood – land parcels along U.S. Route 501 are vulnerable to flash flooding and parcels in downtown South Boston are vulnerable to both flash and regular floods.

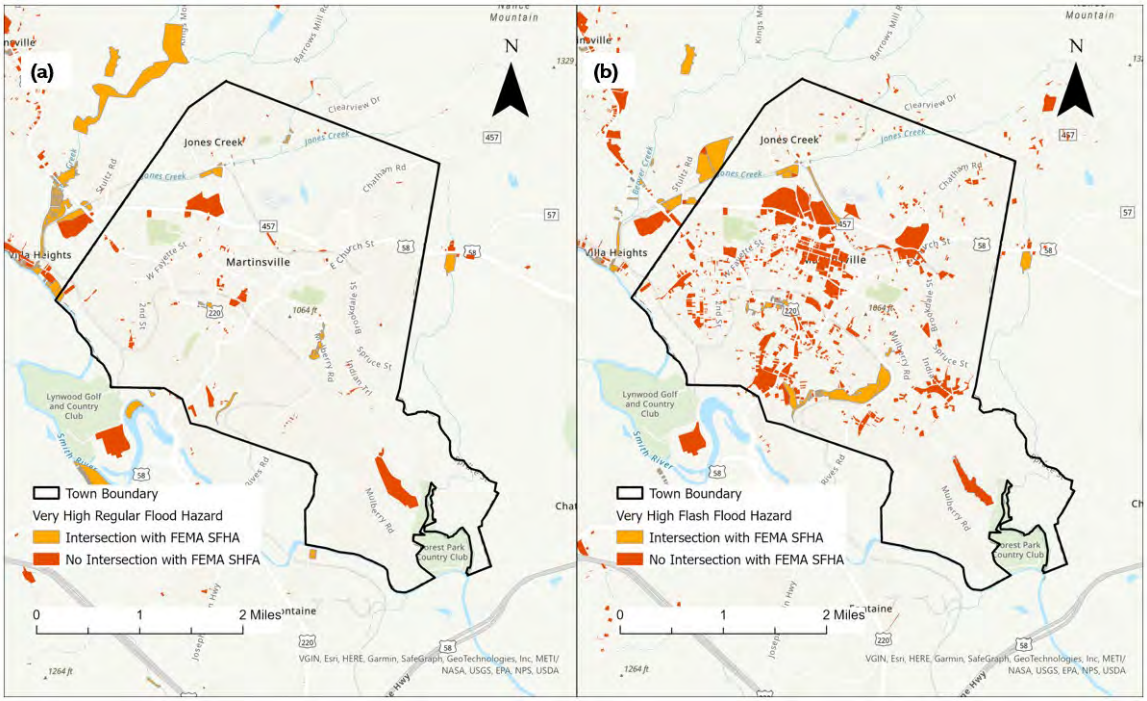

Figure 11. Comparison between very high hazard parcels and FEMA SFHA regions in the City of Martinsville based on (a) regular flood and (b) flash flood hazard analysis.

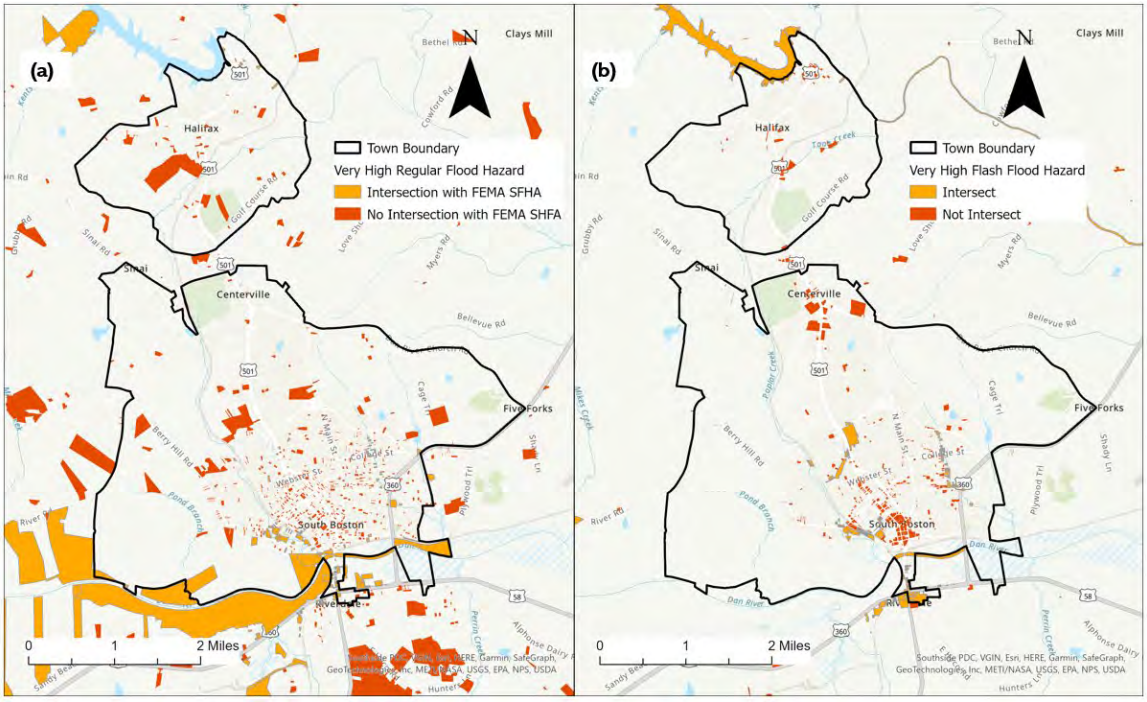

Figure 12. Comparison between very high hazard parcels and FEMA SFHA regions in the Towns of Halifax and South Boston based on (a) regular flood and (b) flash flood hazard analysis.

Cascading Impacts – Preliminary Analysis

In this project, a preliminary analysis was conducted to determine how vulnerable some of the key infrastructure and critical facilities are to flooding. For the preliminary analysis conducted here, we identified two water treatment plants and one wastewater treatment plant (WWTP) in the study area. First, the boundaries of these facilities were mapped based on ArcGIS imagery basemap. Then, a hazard level was assigned to each facility considering both flash flood and regular flood hazard levels. Figure 13 maps the location of these facilities and their vulnerability. Halifax County Service Authority and Martinsville Water Purification are located in high flood hazard areas, while the Maple Ave WWTP is located in an area under moderate flood hazard.

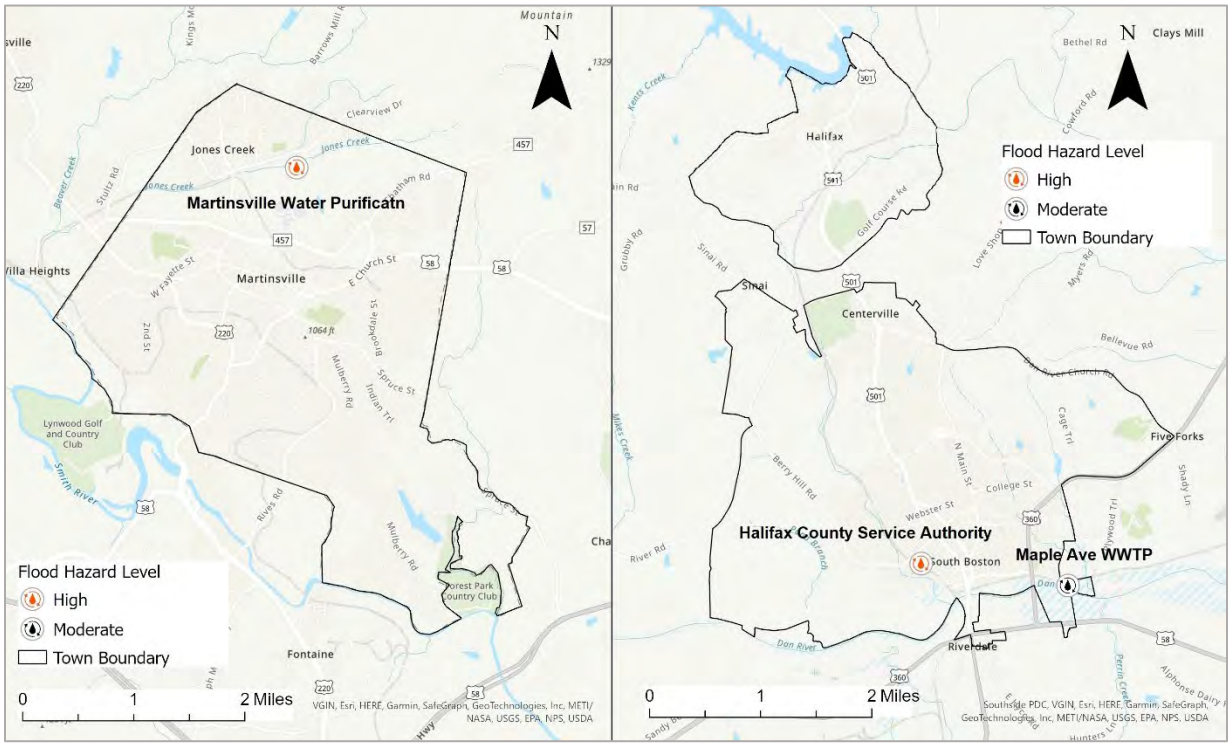

Figure 13. Susceptibility of water and wastewater treatment plants within the study area.

We also analyzed the impact of flooding on accessibility to the hospitals and public schools in the study area. For this analysis, we first utilized the Network Analysis tool in ArcGIS Pro software to map the area within a 15-minute drive (referred to as 15-minute service area) from each facility. Once the 15-minute service area for each facility is mapped, the the Network Analysis tool was used again but with the grid cells with high flood hazard (under either regular or flash flood scenario) as the barriers to generate the 15-minute service area under flooding. Figure 14 shows the accessibility to the hospitals serving the two study sites under normal (i.e., no flood) and flooded conditions. Our results show that under the no-flood scenario, all residents in the City of Martinsville and the Town of Halifax as well as most residents located in the east side of Berry Hill Road in the Town of South Boston have access to the hospitals within

a 15-minute drive. Under the flooded condition, however, access to the hospitals would significantly reduce. The extreme decrease in the service area is caused by the assumption that there will be road closure in the large continuous regions under very high flood hazard level that are close to the hospital. For the SOVAH Health hospital, for example, the intersection of Stultz Road and Liberty Street is close to the Jones Creek, which is highly vulnerable to flooding and therefore, if flooded, the access to the hospital from the west side of the city will be significantly compromised. Similarly, the intersection of Hooker Street and U.S. Route 58 is located in very high level of flash flood hazard. For the Sentara Halifax Regional Hospital, continuous flooded areas would block Hamilton Blvd and U.S. Route 501. These regions have very high flood hazard level under both flash flood and regular flood. Finally, Figure 15 maps the accessibility of public schools in two study sites under the no-flood and flooded conditions. The accessibility of schools would reduce by 85% to 99% for each of the schools.

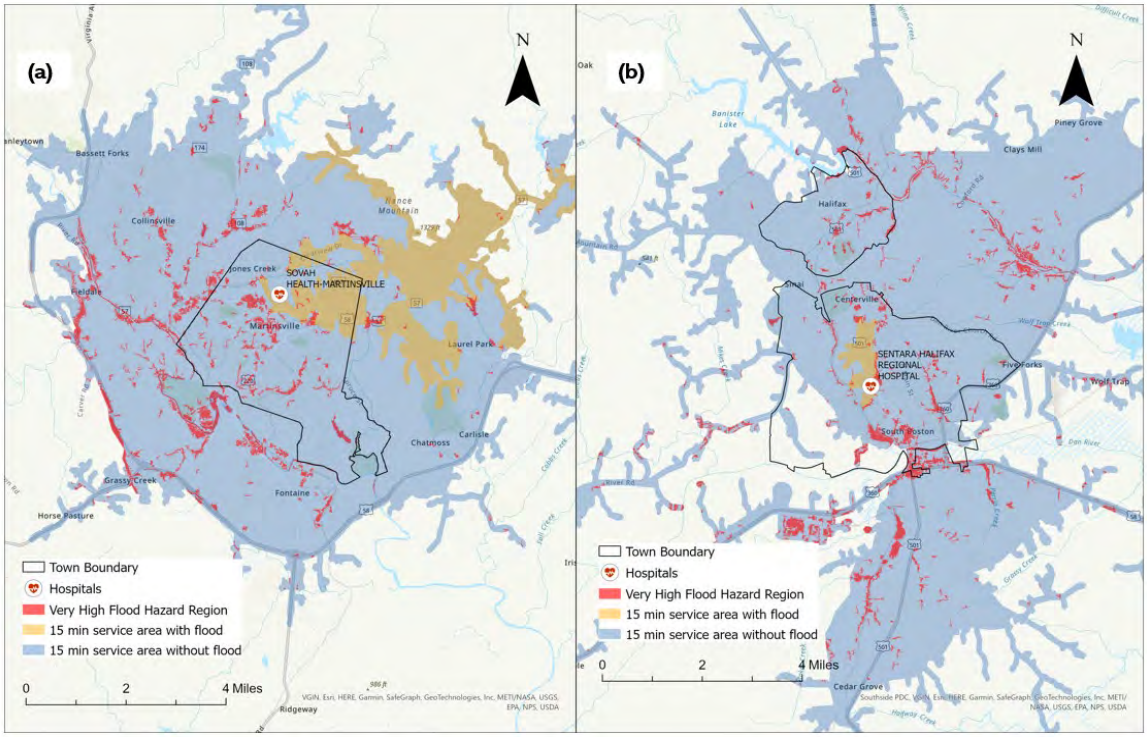

Figure 14. 15-minute service area of the hospitals in (a) Martinsville and (b) Halifax and South Boston with and without flooding

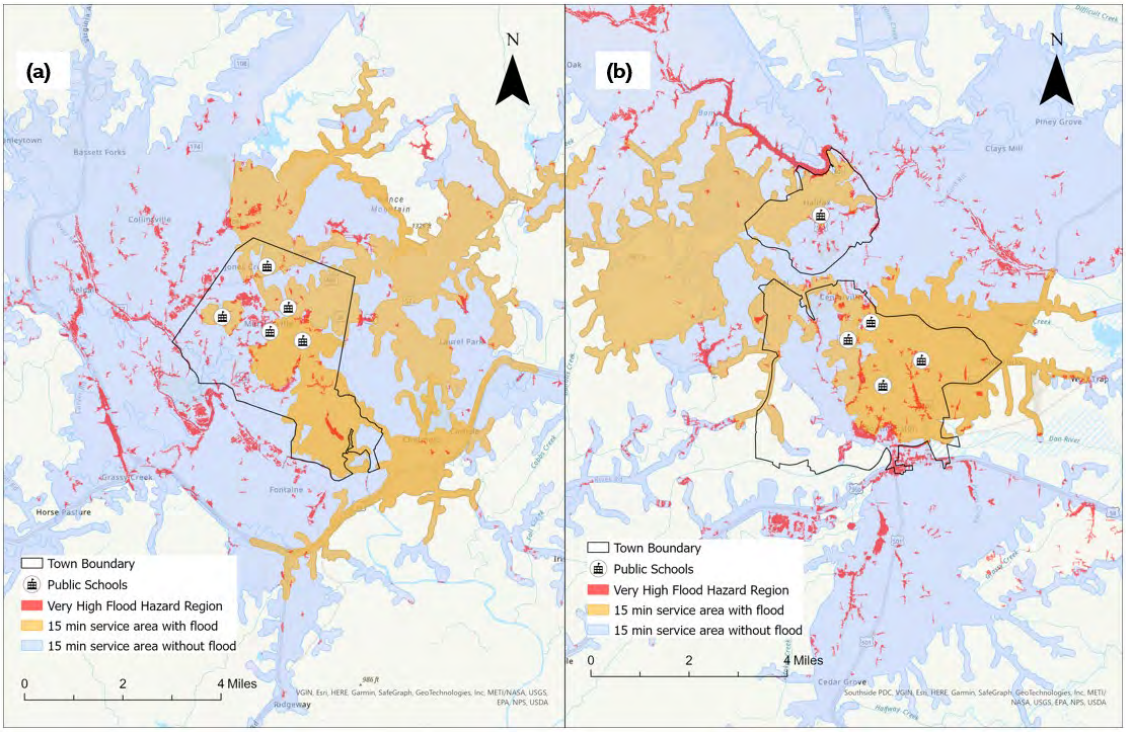

Figure 15. 15-minute service area of public schools in (a) Martinsville and (b) Halifax and South Boston with and without flooding

COMPREHENSIVE INVENTORY OF RESOURCES

The Southside Planning District Commission was established in 1969 and serves the Counties of Brunswick, Halifax, and Mecklenburg as well as the towns of South Boston and South Hill. However, this benchmarking study focuses on three localities—the City of Martinsville, Town of Halifax, and Town of South Boston. This project aims to take stock of what already exists from a land use planning and regulatory perspective and as a result, we accessed comprehensive plans, floodplain ordinances, zoning codes from the participating localities. Next, we developed a set of indicators based on the criteria established by the Virginia Department of Conservation and Recreation (DCR) for proposals requesting flood resilience funds (Virginia Community Flood Preparedness Fund Grant Program) and used a plan evaluation scoring system (Berke et al. 2015) to identify areas of strength and potential gaps between the documents considered and the review criteria. With assistance from the Southside Planning District Commission and representatives of the participating localities, the following comprehensive plans, floodplain ordinances, and zoning codes were compiled and reviewed:

- *City of Martinsville Comprehensive Plan* (updated 2021)
    - See Floodplains (p. 3-13)
    - See floodplain map (p. 3-15) dated April 1, 1981)
- *City of Martinsville Code of Ordinances*
    - *Building Regulations* reference Flood Damage Reduction Act, Code of Virginia and City of Martinsville Flood Plain Ordinance 91-11 adopted in 1981
    - *Zoning Ordinance* does not establish a distinct zoning district for floodplains
    - *Land Subdivision Ordinance* prohibits development within the 100-year floodplain except in compliance with Ordinance No. 91-11, City of Martinsville Flood Plain Ordinance
- Town of Halifax Comprehensive Plan (2007)
    - See Figure 6 (p. 62) for floodplain map
- Town of Halifax Floodplain Ordinance (adopted 2009)
    - See Section 4.2 General Standards (p. 9) and Section 4.3 Specific Standards (p. 10)
- *Town of South Boston Comprehensive Plan* (adopted 2021)
    - See Hydrology: Streams and Floodplains (p. 107)
- *Town of South Boston Zoning Ordinance* (adopted 1991, amendments through 2020)
    - See Division 15-Flood Hazard Overlay District (p. 49)
- *Southside Planning District Commission Regional Hazard Mitigation Plan 2020*
    - See Flooding (p. 4-30)
- *West Piedmont Planning District Commission Multi-Jurisdictional Hazard Mitigation Plan 2021 Update*
    - See Flooding (p. 56) and Floodplain Management (p. 203)

These are the relevant plans and ordinances that were accessible to us (i.e., available on the internet or provided by local government partners) at the time that this phase was completed, roughly May through July of 2022.

Explanation of Scoring

The plans and ordinances listed above were compiled and reviewed using an evaluation instrument with a **three-part scoring system** aligned to themes and criteria established by the DCR for regulatory review of resilience plans. The three possible scores for each plan or ordinance element are as follows:

0 means no evidence of the indicator,

1 means the indicator was suggested/inferred/identified but not in detail, and

2 means the indicator was more fully described.

The themes important to explore in this evaluation included: **project-based relevancy (i.e., clear connection to flood control and resilience), nature-based infrastructure, equity, cross-jurisdiction coordination, planned timeline, and best available science.** These themes are all among the resilience planning principles established by the Virginia Community Flood Preparedness Fund Grant Program (CFPF) and localities applying for funding must have a resilience plan that has been approved by the Department of Conservation and Recreation (DCR) in place. This benchmarking evaluation is designed to document resilience planning principles that are currently being met and to identify those that may not be as clearly addressed at this time.

Through our research, three other common themes were discovered and included in the evaluation, though they might not be explicitly mentioned in the DCR criteria. These three themes are: **adaptive management**, **emergency readiness**, and **economic impact**. Adaptive management has been described as a flexible, iterative approach where adjustments are regularly made based on new information that has been gained through monitoring. Similarly, DCR criteria[1] include assessing whether a resilience plan submitted for review "is based on the best available science and incorporates climate change, sea level rise, and storm surge (where appropriate), and current flood maps." The results of this plan and ordinance evaluation and review scores are included in Appendix B, but an overview of the findings for each jurisdiction and for the region is presented in the following paragraphs. The summary scores (Appendix B) also help to identify specific areas where existing plans and ordinances could be strengthened and better aligned with DCR review criteria. This is particularly important given that **individual localities will be required to submit their own resilience plan** that combines local plans and

[1] Virginia Department of Conservation and Recreation. (2022). *2022 Grant Manual for the Virginia Community Flood Preparedness Fund*. Available at *https://www.dcr.virginia.gov/dam-safety-and-floodplains/document/Round-3-2022-CFPF-Manual-final.pdf*

ordinances with regional plans like the *Southside PDC Regional Hazard Mitigation Plan 2020* or the *West Piedmont PDC Multi-Jurisdictional Hazard Mitigation Plan 2021* (i.e., a locality-specific version of the table presented in the Baseline Assessment section of this document).

City of Martinsville

Although the City of Martinsville is a participating locality for this study, it should be noted that it is not part of the Southside PDC and is instead served by the adjoining West Piedmont Planning District Commission (WPPDC). Martinsville is an independent city and the largest locality included in this study with an estimated 2019 population of 12,852 (U.S. Census Bureau, 2022). Martinsville has a comprehensive plan updated most recently in 2021 and a set of resilience benchmarks that were established in 2020. The resilience benchmarks are best interpreted as guiding principles for increasing resilience rather than as a plan with specific goals and policies or that brings regulatory requirements to bear. Although the benchmarks emerged through Martinsville's participation in the Alliance for National and Community Resilience process and led to a formal city council resolution in April 2021, they were not directly included in the plan and ordinance evaluation component of this project—although one could argue that these should be considered an extension of the "Adaptive Management" aspects of the city's comprehensive plan. The City of Martinsville's zoning ordinance does not establish a floodplain district, but its land subdivision ordinance prohibits development within the 100-year floodplain except in compliance with Ordinance No. 91-11, City of Martinsville Flood Plain Ordinance. Earlier versions of the code indicate that this ordinance is "found in the office of the building official, adopted August 27, 1991" and specifically include a floodplain overlay district among those established in the zoning ordinance (i.e., November 26, 2008 version of the code).

Strengths

The City of Martinsville Comprehensive Plan relies on relevant flood control and flood resilience data and includes clear timelines for implementation and updates. It uses factual and current evidence to explain flooding as an important issue and presents historical information regarding flooding issues in Martinsville to reinforce and contextualize the importance of addressing flooding. The comprehensive plan identifies natural resources important to the region and to ecosystem health, as well as specific features that can be leveraged or built upon to advance flooding resilience and increase flood protection.

Because Martinsville is part of a region adjacent to the Southside PDC service area, the *West Piedmont Planning District Commission Multi-Jurisdictional Hazard Mitigation Plan* was also evaluated. Overall, this document scored well on all of the core principles identified by DCR for its review of resilience plans. The plan relies on current data and factual evidence to identify areas within the region that are of concern, then offers an historical assessment of the issues and their impacts on the present day. Both the populations and assets of the region that are vulnerable to flooding were identified as part of the plan, although vulnerable populations could

be better integrated into the planning process as a means of better aligning with DCR regulatory review criteria. The plan also excelled at explaining the critically important role of natural resources in defending against flooding hazards and integrating nature-based solutions into the plan. Lastly, the plan contains evidence of robust community engagement efforts throughout the planning process.

Opportunities

While there was strong evidence of resident participation in the comprehensive planning process in Martinsville, there is room for more analysis on the populations that will be affected by flooding, particularly socially vulnerable populations. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazard. There is potential for this to be accomplished by describing if and how social factors like racial discrimination and income inequality contributed to the uneven distribution of flood risk across different areas of the city and across different groups of residents. Explicitly addressing whether hazard mitigation or resiliency action items outlined in the plan are likely to have disparate impacts on various racial, ethnic, or income groups within the city would further align with DCR regulatory review criteria. In both the West Piedmont Hazard Mitigation Plan and the Martinsville Comprehensive Plan, there is opportunity to strengthen alignment with DCR regulatory review criteria for nature-based solutions (e.g., wetlands, tree planting, rain gardens) by mapping the resources that are important for ecosystem health and those that are at risk of being lost due to flooding hazards, as well as informing residents of the benefits of and advocating for incentives that adopt natural resource protection practices.

We recognize that not all plans that exert an influence on flood resilience are intended to address flooding. For example, an economic development strategy will not engage with flood risk in the same way or to the same extent that a hazard mitigation plan typically does. However, we read the *West Piedmont Comprehensive Economic Development Strategy* and found that it exhibits clear timelines for implementation and updates as well as offering further evidence of cross jurisdiction coordination within the region. With that said, there is room here to explicitly assess the economic impact of flooding without veering from the purpose and scope of the economic development strategy itself.

Town of Halifax

The Town of Halifax had a population of 1,118 in 2019 (U.S. Census Bureau, 2022) and this evaluation focused on the *Halifax 2025 Comprehensive Plan: Embracing our Heritage for a Vibrant Future* plan which was adopted in 2007. This comprehensive plan aims to lay a foundation for community development goals, policies, and actions in the development of future initiatives in the town. The community actively strives to preserve its heritage, protect the high quality of life, enhance environmental and recreational assets, and to encourage economic

vitality and the comprehensive plan emphasizes the economic and cultural importance of tourism and recreation of the town's natural resources. Halifax has strong zoning and subdivision ordinances that advance flood control and resilience by designating floodplain districts and outlining required actions to protect natural resources and limit development in those areas. The land subdivision ordinance states "Land subject to flooding and land deemed to be topographically unsuitable shall not be platted for residential occupancy" (Section 5-3. Flooding) and while a zoning ordinance is referenced the table of contents of the Town Code, that portion appears to be missing from the *files available on the local website*. The Town of Halifax Floodplain Ordinance was adopted in October 2009 and establishes a floodplain district overlay consistent with delineated 100-year floodplain where the construction, repair, and characteristics of structures is regulated.

Strengths

The comprehensive plan relies on factual evidence and the best available data at the time of publication (i.e., 2007) to explain flooding concerns, particularly in relation to the natural resources of the area. The emphasis on floodplains and the potential impacts on development, economics, and historical preservation is clearly important to the town. There is ample evidence of adequate public participation as part of the community engagement planning process and the timelines given within the comprehensive plan were clearly stated and in accordance with the articulated goals of the plan.

Opportunities

There is an opportunity for the Town of Halifax to better align with DCR regulatory review criteria by identifying and mapping the sources of flooding, evaluating any changes in the frequency and magnitude of flood events since the completion of the comprehensive plan, and incorporating projections of flood event frequency and magnitude in the future into its comprehensive plan. Further, an updated comprehensive plan could also include strategies for leveraging natural resources for flood mitigation while informing residents and property owners of the benefits and incentives that tree plantings, rain gardens, constructed wetlands, and other interventions can provide. Lastly, the comprehensive plan could explicitly consider if and how social factors like racial discrimination and income inequality contributed to the uneven distribution of flood risk across different areas of the town and across different groups of residents, as well as strategies for addressing the root causes of those disparities. While there is evidence of public participation in the planning process, better integrating socially vulnerable populations into the planning process would help the town to better align with DCR review criteria.

Town of South Boston

The Town of South Boston's *Comprehensive Plan 2040: Progress and Preservation on the Dan* plan provides a long-term vision and recommendations that serves as a guide for land

management and decision-making. The Town of South Boston is located on the bluffs of the Dan River and had a population of 7,966 in 2019 (U.S. Census Bureau, 2022). The town has a strong zoning ordinance, as well as a sediment and erosion control ordinance, that address flood mitigation and resilience in the town. Specifically, the zoning ordinance establishes a flood hazard overlay district that includes "all lands within the jurisdiction of the town and identified as being in the 100-year floodplain by the Federal Insurance Administration" and that imposes critical infrastructure and permanent structures to restrictions.

Strengths

The comprehensive plan very strongly situates the Dan River floodway and/or floodplain as a key resource and identifies ways in which its flooding has shaped the development of South Boston. It also makes specific recommendations for how existing development could respond to that flooding, such as the creation of a flood-safe and elevated Visitor Center. The plan addresses current sources of flooding, presents historical assessments of flooding, and engages with flood concerns among current leaders and residents. It is evident from reviewing the comprehensive plan that protecting natural features is a key goal and that the careful management and conservation of development situated near or in floodplains is a central feature of the town's 20-year vision. As it relates to the DCR review criteria, the comprehensive plan documents public participation as part of the community engagement process, and strongly emphasizes the importance of accessibility and communication as part of that process. There is also clear evidence of cross-jurisdiction coordination to address flooding concerns and resilience, as well as an obvious effort to incorporate the best available science into managing flood risk.

Opportunities

Given the importance of the Dan River as a natural resource, there is an opportunity for the town to offer incentives for residents and property owners to adopt natural resource protection practices and policies, as well as implementing green infrastructure practices on town-owned land. Educating residents and property owners of the benefits of natural resource protections of communities at an increased risk of flooding could also provide a way to strengthen alignment with DCR regulatory review criteria. Lastly, a risk assessment of vulnerable resident groups could be conducted and the location of socially vulnerable populations could be mapped. Describing if and how social factors like racial discrimination and income inequality contributed to the uneven distribution of flood risk across different areas of the city and across different groups of residents and explicitly addressing whether hazard mitigation or resiliency action items outlined in the plan are likely to have disparate impacts on various racial, ethnic, or income groups within the city would further align with DCR regulatory review criteria.

Southside PDC Regional Hazard Mitigation Plan

Natural and technological hazards typically do not adhere to the jurisdictional boundaries of localities and in many cases, hazard mitigation plans are developed at the regional scale. This is true of the Southside PDC service area and referencing elements of the *Southside Planning District Commission Regional Hazard Mitigation Plan* will be important for the Towns of Halifax and South Boston when they prepare and submit a resilience plan for DCR approval. This regional hazard mitigation plan was included in the evaluation component of this project for this reason.

Strengths

The Southside PDC *Regional Hazard Mitigation Plan* includes a section that is notably strong in its treatment of nature-based infrastructure, but it actually excels in all categories considered by this review with highlights including:

- Identifying assets and populations that are vulnerable to flooding impacts
- Identifying and planning for natural and nature-based features that are protective
- Integrating natural resources into defenses against flooding through projects, programs, or other policies
- Implementing incentives for natural resources protection practices and green infrastructure

The *Regional Hazard Mitigation Plan* relies on current data and factual evidence, it provides an overview of historical flood events and impacts and also explains why flooding is of such concern and importance to the region. This plan also includes a thorough analysis of critical infrastructure and assets with respect to flood risk.

Opportunities

There is an opportunity to expand the elements of the plan that engage with the equity criteria established by the Department of Conservation and Recreation for approved resilience plans. While the *Regional Hazard Mitigation Plan* documents robust public participation as part of the planning process, drawing more direct linkages between that participation and the substance of the resulting plan would underscore and strengthen its impact. Here are a few ways that this could be achieved:

- Conduct a risk assessment of socially vulnerable populations who are also at high risk of flooding
- Fully incorporate socially vulnerable community members into the planning process, with special attention to communication and accessibility needs these individuals may have

- Explicitly address past and existing inequalities in the region as it relates to flooding concerns, as well as the potential impacts on these populations once flood resilience measures have been implemented (i.e., the potential for these measures to have unintended consequences)

Finally, an assessment could be conducted to identify likely impacts of the projected changes in the frequency and severity of flooding in the coming decades—this could maps corresponding to different annual probabilities (e.g., the 500-year floodplain) or downscaled climate model predictions.

Regional Summary

The study region includes the City of Martinsville, the Town of Halifax, and the Town of South Boston with the Southside Planning District Commission as the primary partner. As a result of the plan and ordinance evaluation work performed, a few overall trends emerged:

- The plans reviewed incorporated current data and drew upon a strong evidence base. These plans often described historical flood events as context for present-day flood risk and flood impacts, however, we did notice that projections of future flooding are typically not part of these documents. This may be due to a lack of access to or awareness of resources that estimate future flood risk and represent an opportunity for strengthening the locality plans as they exist today. Perhaps not surprisingly, the regional hazard mitigation plans engaged with flooding and flood resilience in much more comprehensive manner and each exhibit a clear connection to flood control and resilience, which is one of the core criteria established by DCR.
- All plans reviewed clearly made use of the best available science to inform decisions, incorporating data and scientific analyses.
- Regulations that are more specific better address the assessment questions (i.e., align with DCR regulatory review criteria).
- Generally, the plans reviewed scored well on the criteria related to clearly articulated timelines for implementation and cross-jurisdiction coordination.
- Zoning ordinances are the most comprehensive and readily available regulatory instrument for advancing flood resilience.
- Alignment with the equity criteria outlined by DCR as part of its requirements for resilience plans could be improved by incorporating assessments of socially vulnerable populations (e.g., define and map) and discussing how past inequalities may contribute to present-day patterns of uneven flood risk (as well as strategies for addressing these disparities). While there was often evidence of public participation in the planning process with documentation of community engagement efforts, more explicit efforts to

bring vulnerable community members into the planning process would better align with these required DCR review criteria.

The evidence supporting nature-based infrastructure as a tool for flood mitigation was quite strong in all the plans. However, there may be additional opportunities to educate residents about the benefits of natural resource protections and to better integrate green infrastructure (e.g., open space requirements) into existing land subdivision ordinances.

STAKEHOLDER INVENTORY

Stakeholders are defined as: (1) those who are affected by the decisions and actions that are taken and (2) those who have the power to influence their outcomes. Stakeholders can be individuals or organizations and are often grouped into three categories—public, private, and non-profit sectors. An initial inventory of stakeholders who are affected by flooding or that have the ability to flood impacts was developed by combining survey responses with insights gathered during the virtual engagement event with "desk research" involving web searches and document reviews.

- Virginia Department of Emergency Management
- Virginia Department of Transportation (i.e., flooded roadways)
- Planning district commission
- Local government
- Small businesses
- Banks and lenders
- Commercial property owners
- Chambers of commerce
- Local tourism industry
- Virginia Farm Bureau
- Civic organizations like the Kiwanis and Lion's Club
- Environmental advocacy groups (e.g., Dan River Basin Association)
- Local churches
- Martinsville Junior County Ministerial Association
- Large employers (e.g., Nationwide Homes)

The online survey of local government staff and elected officials asked questions about who respondents believed were stakeholders that should be involved in flood resilience planning. In each sector (e.g., public, private, non-profit) individuals and organizations with the most regulatory responsibilities (e.g., floodplain and zoning administrators), the greatest financial exposure (e.g., insurance companies), and a combination of social connections and resources (e.g., civic organizations like the Kiwanis) emerged as the most important constituencies. One participant suggested that private contractors who repair structures and roads in the aftermath of a flood event should be considered stakeholders and included in resilience planning processes as well.

A second online survey asked similar questions of residents who live in areas with a history of flood impacts. A total of 2,730 survey invitations were mailed to residents of Crystal Hill, Halifax County, Town of Halifax, City of Martinsville, Town of Scottsburg, and the Town of South Boston during August 2022. Of the 32 completed responses received (response rate of 1.2%), the questions about relevant stakeholders mirrored those responses offered by local government staff and elected officials with floodplain administrators, elected officials, and other local government staff topping the list (e.g., zoning administrator, emergency management professionals, public works and engineering). For the private sector, respondents unanimously indicated that insurance companies should be part of the process, followed by small businesses, commercial property owners, and banks. Similar to the responses offered by local government staff and elected officials, resident respondents identified agricultural and environmental non-profit organizations as important stakeholders for flood resilience. Local public school administrators were also identified as an important constituency by residents who responded to the survey due to the effects of flooded roadways on transporting children to and from school. The results of these online surveys are discussed in greater detail Appendix E of this report.

ANALYSIS OF "SOFT" CAPACITIES

To effectively plan for flooding, localities need to have adequate staffing, training, and other resources in place to support their work. These "soft capacities" were evaluated through: (1) a review of existing planning documents, (2) an online survey of local government staff and elected officials conducted in the summer of 2022, (3) a virtual focus group meeting held in November 2022, and (4) a series of five key informant interviews conducted during the January and February of 2023.

Based on the online surveys, virtual focus group engagement event, and key informant interviews, the financial resources to support flood resilience planning and flood mitigation work are rarely sufficient to fully address realities that participating localities face. Respondents to the local government staff survey indicated that funding was the most significant barrier to flood resilience by a wide margin followed by the demands on staff time (e.g., police, public works) and additional government expenses (i.e., overtime pay) when floodwaters impact roads.

In addition to the scarcity of funding, staffing levels in many localities within the study area are not adequate. Local government organizations have seen numerous retirements but it has often been a challenge to fill vacant positions. A reduction in local government staffing levels has also meant an effective increase in workload for staff members that remain, which makes training new hires difficult from a time allocation perspective. However, it should be noted that despite these challenges, all participating jurisdictions have a designated Floodplain Administrator and two of these three individuals either participated in the November 2022 engagement event or completed the online survey.

The existence and adequacy of succession plans is not reflected in the planning documents reviewed and may be internal to each locality. However, local government staff from all three jurisdictions indicated during the November 2022 event that there is an awareness of their importance, but succession plans are not widely available in local government outside of the Standard Operating Procedures (SOPs) for police and fire personnel. When longtime employees retire, they often take valuable institutional knowledge with them that is difficult to capture.

According to recent analysis from the *Weldon Cooper Center's Demographics Research Group* the population of both Martinsville and South Boston is expected to continue decreasing over the next three decades. Further, all three localities have resident populations that are older than that of the both the state and the nation (Figure 16) and with the additional caveat that American Community Survey (ACS) estimates have a significant margin of error for smaller jurisdictions due to survey sample size limitations.

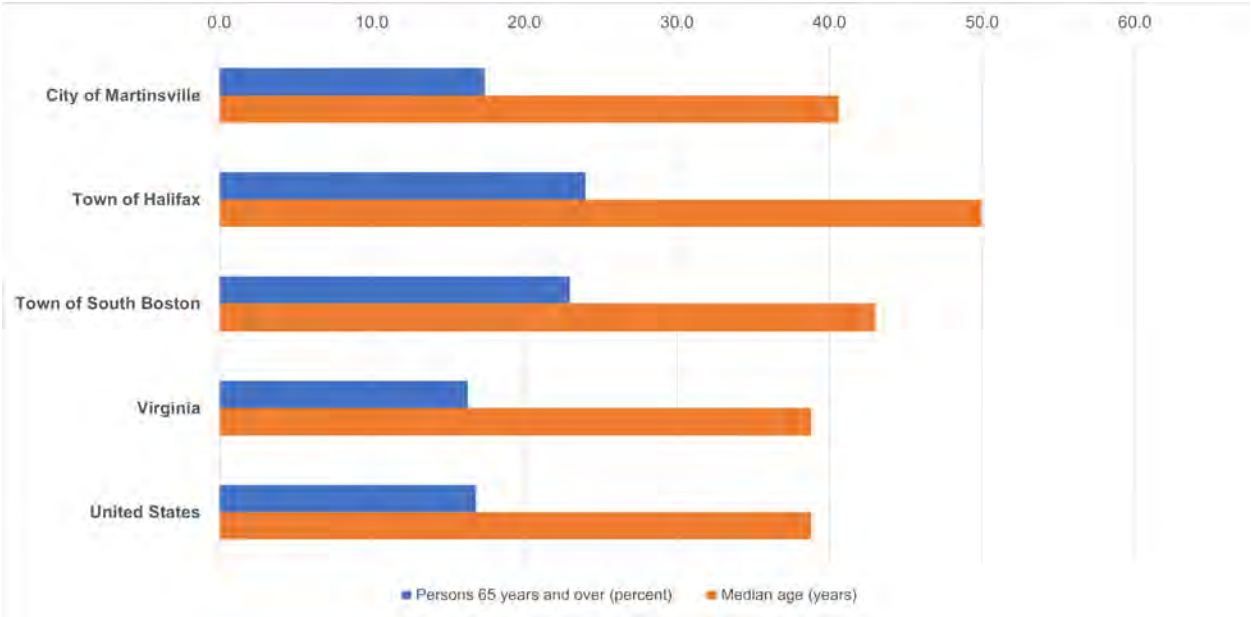

Figure 16. Age characteristics of localities within the study region relative to the state and nation. Source: U.S. Census Bureau, ACS 5-Year Estimates 2021: Table S0101 Age and Sex.

This demographic trend could potentially affect the ability of Southern Virginia localities to continue to meet staffing requirements if there is a wave of retirements in the coming years and if population continues to decline—as anticipated. One particular risk is that institutional knowledge that has been accumulated by retirees may be lost if transition plans are not in place to document that knowledge and—to the extent possible—have replacement staff overlap with retiring staff for some period of time.

The "Capability Assessment" section of the *Southside Planning District Commission Regional Hazard Mitigation Plan* provides more detailed information on the staffing, fiscal, and outreach capacities of the Town of Halifax and the Town of South Boston while the "Capability Assessment" section of the *West Piedmont Planning District Commission Multi-Jurisdictional Hazard Mitigation Plan* provides similar information for Martinsville:

- The City of Martinsville has a Community Development department that is responsible for land use planning and implementing building and zoning regulations. Its Public Works department is home to the designated Floodplain Administrator and the geographic information systems (GIS) staff
- The Town of Halifax has a planner, zoning administrator, and Floodplain Administrator on staff as well as mutual aid agreements in place whereby counties collaborate with and assist their respective towns with hazard mitigation efforts when needed or in the event of a request for this kind of support
- The Town of South Boston has a planner, zoning administrator, emergency manager, Floodplain Administrator, and GIS coordinator on staff

However, in several of the five key informant interviews, participants described regular interactions and coordination with state and federal government agencies (e.g., Virginia Department of Transportation, Federal Emergency Management Agency) and this is evidence of lines of communication and a working relationship that could be crucial in the event of large flood event. A final theme that emerged from the interviews is that flood impacts within the Southern Virginia region and the City of Martinsville have been very localized to date, which means that the majority of the population is not very aware of the threat posed by flooding or of steps that are being taken to mitigate flooding. Therefore, public outreach and education should be an area of emphasis as the region and its localities continue to refine and extend their flood resilience initiatives.

BASELINE ASSESSMENT

The goal of the baseline assessment presented here is to: (1) test the framework that has been developed over the past year through this project and (2) identify areas of strength and gaps when the planning and regulatory assets are evaluated against DCR review criteria. The information included in Table 3 represents a starting point for individual localities to create and submit a resilience plan to the Virginia Department of Conservation and Recreation for approval in that those tables explicitly show evidence of meeting criteria and resilience indicators established as part of the regulatory review process. This approach—along with the template provided in Appendix C and the plan/ordinance evaluation spreadsheet that accompanies this document—can be used to help other low-income, under-resourced communities begin the process of resilience planning.

Through a review of existing materials related to the *Community Flood Preparedness Fund Grants and Loans Program* and a conversation with a DCR Floodplain Program Manager, it is clear that each locality within the Southside Planning District Commission's service region that intends to request funding for resilience planning and project implementation will need its own resilience plan. However, many of the DCR requirements may be met by plans developed at the regional scale such as the *Southside Planning District Commission Regional Hazard Mitigation Plan*. Further, resilience plans submitted on a regional basis must meet the same criteria as plans submitted for a single locality and because regional plans generally address larger scale planning issues, cross-jurisdictional considerations, and studies or projects that affect more than one locality, the most feasible model is for each locality to reference regional plans to supplement local ordinances and plans.

Appendix F contains the most recent guidance from DCR (dated January 2023). In addition to reiterating the core resilience plan requirements, it also discusses the difference between a standalone plan approach and a compilation plan approach. The latter is recommended for Southern Virginia localities given how much information and relevant planning provisions already exist in regional plans. Rather than "reinventing the wheel", participating localities should use the baseline assessment template to explicitly map how and where these core DCR requirements are being met in local and regional plans and ordinances. In addition to the DCR core resilience plan requirements (i.e., "must have" elements), Appendix G of the 2022 Grant Manual for the Virginia Community Flood Preparedness Fund outlines examples of resilience plan elements that may be appropriate for inclusion and other Virginia localities have used these "nice to have" elements to further support their submission. These optional elements are also included in Table 2 as well as the baseline assessment template in Appendix C.

Table 2. Baseline assessment – regions, city, and towns

Plan/Ordinance Component	Southside Hazard Mitigation Plan (2020 Update)	West Piedmont Hazard Mitigation Plan (2021 Update)	City of Martinsville	Town of Halifax	Town of South Boston
It is project-based with projects focused on flood control and resilience. It identifies and includes all flooding occurring in all flood zones, and the number of repetitive loss and severe repetitive loss properties.	Section 5- Risk Assessment, Section 8 – Executive Summaries (National Flood Insurance Program survey responses)	Section 5 - Hazard Identification and Risk Assessment, Section 3 Planning Process (Subsection C)	p. 3-13, 3-15, Floodplain Ordinance	p. 61-65 (repeated losses are not identified), Floodplain Ordinance	p. 19, 103-104, 120-123, Flooding Ordinance
It incorporates nature-based infrastructure to the maximum extent possible.	pp. 4-30, 8-46	p. 227, 246-247, 268, 272 (Section 7-Mitigation Strategy)	p.10-2 (not fully realized)	p.13, 55-58 (not fully realized)	p. 83, 121-122 (not fully realized)
It includes considerations of all parts of a local government regardless of socioeconomics or race. It is equity focused and prioritizes vulnerable populations subjected to flooding, not just populations vulnerable to flooding.	p. 2-1 *There is no mention of vulnerable populations or equity in this plan. Although Section 3 does look at regional profiles (employment + population)	p. 215, 223, 236, 245 (Section 7-Mitigation Strategy)	N/A	N/A	p. 21-22 – as found in HMP

Plan/Ordinance Component	Southside Hazard Mitigation Plan (2020 Update)	West Piedmont Hazard Mitigation Plan (2021 Update)	City of Martinsville	Town of Halifax	Town of South Boston
It includes coordination with other local and inter-jurisdictional projects, plans, and activities and has a clearly articulated timeline or phasing for plan implementation.	Section 8- Executive Summaries, Section 9-Plan Maintenance	Section 8 - Plan Monitoring and Maintenance Procedures	p.3-14, Section 4 – Community Facilities, Services, Utilities	p.11, 13, 107, Appendix p. 1-17	p. 9, 102, 119, Section VI- Plan Implementation Matrix and Maps (includes partnerships)
It is based on the best available science, and incorporates climate change, sea level rise, and storm surge (where appropriate), and current flood maps.	p. 1-1, Section 2-8, Section 4-Hazard Identification, Section 8-Executive Summaries (flood maps by jurisdiction)	p. 59, 82, 97, 111-112, 119, 128, 135, 146, 149, 200, 264, 286 *There is mention of new flood maps/manuals, but they are not in the plan (p.226, 297)	p. 3-13, 3-15 (not fully realized)	p. 62 (not fully realized)	p.107-110
Equity based strategic polices for local government-wide flood protection and prevention.	p.4-33 *While there are strategic policies, they are not explicitly equity based	Section 7 – Mitigation Strategy, p. 212, 292	*In the Hazard Mitigation Plan	Appendix p. 1-17 Implementation Matrix (not fully realized – Watershed protections could be expanded to include flood protections)	p. 122-123

Plan/Ordinance Component	Southside Hazard Mitigation Plan (2020 Update)	West Piedmont Hazard Mitigation Plan (2021 Update)	City of Martinsville	Town of Halifax	Town of South Boston
Proposed projects that enable communities to adapt to and thrive through natural or human hazards.	Section 7- Regional Mitigation Goals and Strategies, Section 8- Executive Summaries (Mitigation Actions by jurisdiction)	Section 5- Hazard Identification and Risk Assessment (Subsections C+D), Section 6 – Capability Assessment (Subsection E3), Section 7 – Mitigation Strategy	p.3-14 *In HMP	N/A (In HMP)	p. 31, 120– as found in HMP
Documentation of existing social, economic, natural, and other conditions present in the local government.	Section 3 – Regional Profile *Focuses primarily on physical landscape	Section 4 – Community Profile	Sections 1-3 (Population and Demographics, Economic, Natural Conditions)	Section I – Halifax and the Region, Section IV (subsections People and Neighborhoods, Economic Development, Natural Resources and Environment)	Section V – Comp Plan Elements (subsections 1, 3, 8)
Review of the vulnerabilities and stressors, both natural and social in the local government.	Section 5- Risk Assessment *Section 3 Regional Profile touches on this, but neither section includes any social vulnerabilities	Section 5- Hazard Identification and Risk Assessment (Subsection B)	p.3-14 *In HMP	N/A	p. 21 – as found in HMP

Plan/Ordinance Component	Southside Hazard Mitigation Plan (2020 Update)	West Piedmont Hazard Mitigation Plan (2021 Update)	City of Martinsville	Town of Halifax	Town of South Boston
Forward-looking goals, actionable strategies, and priorities through as seen through an equity-based lens.	Section 7 – Regional Mitigation Goals and Strategies, Section 8- Executive Summaries *There is no equity lens, but there are clear forward looking goals	Section 7 – Mitigation Strategy (particularly p. 215, 223, 236, 245)	Section 10 – Recommendations (not fully realized in Comp Plan, but in HMP)	Appendix p. 1-17 (equity lens not fully realized + very few flooding-related goals)	p. 31, 120– as found in HMP
Strategies that guides growth and development away from high-risk locations that may include strategies in comprehensive plans or other land use plans or ordinances or other studies, plans or strategies adopted by a local government.	p. 4-7, 4-45, 5-79, Section 6 Capability Assessment (Planning and Regulatory, begins p. 6-2)	p. 30-36, Section 6 – Capability Assessment (Subsection E3), p.57, 62-63	Section 9 (Smart Growth Subsection) (not fully realized)	p. 11 (goals for coordination for land use, though there is no flooding related hazards mentioned), Flood Plain Ordinance	p.65, Floodplain Ordinance

Plan/Ordinance Component	Southside Hazard Mitigation Plan (2020 Update)	West Piedmont Hazard Mitigation Plan (2021 Update)	City of Martinsville	Town of Halifax	Town of South Boston
Proposed acquisition of land or conservation easements or identification of areas suitable for conservation particularly areas identified as having high flood attenuation benefit by ConserveVirginia or similar data driven tools.	p.7-2-3, 9-1	p.64, 187-188, 199, 205, 209, 211, 221, 226-227, 237, 247-249, 264-265	p. ii, p.3-5-6 (not fully realized)	p.61-64, 97 (not fully realized), Flood Plain Ordinance	p. 83, 119
Identification of areas suitable for property buyouts in frequently flooded areas.		p. 62-65, 235 *Buyouts are not made explicit	N/A	N/A	p. 103
Identification of critical facilities and their vulnerability throughout the local government such as water and sewer or other types identified as “lifelines” by FEMA.	Section 5 – Risk Assessment (Community Assets and Critical Facilities)	Section 5- Hazard Identification and Risk Assessment (Subsection B)	Section 4 – Community Facilities, Services, Utilities (not fully realized, but in HMP)	p.81-84 (does not consider their vulnerabilities, but does identify critical facilities)	p. 31 – as seen in HMP

Plan/Ordinance Component	Southside Hazard Mitigation Plan (2020 Update)	West Piedmont Hazard Mitigation Plan (2021 Update)	City of Martinsville	Town of Halifax	Town of South Boston
Identified ecosystems/wetlands/floodplains suitable for permanent protection.	p.7-2, Section 7 – Regional Mitigation Goals and Strategies	p.241, 246, 268	Table 10 (pdf p. 223), p.4-23 (not fully realized)	p. 60, Appendix Implementation Matrix p.3	p.79
Identified incentives for restoring riparian and wetland vegetation.	There are incentives for floodplain development, but not restoration.	p. 217 (not fully realized)	N/A	N/A	p.123, 156 (not fully realized)
A framework for implementation, capacity building and community engagement.	Section 6- Capability Assessment	Section 3 – Planning Process (subsections A+B), Section 6- Capability Assessment, Section 8 - Plan Monitoring and Maintenance Procedures	Section 1- Introduction (not fully realized)	Section III – Comprehensive Planning Process and Section V – Plan Implementation	p.143-166, Floodplain Ordinance
Strategies for creating knowledgeable, inclusive community leaders and networks.	N/A	Section 8 - Plan Monitoring and Maintenance Procedures (Subsection C)	p.iv, 2-10 (not fully realized, contains more specific leadership roles)	p.107, Implementation Matrix (partners)	p.15, Plan implementation includes partners
A community dam safety inventory and risk assessment posed by the location and condition of dams.	Section 4- Hazard Identification	Section 5- Hazard Identification and Risk Assessment (particularly p. 167-171)	p. 3-8, 3-19, 4-8,	p.36-37, p. 73	p. 103- as seen in HMP

Plan/Ordinance Component	Southside Hazard Mitigation Plan (2020 Update)	West Piedmont Hazard Mitigation Plan (2021 Update)	City of Martinsville	Town of Halifax	Town of South Boston
A characterization of the community including population, economics, cultural and historic resources, dependence on the built environment and infrastructure and the risks posed to such infrastructure and characteristics by flooding from climate change, sea level rise, tidal events or storm surges or other weather.	Section 3- Regional Profile	Section 4- Community Profile	N/A *Addressed in HMP	N/A	p. 19, 120
Strategies to address other natural hazards that would cause, affect or result from flooding events	Section 4- Risk Assessment,	Section 5- Hazard Identification and Risk Assessment (particularly subsection B)	N/A	N/A, Floodplain Ordinance mentions this but does not provide strategies	

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APPENDIX A: METHODOLOGY – FLOOD HAZARD MAPPING AND ANALYSIS

Physically based flood models are typically used to assess flood hazard and risk. These models usually require a large set of data and need to be calibrated and validated. Additionally, these models are typically computationally expensive if they are to be developed and used for a large area. As an alternative to physically based models, GIS-based Analytical Hierarchy Process (AHP) method has been widely used over the past decade for disaster risk evaluation and management, particularly in flood hazard and risk assessment (Pourghasemi et al., 2012; Stefanidis and Stathis, 2013; Mukherjee and Singh, 2019; Chen et al., 2021; Hussain et al., 2021; Dung et al., 2022). AHP is a multi-criteria decision-making method that is primarily used for assessing and integrating the impacts of various factors (Saaty, 1980; 1990).

In this project, a GIS-based AHP method was used to derive estimate and map flood hazard in the Southside PDC region and City of Martinsville. To implement AHP in flood hazard mapping, it is critical to select the appropriate set of criteria (or factors) which contribute to flooding and their relative level of importance (Hussain et al., 2021). After conducting an extensive literature review, ten factors were selected to be included in the GIS-based AHP method for flood hazard mapping. These factors are listed in Table A-1.

Table A-1. Selected factors for the GIS-based AHP method

Factor	Symbol	Source
Elevation	ELE	30-meter resolution DEM (*USGS*)
Topographic Wetness Index	TWI	Developed from DEM
Stream Power Index	SPI	Developed from DEM
Vertical Distance to Drainage	HAND	Developed from DEM
Average Annual Precipitation	AAPrep	*PRISM-Historical Past* year 1991-2020
Maximum 5 Day Precipitation	M5DP	*NOAA Climate Data* Rain Gauge Records year 2000-2020
Drainage Density	DD	Developed from DEM
Land Use / Land Cover	LULC	*NLCD* 2019
Hydrologic Soil Type	Soil	Esri *USA Soils Maps Units*
Lithology	Litho	Esri *World Lithology*

We used the DEM data in ArcGIS Pro software to generate TWI, SPI, HAND, and DD maps. TWI and SPI were calculated using equations A-1 and A-2, respectively.

$$TWI = \ln(\frac{upstream\ draining\ area}{\tan(slope\ in\ radians)}) \quad \text{Equation A-1}$$

$$SPI = \ln(upstream\ draining\ area\text{area} * tan(slope\ in\ radians)) \quad \text{Equation A-2}$$

To generate M5DP map, daily precipitation records from rain gauges surrounding the City of Martinsville, the Town of Halifax, and the Town of South Boston with full coverage for at least 5 years in the period of 2000-2020 were downloaded. For each station, total precipitation was calculated for each consecutive five days, and a maximum 5-day precipitation value was selected for each year and averaged among years. The inverse distance weighted method was then used to generate a raster map of M5DP covering the entire study area.

Original values of each of the factors were first classified into five levels, with level 1 being the least hazardous, and 5 being the most hazardous. ELE, TWI, SPI, HAND, AAPrep, and DD are classified with natural break method in ArcGIS Pro analysis. It is noted that M5DP values have a very narrow range in the study area. Thus, z-score of M5DP within the two watersheds was calculated and classified with break points of -0.2, 0, 0.2, and 0.4 corresponding to levels 1 through 5. Factor levels of non-continuous factors including LULC, Soil Type, and Lithology are manually assigned according to their potential contribution to flood hazard as listed in Table A-2. The spatial distribution of these levels for all ten factors for the two HUC 10 watersheds are shown in Figure A-1 and Figure A-2, respectively.

Table A-2. Values and Assigned Levels for Non-Continuous Factors

Factor	Value	Level
LULC	deciduous forest, evergreen forest	1
	mixed forest, woody wetlands, emergent herbaceous wetlands, shrub, herbaceous,	2
	developed low intensity, developed open space, hay/pasture, barren land	3
	cultivated crops, developed medium intensity	4
	open water, developed high intensity	5
Soil Type	A	1
	B	2
	C	3
	B/D, C/D	4
	D	5

Factor	Value	Level
Lithology	unconsolidated sediment	1
	acid plutonic, basic plutonic	2
	carbonate sedimentary rock, acid volcanic	3
	metamorphic, mixed sedimentary rock	4
	siliciclastic sedimentary rock	5

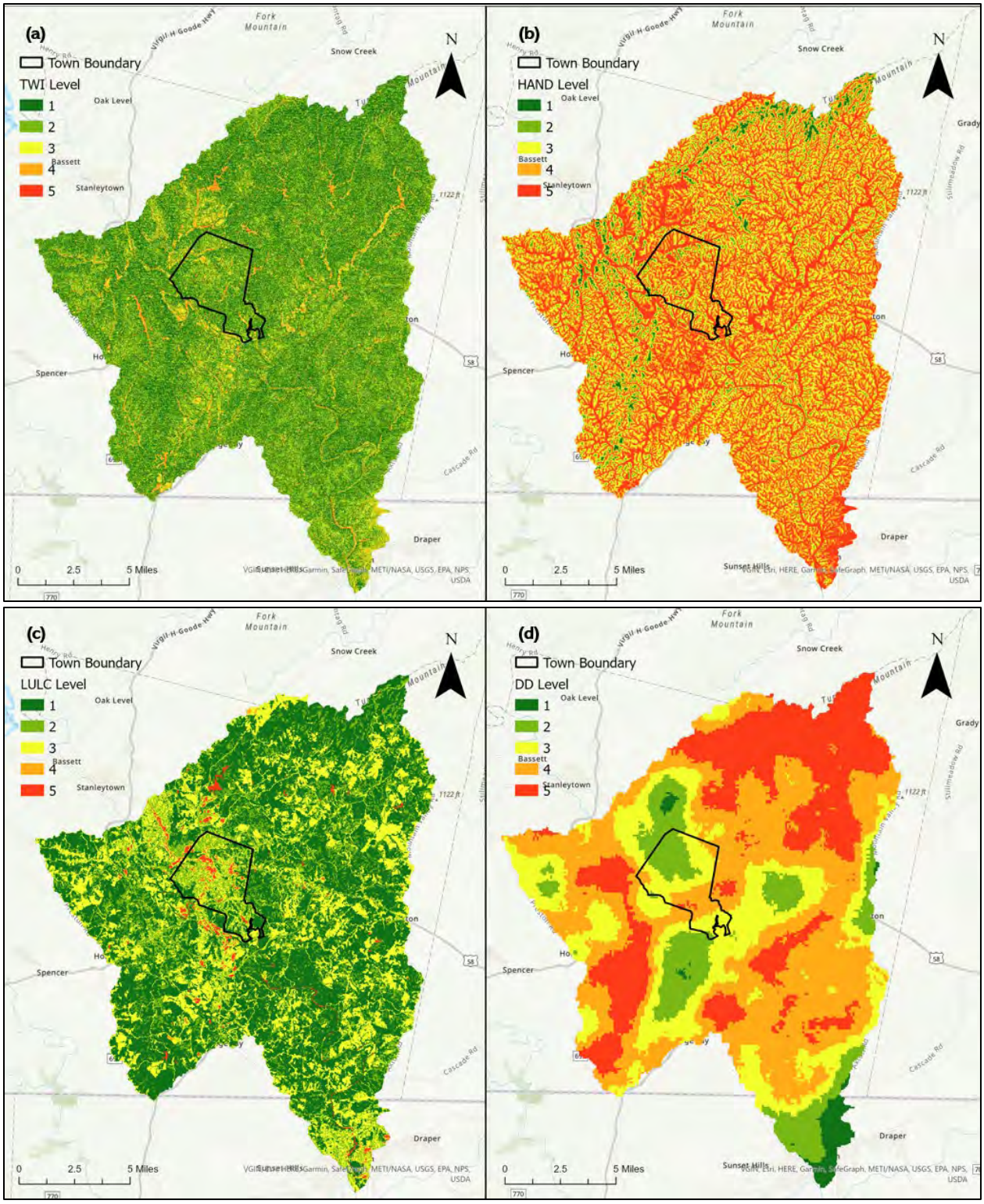


Figure A-1. Map of (a) Topographic Wetness Index (TWI), (b) Vertical Distance to Drainage (HAND), (c) Land Use/Land Cover (LULC), and (d) Drainage Density (DD) classified into five levels for the HUC 10 watershed incorporating the City of Martinsville.

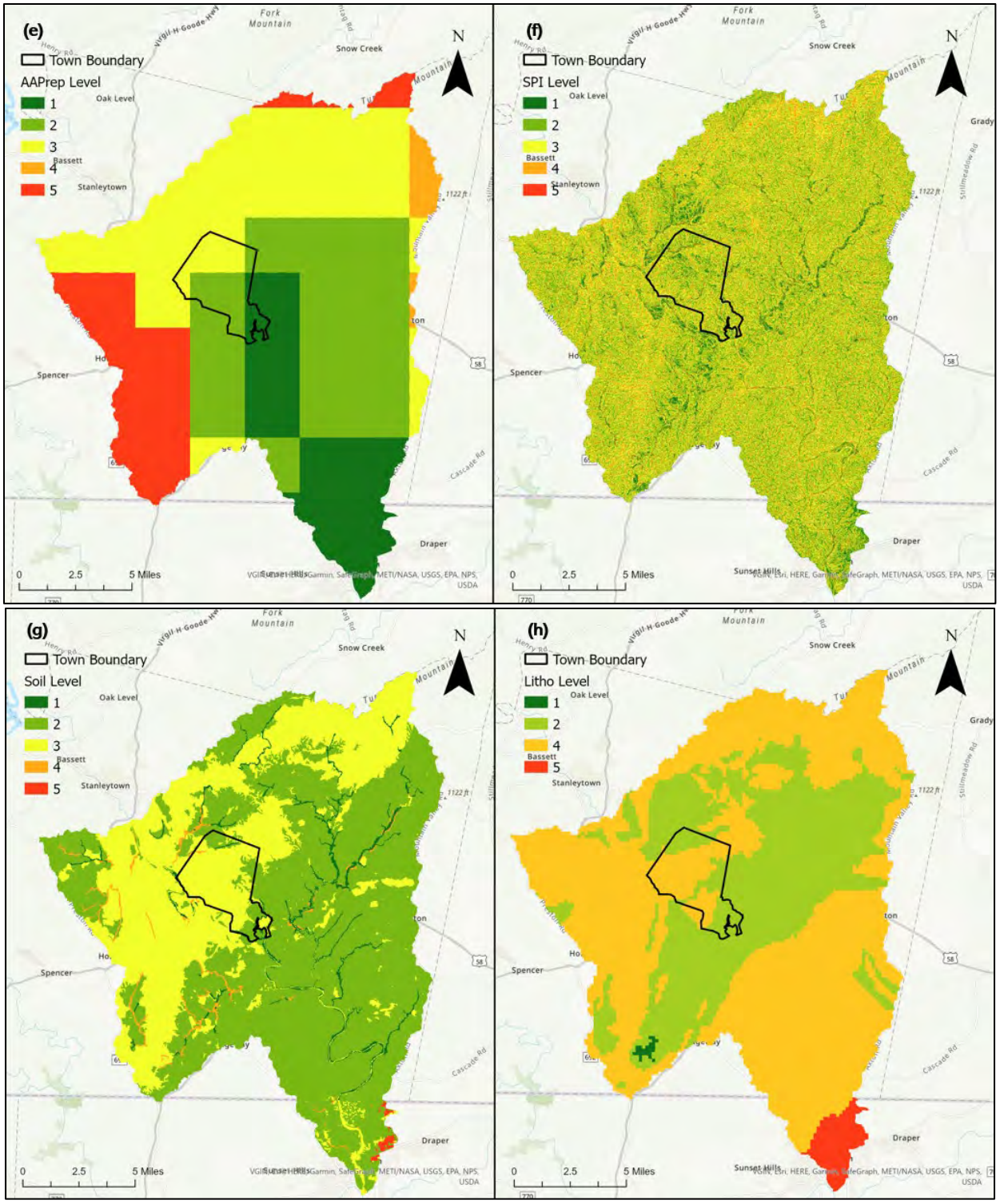


Figure A-1 (Continued). Map of (e) Average Annual Precipitation (AAPrep), (f) Stream Power Index (SPI), (g) Hydrologic Soil Type (Soil), and (h) Lithology (Litho) classified into five levels for the HUC 10 watershed incorporating the City of Martinsville.

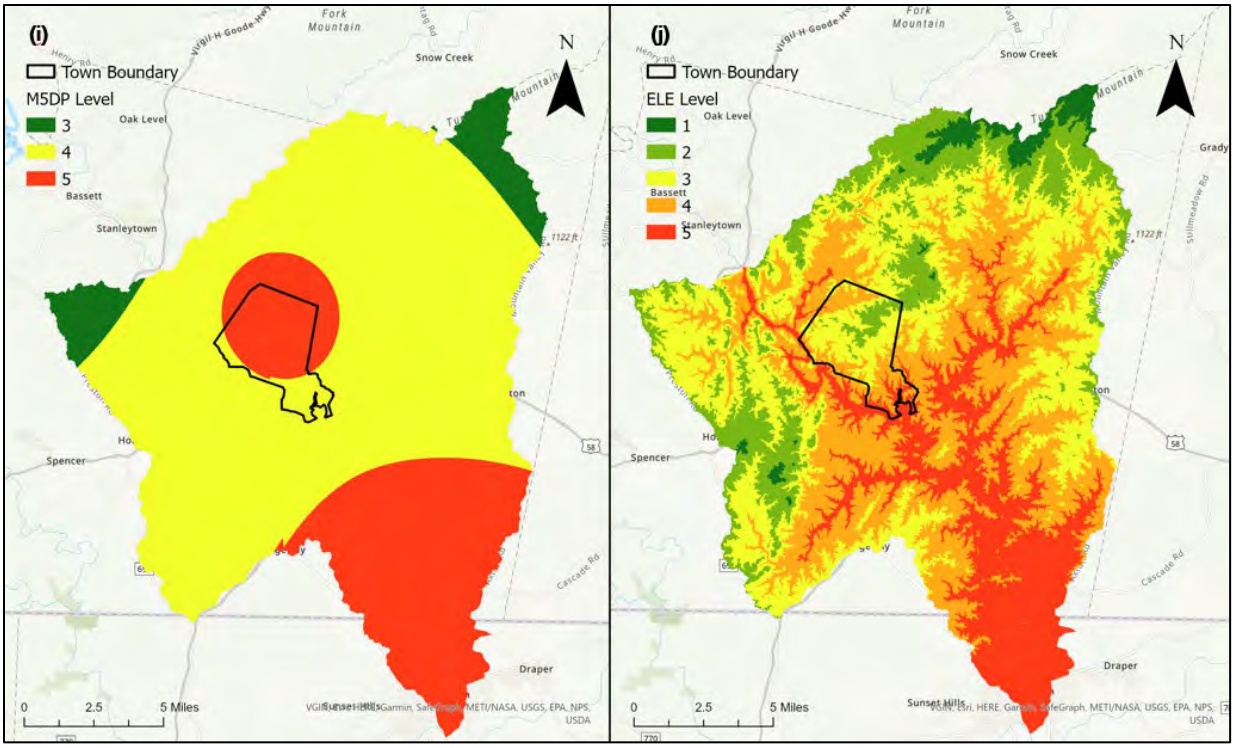


Figure A-1 (Continued). Map of i) Maximum 5-day Precipitation (M5DP) and (j) Elevation (ELE) classified into five levels for the HUC 10 watershed incorporating the City of Martinsville.

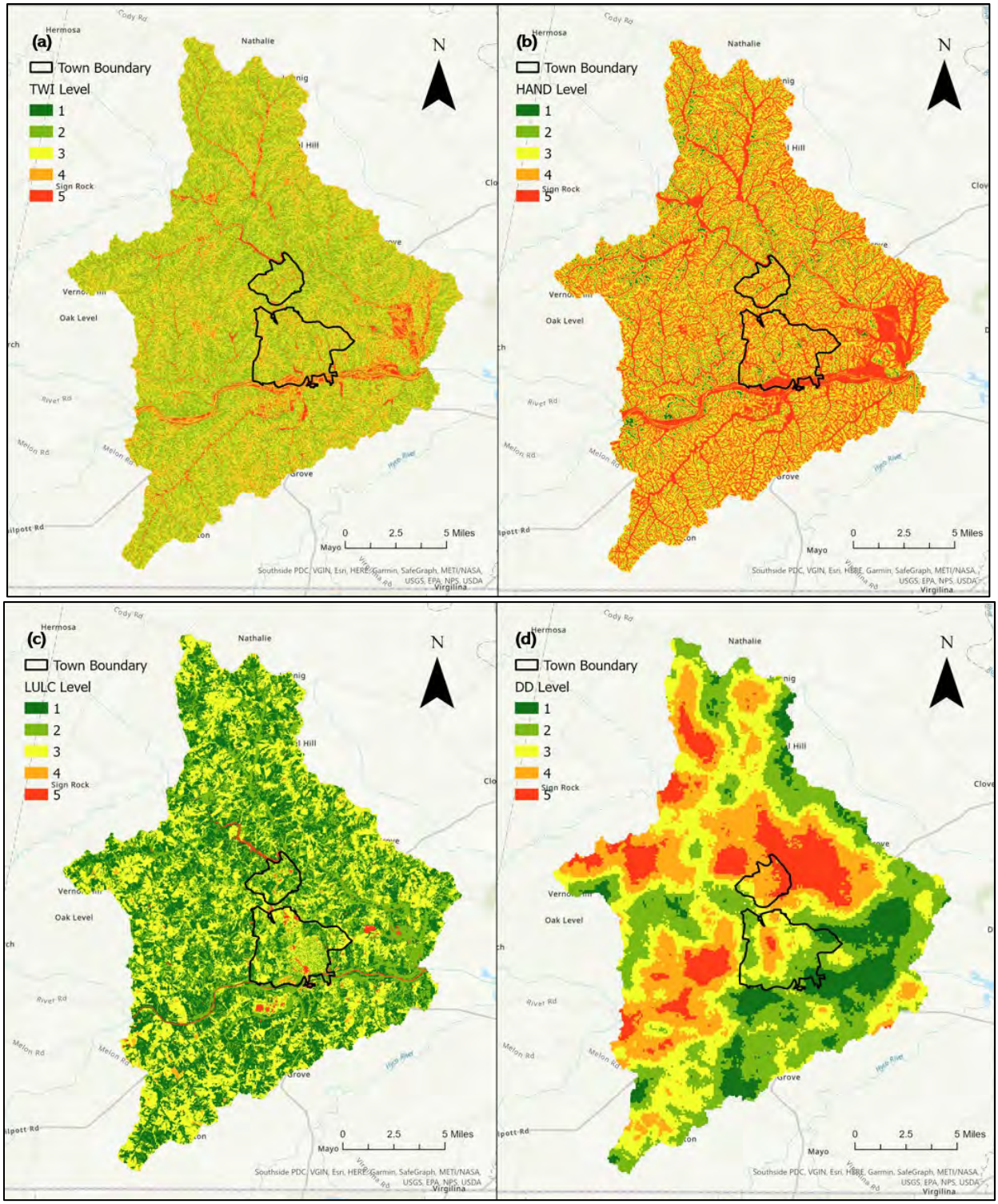


Figure A-2. Map of (a) Topographic Wetness Index (TWI), (b) Vertical Distance to Drainage (HAND), (c) Land Use/Land Cover (LULC), and (d) Drainage Density (DD) classified into five levels for the HUC 10 watershed incorporating the Towns of South Boston and Halifax.

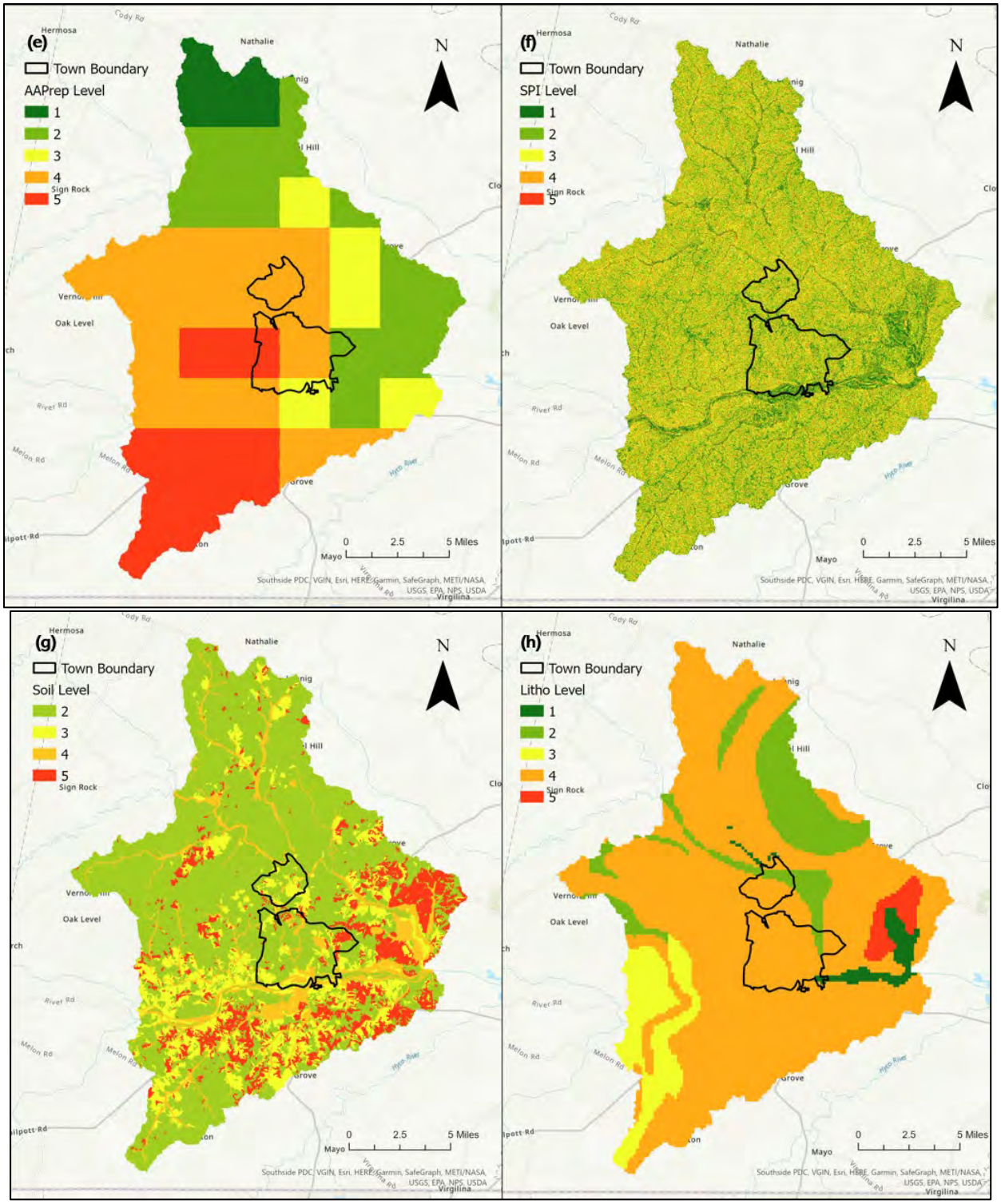


Figure A-2 (Continued). Map of (e) Average Annual Precipitation (AAPrep), (f) Stream Power Index (SPI), (g) Hydrologic Soil Type (Soil), and (h) Lithology (Litho) classified into five levels for the HUC 10 watershed incorporating the Towns of South Boston and Halifax.

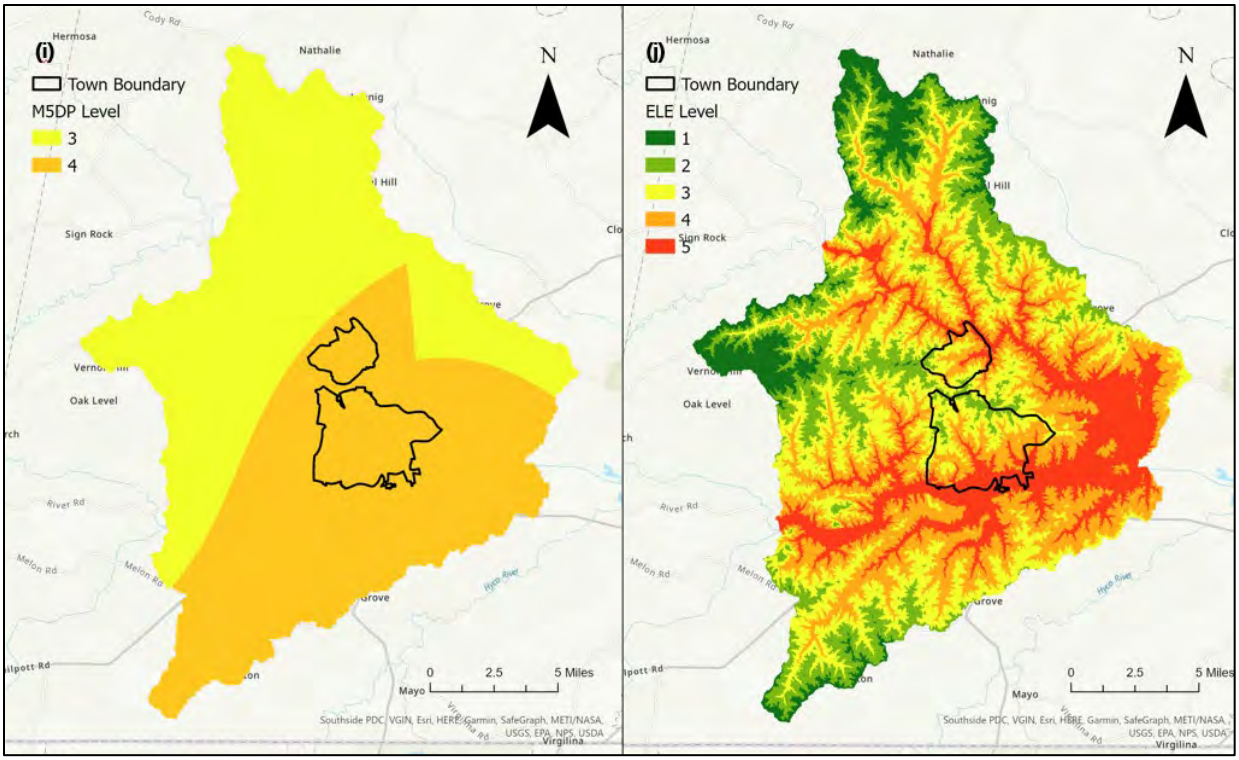


Figure A-2 (Continued). Map of i) Maximum 5-day Precipitation (M5DP) and (j) Elevation (ELE) classified into five levels for the HUC 10 watershed incorporating the Towns of South Boston and Halifax.

It is evident from Figure A-1(a) and (f) and Figure A-2 (a) and (f) that SPI and TWI levels are negatively correlated. According to Equations A-1 and A-2, it is expected that higher levels of TWI correspond to flatter locations and contribute more to fluvial flood hazard, whereas SPI has higher level at stepper locations, thereby contributing more to pluvial flood hazard. According to Figure Aa1, the southeast corner of the City of Martinsville has a high factor levels for ELE, but low factor levels for AAPrep, M5DP, and LULC. Distribution of levels of other factors in the City of Martinsville is generally even. The southern boundary of the Town of South Boston has the highest levels for ELE, TWI, HAND, and LULC, contributing to higher regular flood hazard level.

Once different levels (or scores) were assigned to each factor, a weighted average method is used to integrate all these factors into one composite value in each 10-meter by 10-meter grid cell. Therefore, identifying the weights is a critical step in the AHP method. In this project, the weights were identified based on extensive literature review, expert knowledge, and comparison of the outputs with historical flood events in the region. Additionally, because the factors that contribute to regular flooding and flash flooding are different, we developed and used two sets of weights as listed in Table A-3. The most important factors contributing to regular flood hazard are TWI, HAND, and AAPrep, which mainly describe inundation in floodplain because of standing water or increased river flow. For the flash flood hazard, highest weights are given to SPI and M5DP which influence the maximum volume flow velocity during a precipitation event.

For both regular and flash flood hazards, LULC is given a high weight, though the LULC weight for flash flood is higher (10.1% and 19.2%).

After the weighted average values were generated for both of types of floods at grid-cell level, they were standardized and then classified into five flood hazard levels of Very Low, Low, Moderate, High, and Very High using break points of -1.5, -0.5, 0.5 and 1.5.

Table A-3. Weights used for the eleven factors considered to determine flood hazard using the AHP method

Factor	Symbol	Weight for Regular Flood	Weight for Flash Flood
Elevation	ELE	10.7%	4.6%
Topographic Wetness Index	TWI	26.0%	7.9%
Stream Power Index	SPI	2.6%	19.0%
Vertical Distance to Drainage	HAND	19.3%	7.1%
Average Annual Precipitation	AAPrep	7.3%	5.4%
Maximum 5 Day Precipitation	M5DP	3.9%	15.9%
Drainage Density	DD	9.1%	6.6%
Land Use / Land Cover	LULC	10.1%	19.2%
Hydrologic Soil Type	Soil	5.5%	7.6%
Lithology	Litho	5.5%	6.7%

Figure A-3 and Figure A-4 show the results of flood hazard mapping at the grid-cell level for the two HUC 10 watersheds. These figures better illustrate the distribution of hazard levels in the entire analyzed region and show that the areas with high or very high regular flood hazard levels are generally along the rivers, while high or very high flash flood hazard levels are usually more concentrated in the developed areas in and surrounding the city and the two towns.

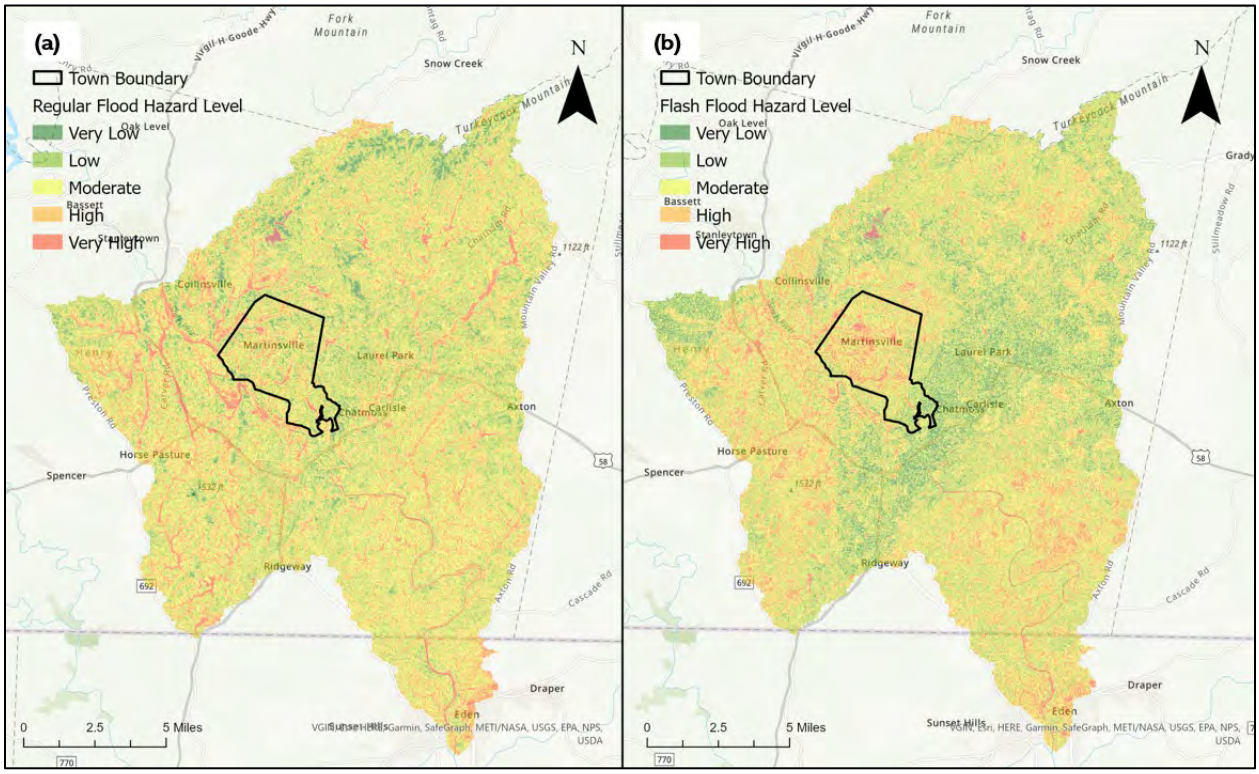


Figure A-3. Flood hazard mapping at grid cell level using AHP method for the HUC 10 watershed incorporating the City of Martinsville for (a) regular flood and (b) flash flood.

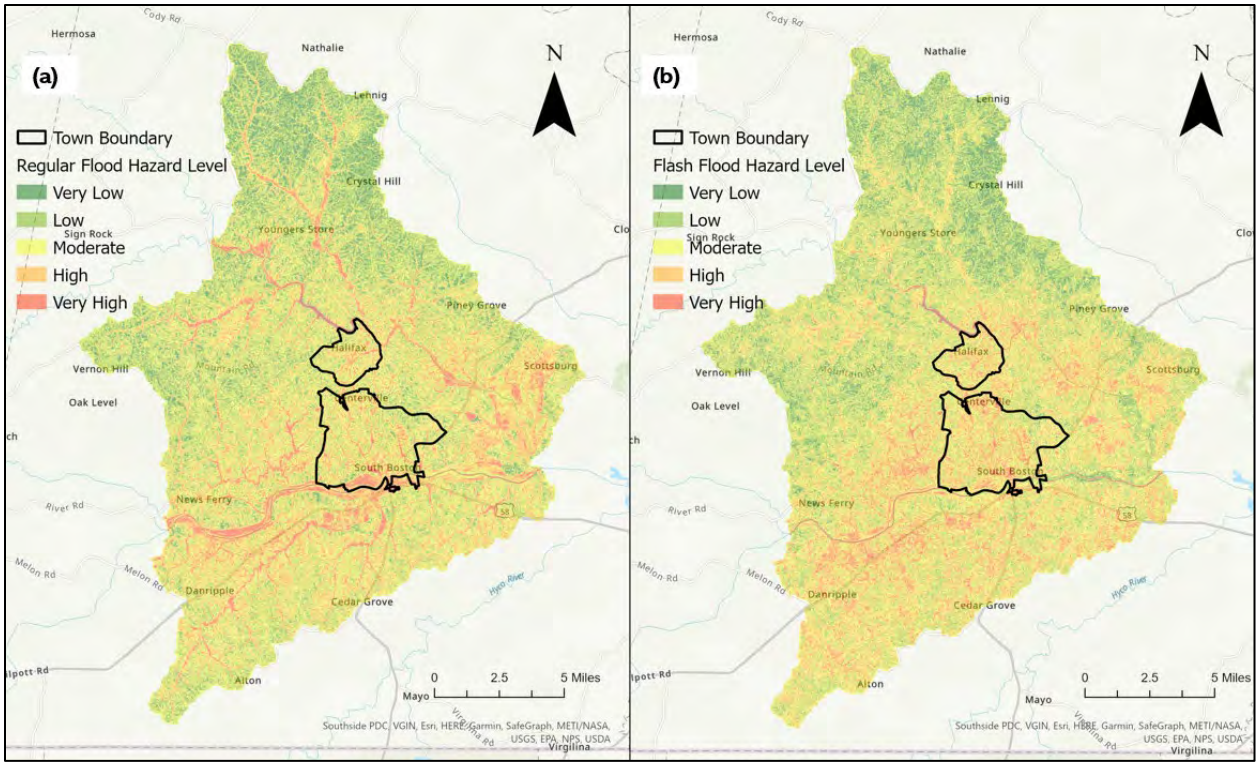


Figure A-4. Flood hazard mapping at grid cell level using AHP method for the HUC 10 watershed incorporating the Towns of South Boston and Halifax for (a) regular flood and (b) flash flood.

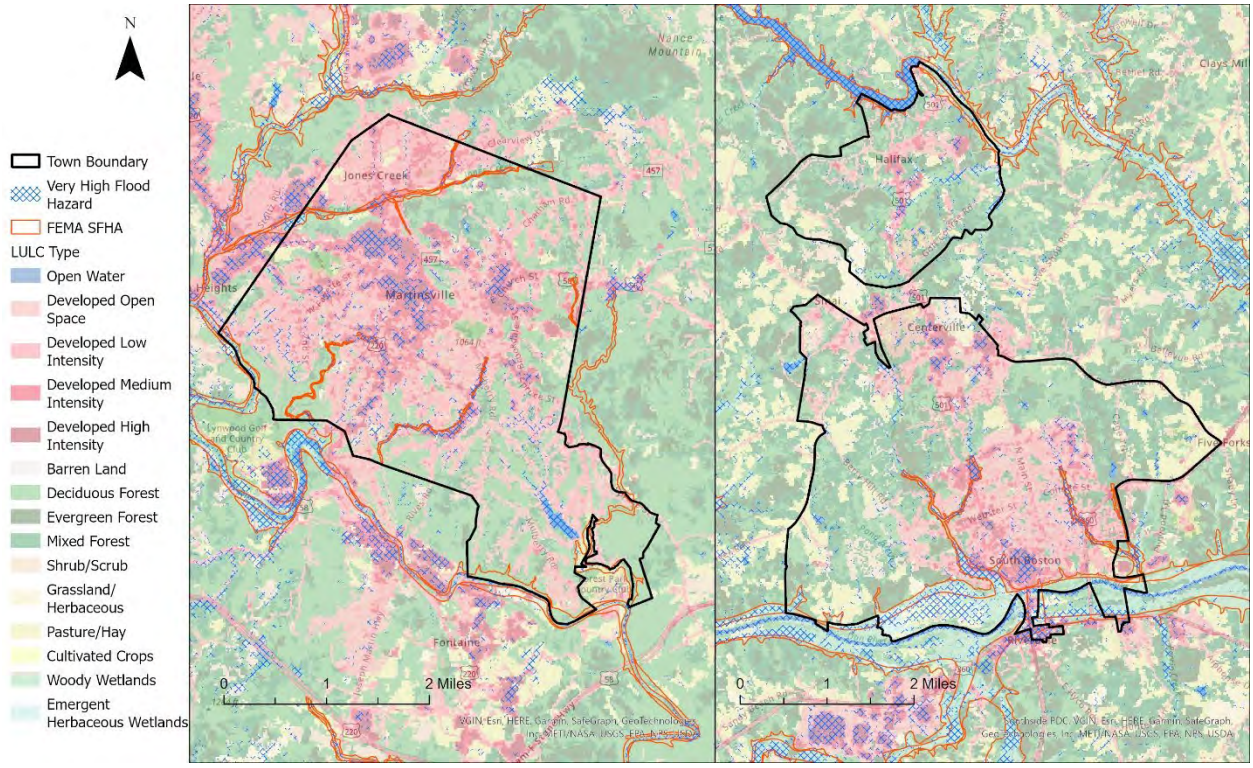


Figure A-5. Land use/land cover type, FEMA SFHA, and very high flood hazard level in the study area.

APPENDIX B: PLAN AND ORDINANCE SCORES

Each of the plans and ordinances identified were independently scored by two reviewers. The three possible scores for each plan or ordinance element are as follows:

0 means no evidence of the indicator,

1 means the indicator was suggested/inferred/identified but not in detail, and

2 means the indicator was more fully described.

Those individual scores and averaged scores are reported in the tables below and are intended to highlight aspects of the plans and ordinances that directly align with a set of indicators based on the criteria established by the Virginia Department of Conservation and Recreation for proposals requesting flood resilience funds (Virginia Community Flood Preparedness Fund Grant Program.

Table B-1: Plan scores.

	Reviewer 1	*Reviewer 2*	*Reviewer 1*	*Reviewer 2*	*Reviewer 1*	*Reviewer 2*	*Reviewer 1*	*Reviewer 2*	*Reviewer 1*	*Reviewer 2*
	Southside Hazard Mitigation Plan		**West Piedmont Hazard Mitigation Plan**		**City of Martinsville Comp Plan**		**Town of Halifax Comp Plan**		**Town of South Boston Comp Plan**	
Project-Based Relevancy										
Does the plan use factual and current evidence to explain why flooding is an important issue?	2	2	2	2	2	2	1	2	2	2
Does the plan offer a historical assessment of climatic impacts?	2	2	2	1	2	2	1	2	2	0
Have sources of flooding been identified and evaluated? Has this happened in the past five years?	1	2	1	1	0	1	1	1	0	1
Have assets and populations been identified that are vulnerable to flooding impacts?	2	2	2	1	0	1	0	1	1	0
Is there a completed or updated exposure and/or vulnerability assessment of localized flooding with mapping? Is there a completed or updated exposure and/or vulnerability assessment of localized flooding with mapping in the last 5 years?	1	2	2	1	1	2	1	2	0	1
Does the assessment identify impacts of climate change, such as changes in the frequency, severity, and extent of flooding risk?	0	0	1	0	1	1	0	0	1	0
Does this assessment include identified and mapped flooding for different annual probabilities?	1	2	1	1	1	2	0	1	0	1
	1.3	**1.7**	**1.6**	**1.0**	**1.0**	**1.6**	**0.6**	**1.3**	**0.9**	**0.7**
	1.5		**1.3**		**1.3**		**0.9**		**0.8**	

	Southside Hazard Mitigation Plan		West Piedmont Hazard Mitigation Plan		City of Martinsville Comp Plan		Town of Halifax Comp Plan		Town of South Boston Comp Plan	
Nature-Based Infrastructure										
Does the plan identify and map natural resources that are important for ecosystem health and are at risk of being lost due to flooding?	2	2	0	1	1	1	0	1	1	1
Is there evidence that steps to integrate natural resources into defenses against flooding/ flooding hazards through projects, programs, or policies have been taken?	2	2	2	2	0	0	1	1	1	1
Has the locality identified and planned for natural and nature-based features that are protective and can assist with resilience?	2	2	2	2	1	2	1	1	1	1
Does the plan educate or inform residents and property owners of the benefits that natural resource protections provide to communities that are at an increased risk of flooding?	1	2	1	2	0	1	1	1	0	1
Does the plan show evidence that there are incentives for adopting natural resource protection practices or implementing green infrastructure/NNBF?	2	2	0	1	1	2	0	1	0	1
	1.8	**2**	**1**	**1.6**	**0.6**	**1.2**	**0.6**	**1**	**0.6**	**1**
	1.9		**1.3**		**0.9**		**0.8**		**0.8**	

	Southside Hazard Mitigation Plan		West Piedmont Hazard Mitigation Plan		City of Martinsville Comp Plan		Town of Halifax Comp Plan		Town of South Boston Comp Plan	
Equity										
Is there evidence of public participation in the planning process?	2	2	2	2	2	1	2	2	0	1
Does the plan fully incorporate vulnerable community members into the planning process?	0	0	1	2	0	1	0	0	1	0
Were there adequate attempts of community engagement, particularly considering communication and accessibility?	1	2	2	2	1	1	1	1	2	2
Was a risk assessment of the socially vulnerable populations conducted?	0	1	1	1	0	1	0	0	0	0
Does the plan explicitly recognize past and existing inequities and present adaptation strategies as a way to address them?	0	1	0	1	0	0	0	0	1	0
Is there evidence that equity and the need to identify and support socially vulnerable populations is a priority for the locality/in the plan?	0	1	1	1	1	1	0	1	0	0
Does the plan have a process to review the equity impacts of hazard mitigation or resilience actions?	0	1	1	1	0	1	0	1	0	1
	0.4	**1.1**	**1.1**	**1.4**	**0.6**	**0.9**	**0.4**	**0.7**	**0.6**	**0.6**
	0.8		**1.3**		**0.7**		**0.6**		**0.6**	

	Southside Hazard Mitigation Plan		West Piedmont Hazard Mitigation Plan		City of Martinsville Comp Plan		Town of Halifax Comp Plan		Town of South Boston Comp Plan	
Cross-Jurisdiction Coordination										
Is there evidence of collaboration across scales (e.g. regional, local, state, etc.)?	1	2	2	1	1	1	0	2	2	2
Have leadership roles been established and trainings/education offered?	1	2	1	1	1	1	2	1	0	1
Has the locality shown evidence that it has reviewed (or has intention to review) its plans and ordinances to ensure that they are coordinated in addressing resilience?	1	2	1	1	2	1	1	1	0	0
	1	**2**	**1.5**	**1**	**1**	**1**	**1**	**1.5**	**1**	**1.5**
	1.5		**1.25**		**1**		**1.25**		**1.25**	
Planned Timeline										
Is the plan's implementation affordable and realistic for the present day?	2	2	1	2	1	2	1	2	1	1
Is there a set time frame for reevaluation?	1	1	1	1	1	2	0	1	0	1
	1.5	**1.5**	**1**	**1.5**	**1**	**2**	**0.5**	**1.5**	**0.5**	**1**
	1.5		**1.25**		**1.5**		**1**		**0.75**	

	Southside Hazard Mitigation Plan		West Piedmont Hazard Mitigation Plan		City of Martinsville Comp Plan		Town of Halifax Comp Plan		Town of South Boston Comp Plan	
Best Available Science										
Is the locality aware of any recurrent flooding outside of the SFHA and is it being addressed in a plan?	0	2	1	2	1	1	0	1	0	1
Does the locality incorporate data, scientific analyses, and approaches to resilience developed into floodplain, zoning, or subdivision ordinances or a comprehensive plan?	2	2	2	2	1	1	1	1	1	1
Is the plan online and easy to locate?	2	2	2	2	1	2	2	2	2	2
	1.3	**2.0**	**1.7**	**2.0**	**1.0**	**1.3**	**1.0**	**1.3**	**1.0**	**1.3**
	1.7		**1.8**		**1.2**		**1.2**		**1.2**	
Adaptive Management										
Does the wording of policies seem to hold space for unexpected situations?	0	1	1	1	1	1	1	1	1	0
Does the plan list ongoing or points of reevaluation recommendations?	1	1	1	1	1	1	0	0	0	0
Are there firm metrics to gauge the plan's success or failure?	1	1	1	0	0	0	1	2	0	0
Are there methods for monitoring whether the plan or the planning interventions are having intended effect?	2	2	2	2	2	1	1	1	1	1
Is there evidence of adaptive capacity for data analysis and best practice research?	2	1	2	1	2	1	1	1	2	1
	1.2	**1.2**	**1.4**	**1.3**	**1.2**	**0.8**	**0.8**	**1.0**	**0.8**	**0.4**
	1.2		**1.4**		**1.0**		**0.9**		**0.6**	

	Southside Hazard Mitigation Plan		West Piedmont Hazard Mitigation Plan		City of Martinsville Comp Plan		Town of Halifax Comp Plan		Town of South Boston Comp Plan	
Emergency Readiness										
Does the plan show evidence of Emergency Operations and readiness, including internal emergency management roles?	1	2	2	2	1	2	1	1	1	1
Does the plan show evidence to support residents' emergency preparedness such as providing information about risks and recommended preparedness actions?	1	2	2	1	1	1	0	2	1	1
Does the plan indicate that the locality has a means of communicating emergency response plans to the public during a hazard event?	1	2	2	1	0	1	0	2	0	1
Has critical infrastructure for emergency services been identified and assessed for vulnerability?	2	2	0	1	0	1	0	1	1	1
Does the plan address access to the following during and after emergencies and storms: food/water, medical, health, transportation, shelter?	2	2	1	1	1	2	0	1	0	1
	1.4	**2.0**	**1.4**	**0.6**	**0.6**	**1.4**	**0.2**	**1.4**	**0.6**	**1.0**
	1.7		**1.0**		**1.0**		**0.8**		**0.8**	

	Southside Hazard Mitigation Plan		West Piedmont Hazard Mitigation Plan		City of Martinsville Comp Plan		Town of Halifax Comp Plan		Town of South Boston Comp Plan	
Economic Impact										
Does the plan indicate that the budget has allocated funds for addressing flooding hazards, protection, and mitigation?	1	2	1	1	1	1	0	1	1	0
Does the plan address the economic base of the locality when discussing climate changes or emergencies?	1	2	1	1	0	1	0	1	1	1
Have local business and economic vulnerabilities been identified?	1	2	1	1	1	1	0	1	0	0
Have the potential economic impact from hazards and sources of funding for mitigation projects been identified?	2	1	2	1	1	1	0	1	0	1
Does the plan address a property buyout program to voluntarily (proactively) acquire properties located in the floodplain?	1	1	0	0	0	1	0	1	1	1
	1.2	**1.6**	**1.0**	**0.8**	**0.6**	**1.0**	**0.0**	**1.0**	**0.6**	**0.6**
	1.4		**0.6**		**0.8**		**0.5**		**0.6**	

Table B-2: Ordinance scores.

	Reviewer 1	*Reviewer 2*	*Reviewer 1*	*Reviewer 2*	*Reviewer 1*	*Reviewer 2*
	City of Martinsville		**Town of Halifax**		**Town of South Boston**	
Is there a **ZONING** ordinance?						
Is there a floodplain district designation as part of the zoning ordinance or as part of a separate floodplain ordinance?	1	1	2	2	2	2
Are homes, permanent structures, and critical infrastructure **prohibited** in the floodplain district?	0	0	2	1	2	1
Are homes, permanent structures, and critical infrastructure limited or **subject to restrictions** in the floodplain district?	1	1	2	2	2	2
Does the ordinance establish setbacks and/or buffers that protect flood-prone areas outside of the FEMA-designated Special Flood Hazard Area?	0	0	0	1	0	1
Does the ordinance place limits on how much of a lot or land parcel may be covered by impervious surfaces?	0	0	1	2	1	1
	0.4	**0.4**	**1.4**	**1.6**	**1.4**	**1.4**
	0.4		**1.5**		**1.4**	
Is there a **SUBDIVISION** ordinance?						
Does the subdivision ordinance refer to flood risk or flood mitigation?	2	2	2	2	1	1
Does the subdivision ordinance contain specific requirements intended to reduce or eliminate flood risk when a proposed subdivision is designed and platted (e.g., street design to avoid flooding)?	2	2	1	1	1	1
Does the subdivision ordinance encourage the use of green infrastructure and/or NNBF in new developments?	0	0	1	1	0	1
Does the subdivision ordinance refer to other relevant ordinances or policies (e.g., zoning or floodplain ordinances)?	2	2	2	2	1	1
	1.5	**1.5**	**1.5**	**1.5**	**0.8**	**1.0**
	1.5		**1.5**		**0.9**	

Is there an **EROSION AND SEDIMENT CONTROL** ordinance?						
Does the ordinance contain requirements related to changes (i.e., pe-development and post-development) in peak runoff rates after the proposed project is completed (e.g., estimated change in stormwater runoff)?	0	1	N/A	N/A	N/A	N/A
Does the ordinance contain requirements related to the preservation or restoration of wetlands?	2	2	N/A	N/A	N/A	N/A
Are there requirements for the creation and maintenance of stormwater management facilities or stormwater control devices as part of the site plan?	1	2	N/A	N/A	N/A	N/A
Does the erosion and sediment control ordinance refer to other relevant ordinances or policies (e.g., zoning or floodplain ordinances)?	2	1	N/A	N/A	N/A	N/A
	1.3	**1.5**	**N/A**	**N/A**	**N/A**	**N/A**
	1.4		**N/A**		**N/A**	

Although the Town of South Boston references an Erosion and Sediment Control Ordinance on its website, it is not available as part of the locality's official code of regulations and was therefore not scored.

APPENDIX C: BASELINE ASSESSMENT TEMPLATE

Table C-1: Baseline assessment template for use by individual Southern Virginia localities.

Plan/Ordinance Component	Local Comprehensive Plan	Local Code of Ordinances	Regional Hazard Mitigation Plan
It is project-based with projects focused on flood control and resilience. It identifies and includes all flooding occurring in all flood zones, and the number of repetitive loss and severe repetitive loss properties.	[insert document, page]	[insert article, section]	[insert document, page]
It incorporates nature-based infrastructure to the maximum extent possible.			
It includes considerations of all parts of a local government regardless of socioeconomics or race. It is equity focused and prioritizes vulnerable populations subjected to flooding, not just populations vulnerable to flooding.			
It includes coordination with other local and inter-jurisdictional projects, plans, and activities and has a clearly articulated timeline or phasing for plan implementation.			
It is based on the best available science, and incorporates climate change, sea level rise, and storm surge (where appropriate), and current flood maps.			
Equity based strategic polices for local government-wide flood protection and prevention.			
Documentation of existing social, economic, natural, and other conditions present in the local government.			
Review of the vulnerabilities and stressors, both natural and social in the local government.			
Forward-looking goals, actionable strategies, and priorities through as seen through an equity-based lens.			

Plan/Ordinance Component	Local Comprehensive Plan	Local Code of Ordinances	Regional Hazard Mitigation Plan
Strategies that guides growth and development away from high-risk locations that may include strategies in comprehensive plans or other land use plans or ordinances or other studies, plans or strategies adopted by a local government.	[insert document, page]	[insert article, section]	[insert document, page]
Identification of areas suitable for property buyouts in frequently flooded areas.			
Identification of critical facilities and their vulnerability throughout the local government such as water and sewer or other types identified as “lifelines” by FEMA.			
Identified ecosystems/wetlands/floodplains suitable for permanent protection.			
Identified incentives for restoring riparian and wetland vegetation.			
A framework for implementation, capacity building and community engagement.			
A community dam safety inventory and risk assessment posed by the location and condition of dams.			
A characterization of the community including population, economics, cultural and historic resources, dependence on the built environment and infrastructure and the risks posed to such infrastructure and characteristics by flooding from climate change, sea level rise, tidal events or storm surges or other weather.			
Strategies to address other natural hazards that would cause, affect or result from flooding events.			

APPENDIX D: SOCIAL VULNERABILITY ASSESSMENT

"Social Vulnerability refers to the characteristics of an individual or group that influences their capacity to anticipate, cope with, resist and recover from a physical hazard" (Blaikie et al., 1994; Stafford and Abramowitz, 2017). Socially vulnerable groups are usually less resilient to natural hazards, including flooding (Tate et al., 2021; Sanders et al., 2022). Understanding of social vulnerabilities, therefore, is critical for governments at different levels to target preparedness, response, and recovery resources in a way that foster socially just flood management strategies (Stafford and Abramowitz, 2017; Chakraborty et al., 2022). While measuring social vulnerability is challenging, the Social Vulnerability Index (SoVI), proposed by Cutter et al. (2003), is one of the most commonly used approaches to quantify social vulnerability. The methodology used in SoVI is principal component analysis (PCA), a statistical technique used for reducing the dimensionality of large datasets, increasing interpretability but at the same time minimizing information loss (Jolliffe and Cadmia, 2016).

Developed by researcher at the Virginia Institute of Marine Science's Center for Coastal Resources Management and the College of William & Mary, Virginia Vulnerability Viewer (*http://cmap2.vims.edu/SocialVulnerability/SocioVul_SS.html*) is one of the main sources of information on social vulnerability in Virginia. The Virginia Vulnerability Viewer includes multiple indices, including the SoVI. The Virginia Vulnerability Viewer's SoVI is commonly used across state agencies for different purposes, including grant applications, such as the DCR's Community Flood Preparedness Fund program According to the "Methods" document available on Virginia Vulnerability Viewer, SoVI was generated 1) at the census tract level, a resolution that may not be fine enough for smaller-scale projects and studies, and 2) using the data from 2010 Census or American Community Survey (ACS), which is obviously outdated. Stafford and Vander Schaaf (2021) generated SoVI using data from the 2015-2019 American Community Survey at census block group level but only for Coastal Virginia.

In this project, an updated version of SoVI was generated for the entire Virginia following the same methodology used in the Virginia Vulnerability Viewer but using 2020 data at census block group level. Table D-1 lists the factors and data sources used in generating SoVI.

Table D-1. Factors and data sources used for SoVI

Factor	Meaning	Data Source
Income	Per capita income in the past 12 months	ACSDT5Y2020.B19301
Black	Percent of population that is Black or African American	ACSDT5Y2020.B02001
Hispanic	Percent of population that is Hispanic	ACSDT5Y2020.B03002
Native	Percent of population that is native American	ACSDT5Y2020.B02001
Over65	Percent of population that is over 65 years of age	ACSDT5Y2020.B01001
Unemployed	Percent of civilian labor force 16 and over that is unemployed	ACSDT5Y2020.B23022
Poverty	Percent of population for whom poverty status is established that is living in poverty	ACSDT5Y2020.B17021
No High School	Percent of population 25 and older with no high school degree or equivalent	ACSDT5Y2020.B15003
Nursing Homes	Percent of population in nursing homes	DECENNIALPL2020.P5
Female Labor Force	Percent of females 16 and over in civilian labor force	ACSDT5Y2020.B23022
Female Households	Percent of households with female head, no spouse	ACSDT5Y2020.B09019
Social Security	Percent of households with social security income	ACSDT5Y2020.B19055

Before conducting the principal component analysis (PCA), all of the variables listed above were standardized to z-scores with zero means and unit variance. After conducting the PCA, all principal components with eigenvalues greater than or equal to 1.0 were selected. The percentages of variance explained by each selected principal components were used as weights. We then conducted Varimax rotation to decide the direction of each selected principal component. For each census block group, matrix multiplication is applied to the z-score values of all factors and the eigenvector of each of the selected principal components. The results are then multiplied with weights and direction signs, and then added up to form the SoVI Index

value. Z-score of the SoVI Index value is calculated, and the SoVI Class is classified with the same threshold used by Virginia Vulnerability Viewer, as shown in Table D-2.

Table D-2. Factors and data sources used for SoVI

Z score of SoVI Index	SoVI Class
$< -\mathbf{1.0}$	Very Low
$[-\mathbf{1.0}, \mathbf{0.0})$	Low
$[\mathbf{0.0}, \mathbf{1.0})$	Moderate
$[\mathbf{1.0}, \mathbf{1.5})$	High
$\geq \mathbf{1.5}$	Very High

Figure D-1 shows the SoVI at census block group level in Virginia. Based on SoVI, the social vulnerability in most census block groups in northern and southeast Virginia are at very low or low level. On the other hand, the majority of census block groups in southwest and southern Virginia are between moderate to very high levels.

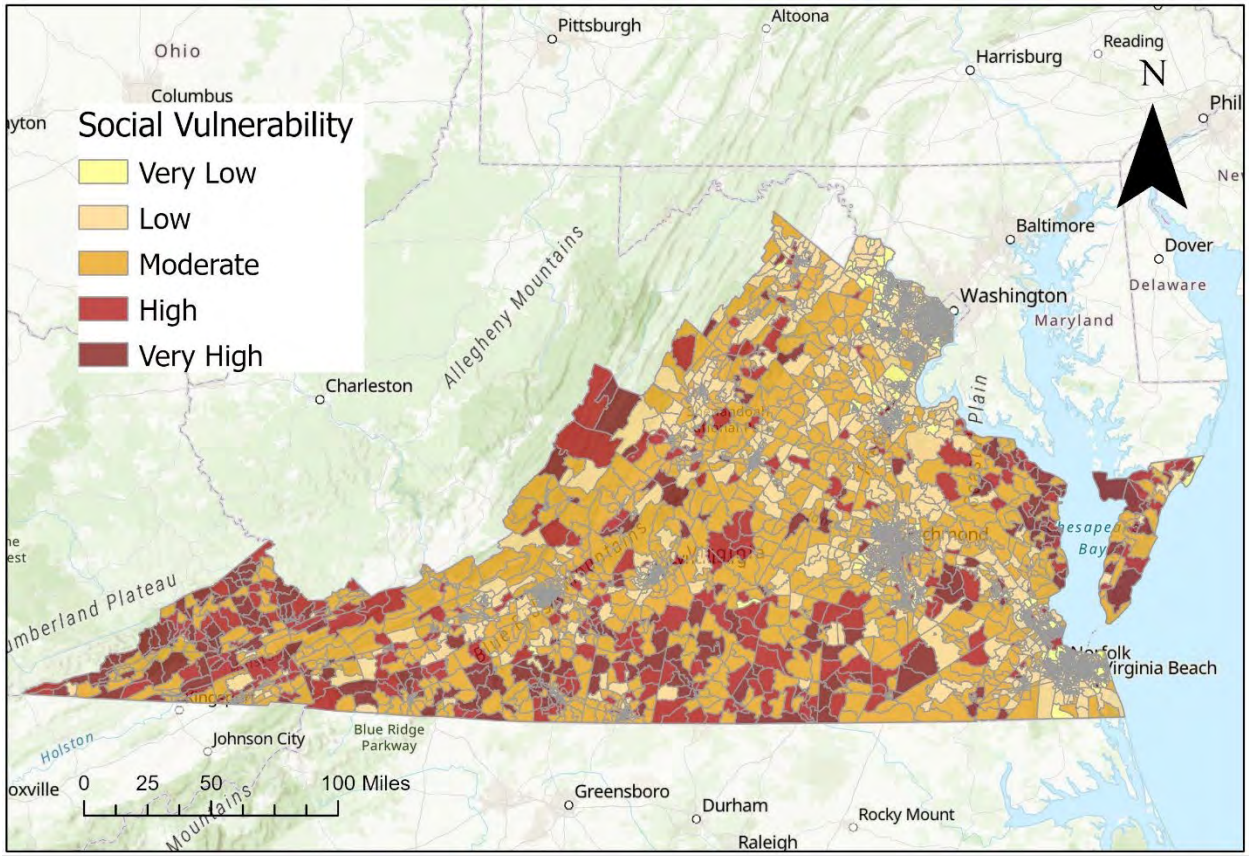


Figure D-1. SoVI at census block group level for Virginia

Figure D-2 shows the SoVI generated at the census block group level in this project. For comparison purposes, Figure D-3 shows the census tract level SoVI adopted from the Virginia Vulnerability Viewer. Note that the latter uses data from 2010. According to Figure D-2a, based on the 2020 data, the City of Martinsville is mostly at moderate social vulnerability level (8 block groups out of 15) with the remainder of the city at high (5 block groups) and very high (2 block groups) levels. Comparing this result with the Virginia Vulnerability Viewer's SoVI (Figure D-3a), we find an increased level of SoVI in the southern half of the city between 2010 and 2020. Figure D-2b shows that most areas in the Towns of Halifax and South Boston are located in block groups with high or very high SoVI. Additionally, comparing the result with the Virginia Vulnerability Viewer's SoVI (Figure D-3b) shows that the SoVI levels in these two towns have not changed much between 2010 and 2020.

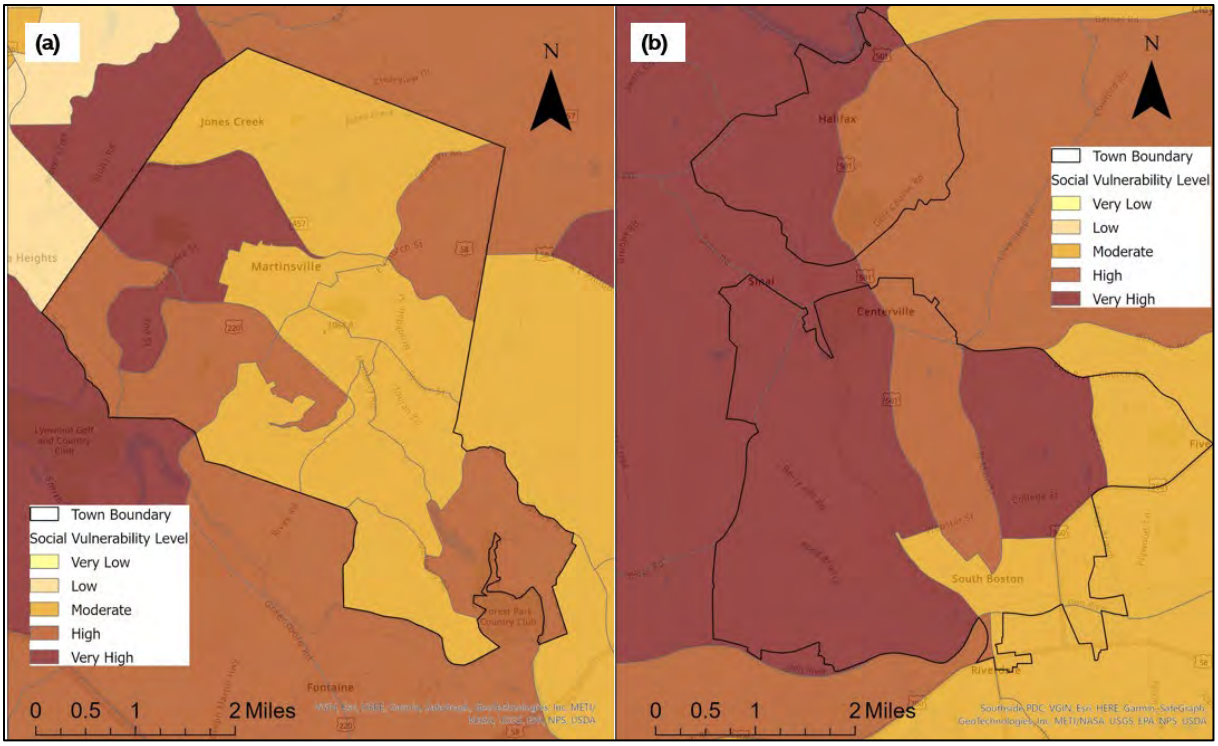


Figure D-2. Census block group-level SoVI for (a) the City of Martinsville and (b) the Towns of Halifax and South Boston.

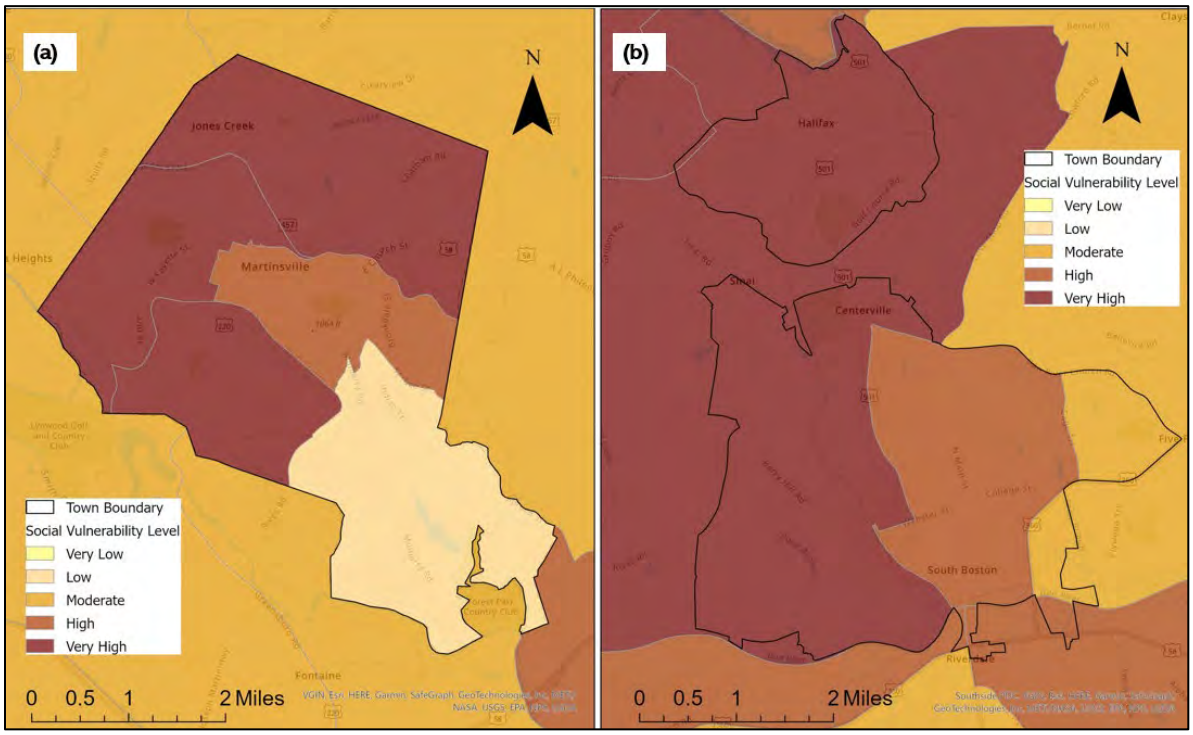


Figure D-3. SoVI for (a) the City of Martinsville and (b) the Towns of Halifax and South Boston adopted from the Virginia Vulnerability Viewer

APPENDIX E: SUMMARY OF ONLINE SURVEY RESPONSES

Local Government Staff and Elected Officials Survey

With the help of the Southside Planning District Commission we conducted an online survey of elected officials and local government staff in August 2022. The survey was designed and administered under Protocol Number 5031 approved by the University of Virginia's Institutional Review Board. The survey focused on questions like:

- How concerned are people about flooding?
- How is flood preparedness and planning work being done right now?
- What kinds of information are being used, what information would be most helpful?
- What are some of the challenges that you face in addressing flooding in the work that you do?

Of the 11 invitations extended, three responses were received (27% response rate) with the respondents identifying their primary role as "Elected Official", "Local Government Administrator" and "Planner or Development Management" working primarily in the Town of South Boston (1) and with the Southside Planning District Commission (2).

When asked "How concerned are you about flooding?" two of the three respondents indicated that they were "Somewhat concerned" while the other respondent was "Very concerned". In terms of specific factors contributing to flooding, "Inadequate stormwater infrastructure" and "changing rainfall patterns" were identified as most important by respondents.

In terms of the most significant impacts of flooding, respondents were most concerned with the "Economic impacts" of flooding, followed by the "Public health impacts" of flooding such as businesses needing to shut down temporarily, contamination being spread by floodwaters, or supporting mosquitoes' reproduction for example.

Zoning regulations, hazard mitigation plans, and comprehensive plans were the most frequently noted places where flooding is addressed, followed by building codes and emergency response plans. Survey respondents most often suggested that localities and the state should be primarily responsible for flood planning.

The survey asked which sources of flood risk information are being used (Figure E-1) and all respondents indicated that FEMA floodplain data and flood risk layers are in use and these remain the primary source of flood risk information. Other important sources of flood risk information currently being used include "Historical flood loss or flood insurance claims data", "Hydrologic or hydraulic model results", and "Real-time stream gauges or sensors" but it should

be noted that downscaled climate model projections and indicators of social vulnerability may be areas for expanding this information base. When asked what flood risk information would be most useful, respondents said more accurate flood maps, predictive models that can forecast flash flood impacts, and early warning systems would add the greatest value.

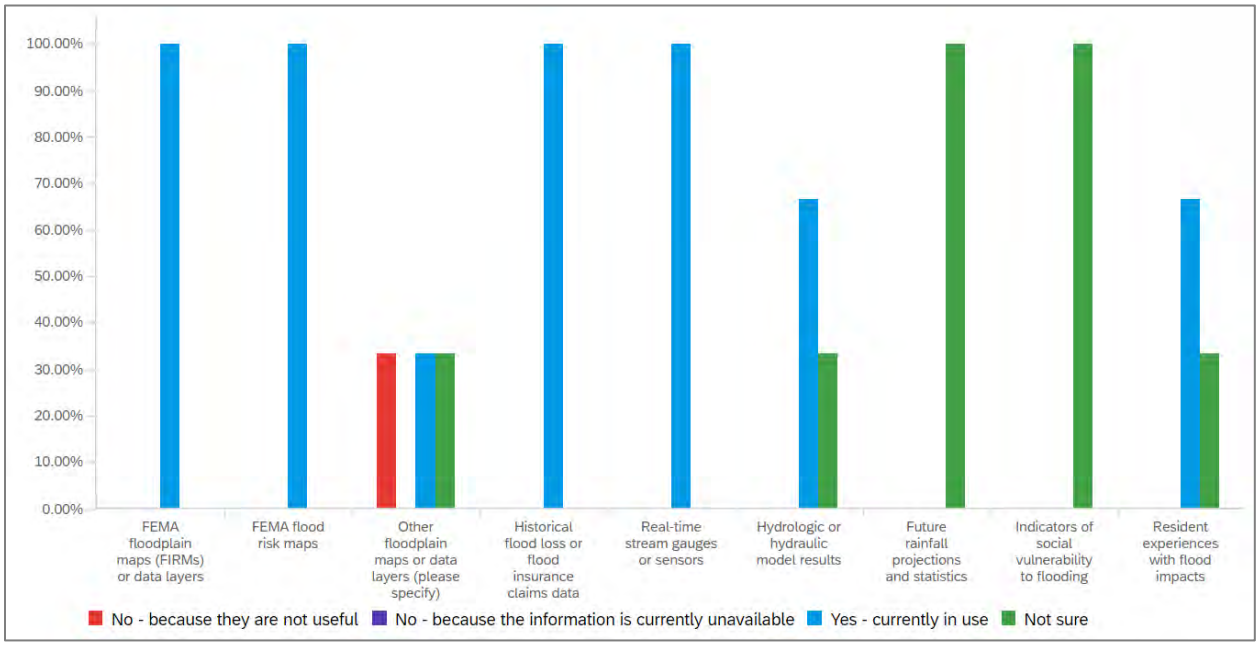


Figure E-1: Local government staff and elected officials survey responses—sources of flood risk information in use.

When asked which flood mitigation strategies they believed were most effective, survey respondents rated acquiring flood-prone properties, modifying zoning and building codes, and developing flood warning systems as "Very effective". Notably, "Upgrading stormwater infrastructure" was rated by all respondents as mostly effective while "Constructing floodwalls and levees" and "Collecting information from residents on how flooding has affected them" registered the highest levels of uncertainty. These may be additional areas for training and raising awareness in the future to enhance flood resilience planning in the region. Respondents identified funding and limitations of currently available data as the as the most significant barriers to flood resilience.

Two of three respondents indicated that their Flood Risk Insurance Map (FIRM) has not been updated within the past five years. In theory, FIRM maps are updated at least every five years (by FEMA) to reflect the latest topographic information, improved hydrological modeling and changes to the resultant floodplains and hazard areas. Two of three respondents indicated that their community participates in the National Flood Insurance Program (NFIP) and two of three respondents indicated that their community does not participate in the Community Rating System (CRS). One of the three respondents indicated that they do not know what the CRS

program is, which suggests that there is an opportunity to raise awareness of these federal flood management programs and to leverage federal funding resources through the NFIP.

In terms of stakeholders who should be involved in flood resilience planning, in each sector individuals and organizations with the most regulatory responsibilities (e.g., zoning administrators), the greatest financial exposure (e.g., banks and lenders), and a combination of social connections and resources (e.g., agricultural organizations like the Farm Bureau) emerged as the most important constituencies. Private contractors who repair buildings and roads following a flood event were identified as additional stakeholders who should be included but were not represented in the preceding questions.

Residents Survey

This portion of the report summarizes responses to the survey provided by residents of the City of Martinsville and localities served by the Southside Planning District Commission (PDC). A total of 2,730 survey invitations were mailed to residents of Crystal Hill, Halifax County, Town of Halifax, City of Martinsville, Town of Scottsburg, and the Town of South Boston during August 2022 (Figure E-2). These localities were selected based on past and future flood risk, as well as on demographic and income characteristics.

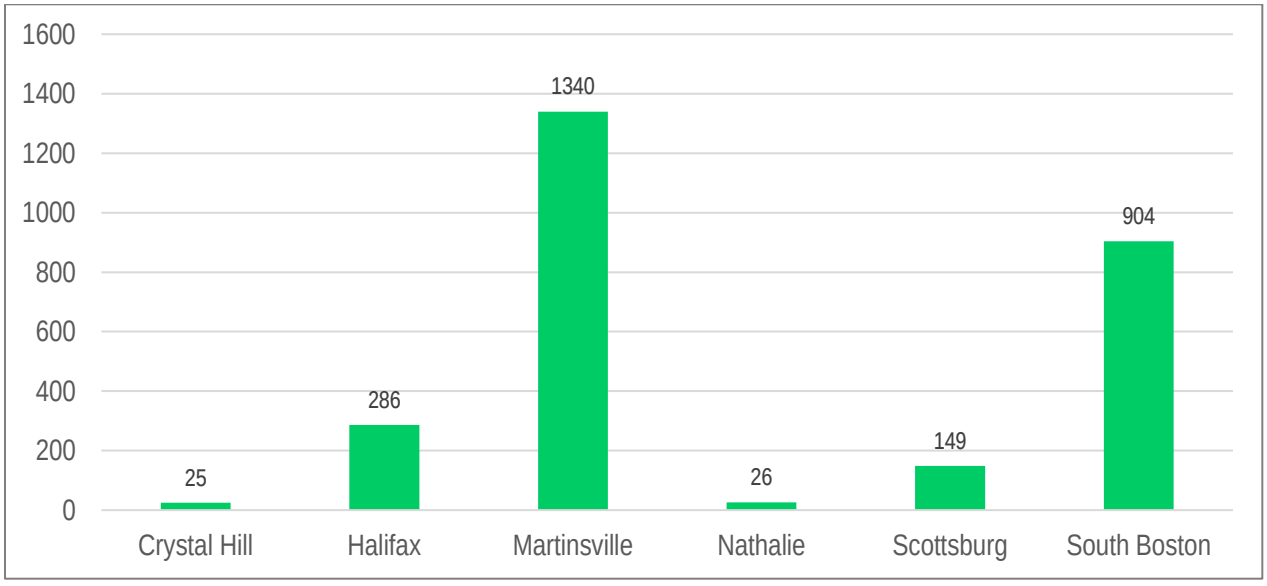


Figure E-2: Resident survey invitations by locality.

Past and future flood risk information was compiled from the Virginia Flood Risk Information System, the Storm Events Database maintained by NOAA, and the First Street Foundation's riskfactor.com database. The population of study localities, poverty rate and median household income were also considered in an effort to achieve economic and demographic variation in the areas surveyed in addition to varying levels of flood risk. The number of survey invitations sent was determined by assuming a 20 percent response rate, a 90 percent confidence level and an 8

percent margin of error. The survey was designed and administered under Protocol Number 5031 approved by the University of Virginia's Institutional Review Board. Households were identified through stratified random selection of a list of occupied housing units purchased from a vendor. Residents received a postcard in the mail with information on the project, a QR code and web link to access the online survey, and information on how to enter a drawing to win a $50 gift card. A second postcard was mailed to non-respondents two weeks later. A total of 32 completed responses were received for a response rate of 1.2 percent.

Three respondents had not been living in their current homes for a full year at the time of the survey while the mean was 17 years and the median was 10.5 years. Transportation impacts and road closures as well as damage to homes and buildings were most commonly cited by those who were "Very concerned" about flooding. When asked about their level of concern for contributing factors to flooding, inadequate stormwater infrastructure (44 percent) ranked higher than changing rainfall patterns (32 percent) or increasing development in flood-prone areas (24 percent) among those who were "Very concerned".

A majority of respondents (53 percent) indicated that flooding is worse (i.e., magnitude of impact) now than it was in the past while 41 percent said that flooding is about the same now as it was in the past. These percentages were exactly equal when asked if flooding is happening more often (i.e., frequency) now than in the past (47 percent said more often and 47 percent said about the same rate). However, nearly two-thirds of respondents (i.e., 64 percent) expect flooding to increase where they live in the future.

Respondents most often identified transportation, utilities, and retail or economic activity as specific sectors or domains that have been affected by flooding. Only four of the 32 respondents (12.5 percent) have personally experienced flood damage to a car or other property and the estimated financial impacts ranged from $0 to $5,000.

While transportation impacts were widely identified as an issue, less than half of respondents (31 percent) indicated that their own street or road flooded more than once per year and only four (12.5 percent) reported being unable to get either in or out of their neighborhood because of flooding within the past year. The impacts of flooding on transportation appear to be less localized with nearly one-half of respondents indicating that they or a member of their household had to alter your commute to work or school(leave later/earlier, take a different route) because of flooding within the past year. An open-ended question asked what other ways has flooding affected you and the responses focused on transportation (e.g., not being able to get to church or a grocery store), mosquitoes, and a dampening effect on business creation. Multiple respondents suggested that school systems are affected by flooding through road closures and the need to reroute school buses and that this constituency is missing from the stakeholder inventory. Another respondent noted the lack of stormwater infrastructure outside incorporated areas, which makes flood prevention more difficult.

Resilience Plan Roadmap

Virginia Department of Conservation and Recreation

I. Introduction to the Resilience Plan Requirements

"Resilience Plan" means a locally adopted plan that describes the entire government's approach to flooding and meets the following criteria:

1. It is project-based with projects focused on flood control and resilience. It identifies and includes all flooding occurring in all flood zones, and the number of repetitive loss and severe repetitive loss properties.

2. It incorporates nature-based infrastructure to the maximum extent possible.

3. It includes considerations of all parts of a local government regardless of socioeconomics or race. It is equity focused and prioritizes vulnerable populations subjected to flooding, not just populations vulnerable to flooding.

4. It includes coordination with other local and inter-jurisdictional projects, plans, and activities and has a clearly articulated timeline or phasing for plan implementation.

5. It is based on the best available science, and incorporates climate change, sea level rise, and storm surge (where appropriate), and current flood maps.

A resilience plan can be either one document or a combination of documents that meet the elements described in the definitions section of the Community Flood Preparedness Fund (CFPF) Grant Manual. Once the Department of Conservation and Recreation (DCR) approves a locality's Resilience Plan, that determination will stand for three years.

Applicants may submit resilience plans at any time. The resilience plan may be submitted before or concurrently with a project plan. Resilience plans should be clearly identified with the name of the local government in the file name (example: CID#_Essex_resilienceplan) and submitted to cfpf@dcr.virginia.gov. The CID# is unique to each county, city or town in Virginia.

II. Stand-Alone Versus Compilation Plan

A resilience plan may be either a "stand alone" plan that meets the required criteria or a "compilation" plan that references the elements of other plans or documents which, when compiled, meet the required criteria. Sources of elements of compilation plans may include sections from a local comprehensive plan or other land use plans or ordinances, a local hazard mitigation plan, a plan developed that addresses flooding and resilience but may include other elements, and plans developed for the local government by a third party. Regardless of the source, the material when compiled must addresses the five criteria described in Section I. Sources for compilation plans may also include regional strategies or plans to which a local government is a party. Some examples of these sources can include:

- Standard comprehensive plans may contain information regarding economic and social conditions. This information could then be used to identify vulnerable populations and address criteria three.

- Strategic plans can identify specific needs and plans. These plans can cover a wide-range of topics such as wetland restoration, infrastructure, and land-use planning, and can be helpful in developing targeted projects as well as incorporating nature-based solutions.

- Hazard mitigation plans (HMPs) identify associated hazards and mitigation strategies to address these hazards. These plans may describe critical infrastructure located within the community and may also contain community profiles. This information can be used to ensure that all hazards that impact the local community have been evaluated and plans are implemented to address these identified hazards. The information in HMPs can potentially be a valuable resource in meeting multiple criteria for the resilience plan, depending on the level of detail of the HMP for the community.

- Stormwater and drainage plans may identify flooding issues and projects designed to mitigate these issues.

The following are examples of elements of plans that local governments may already possess that would be appropriate for including in a resilience plan:

- Equity-based strategic polices for local government-wide flood protection and prevention

- Proposed projects that enable communities to adapt to and thrive when faced with natural or human hazards

- Documentation of existing social, economic, natural, and other conditions present in the local government

- Review of the vulnerabilities and stressors, both natural and social in the local government

- Forward-looking goals, actionable strategies, and priorities through as seen through an equity-based lens

- Strategies that guide growth and development away from high-risk locations, including strategies in comprehensive plans or other land use plans or ordinances or other studies, plans or strategies adopted by a local government

- Proposed acquisition of land or conservation easements or identification of areas suitable for conservation particularly areas identified as having high flood attenuation benefit by *ConserveVirginia* or similar data driven tools

- Identification of areas suitable for property buyouts in frequently flooded areas

- Identification of critical facilities and their vulnerability throughout the local government such as water and sewer or other types identified as “lifelines” by FEMA

- Identified ecosystems/wetlands/floodplains suitable for permanent protection

- Identified incentives for restoring riparian and wetland vegetation

- A framework for implementation, capacity building and community engagement

- Strategies for creating knowledgeable, inclusive community leaders and networks

- A community dam safety inventory and risk assessment posed by the location and condition of dams

- A characterization of the community including population, economics, cultural and historic resources, dependence on the built environment and infrastructure and the risks posed to such infrastructure and characteristics by flooding from climate change, sea level rise, tidal events or storm surges or other weather

- Strategies to address other natural hazards that would cause, affect, or result from flooding events including:
    - Earthquakes
    - Storage of hazardous materials
    - Landslides/mud/debris flow/rock falls

- Prevention of wildfires that would result in denuded lands making flooding, mudslides or similar events more likely
- Preparations for severe weather events including tropical storms or other severe storms, including winter storms

For either a stand-alone plan or a compilation plan, documents should be submitted that identify the sources of the plans or elements submitted.

III. Developing a Resilience Plan

The following stepwise approach can be used to develop a resilience plan. Included with each step are examples of how various localities developed the information required under the plan criteria and incorporated this information into the final resilience plan.

Step 1: Evaluate the resources, capabilities, and needs of the community.

1. Is this a stand-alone plan or compilation plan (combination of documents) that meets the elements described in the definitions section of the CFPF grant manual?

2. How robust does the plan need to be?

3. Does the community have access to a compilation of documents to meet the elements described in the Grant Manual?

4. Does the community have the staff and resources necessary to gather and organize this information into a format that meets the requirements of the Grant Manual?

Step 2: Determine how the plan will be drafted.

If a community lacks the resources or existing plans necessary to compile a resilience plan submission, then consider applying for a capacity building grant to hire a contractor to complete the plan. A contractor with appropriate expertise can conduct a thorough and robust evaluation of the needs of the entire community and develop a resilience plan. This approach might benefit smaller communities whose floodplain administrators fill multiple roles and may not have the ability to research and obtain the information needed to create a resilience plan on their own.

If a community lacks the resources necessary to compile a stand-alone document but has access to other local and regional plans that contain the information necessary, it is possible to use excerpts of these existing plans to fulfill the requirements. If the community decides to use components from other existing plans, it must submit an outline or cover page that identifies the components or excerpts used and how they are applicable, the source and location within the source for these excerpts, and which specific requirement criteria that the excerpt satisfies.

The following three examples are from approved resilience plans and offer various approaches to documenting a compilation plan.

Compilation Plan Example – Criteria Location
In the following example, the locality developed a spreadsheet that outlines each component of the resilience plan on the left side of the spreadsheet, lists the plan(s) in which the criteria were met along the top of the spreadsheet, and identifies the location in each plan where the criteria are satisfied.

Appendix 1: Plan and Program Inventory

Plan/Program Components	Comprehensive Plan, 2026	Richmond-Crater Multi-Regional Hazard Mitigation Plan, 2017	Emergency Operations Plan, 2021	Floodplain Management Ordinance, 2021	Zoning Ordinance, 2021	Subdivision Ordinance, 2021	Capital Improvement Program (CIP), FY21-22 - FY30-31	Dam Safety Program	Watershed Program	Other
Equity based strategic policies for local government-wide flood protection & prevention	Chapter 4	Chapter 7	N/A	Division 1	Article 1, Division 1	Article 1, Division 1	N/A	N/A	N/A	Local Resilience Plan
Proposed projects that enable communities to adapt to and thrive through natural or human hazards	Chapter 9	Chapter 7	N/A	N/A	N/A	N/A	CIP	N/A	N/A	Local Resilience Plan
Documentation of existing social, economic, natural, and other conditions present in the local government	Chapter 3	Chapter 4, Chapter 5	Volume 1: Basic Plan	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Review of the vulnerabilities and stressors, both natural and social in the local government	Chapter 3, Chapter 5, Chapter 8, Appendices	Chapter 5	Volume 1: Basic Plan	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Forward-looking goals, actionable strategies, and priorities as seen through an equity-based lens	Chapter 4, Chapter 7	Chapter 7	Volume 1: Basic Plan	N/A	N/A	N/A	N/A	N/A	N/A	Local Resilience Plan
Strategies that guide growth and development away from high-risk locations that may include strategies in comprehensive plans or other land use plans or ordinances or other studies, plans or strategies adopted by a local government	Chapter 4, Chapter 5	N/A	N/A	Division 4	Article 3	Article 5	N/A	N/A	N/A	Local Resilience Plan
Proposed acquisition of land or conservation easements or identification of areas suitable for conservation particularly areas identified as having high flood attenuation benefit by *ConserveVirginia* or similar data driven tools	Chapter 6, Chapter 8, Chapter 9	N/A	N/A	N/A	Article 3	Article 5	N/A	N/A	N/A	Local Resilience Plan
Identification of areas suitable for property buyouts in frequently flooded areas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Local Resilience Plan
Identification of critical facilities and their vulnerability throughout the local government such as water and sewer or other types identified as "lifelines" by FEMA	Chapter 11	Chapter 5	Volume 1: Basic Plan	N/A	N/A	N/A	CIP	N/A	N/A	N/A
Identified ecosystems/wetlands/floodplains suitable for permanent protection	Chapter 8, Chapter 9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Watershed Restoration Areas	N/A
Identified incentives for restoring riparian and wetland vegetation	Chapter 8	N/A	N/A	N/A	N/A	Article 5	N/A	N/A	Chesapeake Bay TMDL Credits	N/A
A framework for implementation, capacity building and community engagement	Chapter 12	Chapter 4, Chapter 7	Volume 1: Basic Plan	N/A	N/A	N/A	N/A	N/A	N/A	Local Resilience Plan

Henrico County Department of Public Works. *Local Resilience Plan*. August 2021. County of Henrico, Virginia

Compilation Plan Example – Criteria Location and Language

The following example is based on a spreadsheet containing both the location and specific language of the relevant information. Note that this example includes the Grant Manual criteria citations, the requirements met, the location and document from which the excerpt is taken, and the specific language that the locality uses to meet the requirement.

Virginia Community Flood Preparedness Fund - Resiliency Plan Requirements
August 16, 2021

No.	Ref.	Requirement	Met Where	Met Language
1	Part III.A	It is project-based with projects focused on flood control and resilience.	RVA Clean Water Pg. 2, 40, 71, 82	Language describes an integrated management plan across the City for the stormwater for the integrated permit, with benefits.
2	Part III.A	It incorporates nature-based infrastructure to the maximum extent possible.	RVA Clean Water Pg. 40	Final strategies for the integrated planning listed, including restoration of riparian areas, green infrastructure, stream restoration, and land conservation.
3	Part III.A	It includes considerations of all parts of a local government regardless of socioeconomics or race.	Crater 2017 4.5.15	Community Description for the City of Richmond documenting these conditions.
4	Part III.A	It includes coordination with other local and inter-jurisdictional projects, plans, and activities and has a clearly articulated timeline or phasing for plan implementation.	Crater 2017 2.1, 2.2, 3.0	Introduction describes the coordination with jurisdictions across the Richmond Metropolitan Area.
5	Part III.A	Is based on the best available science and incorporates climate change, sea level rise, and storm surge (where appropriate), and current flood maps.	Crater 2017 1.1, 3.3, 5.6.5, 5.6.6 Fig. 5-1, 5-2	The Richmond-Crater Multi-Regional Hazard Mitigation Plan update incorporates information from a number of other plans, studies, and reports. These documents include: - Virginia Department of Conservation & Recreation (DCR) climate reports Sections 5.6.5 & 5.6.6. FEMA Floord Insurance Rate Map (FIRM) map was developed based on details hydrologic and hydraulic studies that was used in the plan to identify flood hazard and asses risk. FIRM's hydrologic and hydraulic studies and their data are affected by climate change, sea level rise (tidal), and storm surge. Section 5.6.5 in the plan identifies various watershed locations and sizes and their drainage area maps.
6	Appendix G	Equity based strategic polices for local government-wide flood protection and prevention.	Crater 2017 7.1 - 7.3	Table 7-1. STAPLE/E Prioritization Criteria for Actions to be Taken - Are there equity issues involved that would mean that one segment of a community is treated unfairly? "After the 2017 actions were selected, the STAPLE/E (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) criteria (Table 7-1) were used to inform prioritization the most appropriate actions for the Richmond-Crater communities. This methodology requires that social, technical, administrative, political, legal, economic, and environmental considerations be taken into account when reviewing potential actions for the area's jurisdictions to undertake. This process was used to help ensure that the most equitable and feasible actions would be undertaken based on a jurisdiction's capabilities.
7	Appendix G	Proposed projects that enables communities to adapt to and thrive through natural or human hazards.	RVA Clean Water Pg. 40-43, 64-66	Describes the selected final strategies that will enable the communities to thrive.
8	Appendix G	Documentation of existing social, economic, natural, and other conditions present in the local government.	See row 3.	See row 3.
9	Appendix G	Review of the vulnerabilities and stressors, both natural and social in the local government.	Crater 2017 5.0, 5.6	Section 5 is Hazard Identification and Risk Assessment. Section 5.6 covers flooding specifically. Additional covered vulnerabilities and stressors are: - Landslides, Shoreline Erosion, Droughts, Earthquakes, Hurricanes, Sinkholes, Wind, Tornados, Wildfires, Winter Weather, Thunderstorms, Extreme Heat
10	Appendix G	Forward-looking goals, actionable strategies, and priorities through as seen through an equity-based lens.	See row 6.	See row 6.
11	Appendix G	Strategies that guides growth and development away from high-risk locations that may include strategies in comprehensive plans or other land use plans or ordinances or other studies, plans or strategies adopted by a local government.	Crater 2017 6.5.3	Section describes the improvements Richmond has taken to improvement the stormwater management of their facilities.

City of Richmond. Virginia Community Flood Preparedness Fund - Resiliency Plan Requirements. August 16, 2021. City of Richmond, Virginia.

Compilation Plan Example – Criteria Narrative Outline

The final example contains a submission in a narrative outline format. This plan outlines each of the five criteria and then specifies the location for the information used to fulfill the criteria. This submission is not as detailed as the previous two examples, but if the plans and documents used to fulfill the criteria are not lengthy or complex, this basic outline format would be sufficient.

Purpose and Introduction

This plan seeks to increase resiliency across the GWRC region by addressing threats to human life and property from flooding, severe weather, and other natural events. It attempts to do so with 5 major criteria in mind: being project based, with projects focused on flood control and resilience; incorporating nature-based solutions to the maximum extent possible; including all parts of the GW Region regardless of race or socioeconomic status; coordination within the region to achieve goals based on mutually-agreed-upon timelines; and being based on the best-available science. Each of these criteria are outlined in this or other regional plans here:

1. It is project-based with projects focused on flood control and resilience.

See the GWRC *Environmental Services Strategic Plan*, detailed on pg. 49 of this Resilience Plan.

2. It incorporates nature-based infrastructure to the maximum extent possible.

The solutions and planning principles outlined in this Resilience Plan and the projects listed in the *Environmental Services Strategic Plan* incorporates nature-based stormwater and flooding BMPs to the greatest extent possible.

3. It includes considerations of all parts of a locality regardless of socioeconomics or race.

This Plan considers solutions that involve every member of the community at every step of the process, and seeks to identify and target the GW Region's most vulnerable communities. See "Social Assets" on pg. 12 of this plan for a detailed breakdown as well as "Appendix G: Considering the Whole Community" on pg. 78.

4. It includes coordination with other local and inter-jurisdictional projects, plans, and activities and has a clearly articulated timeline or phasing for plan implementation.

The *Environmental Services Strategic Plan* has detailed timelines and cost estimates for projects throughout the region.

5. Is based on the best available science, and incorporates climate change, sea level rise, storm surge (where appropriate), and current flood maps.

This plan attempts to quantify the resiliency challenges that climate change will bring using the best available data and science. See "Natural Hazards", pg. 16, which includes specific plan elements related to flooding, climate change, flood maps, and vulnerability to sea level, with specific considerations for each locality in the region.

Berkley Group. George Washington Region Resilience Plan. September 2021. George Washington Regional Commission, Virginia.

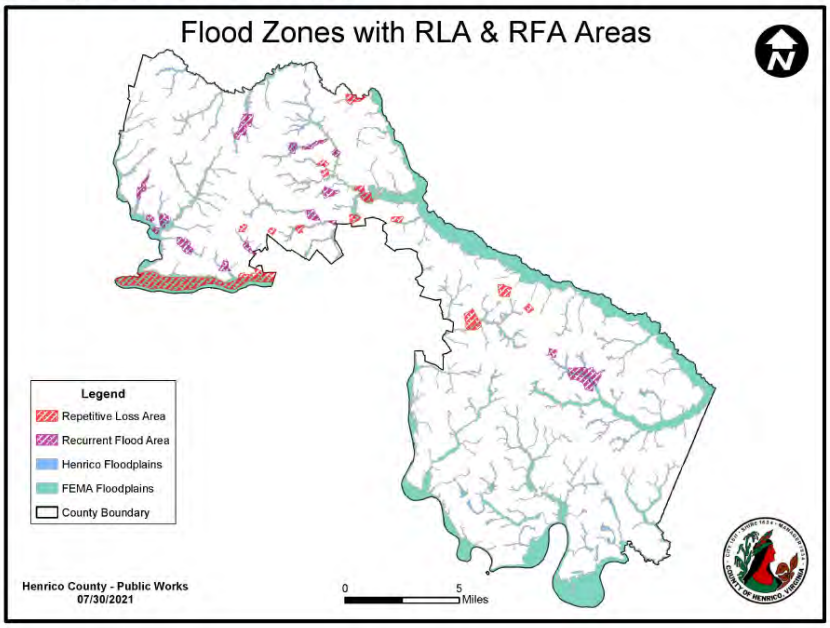
Step 3: Ensure the resilience plan contains all required components.

1. *It must be project-based with projects focused on flood control and resilience.*

    - Identify and include the various types of flooding occurring in all flood zones, and the number of repetitive loss and severe repetitive loss properties.
    - Consider all watersheds within the community with projects encompassing each of these watersheds.
    - Analyze community social and environmental characteristics.
    - Tailor flood resilience strategies to the community with discrete projects identified.

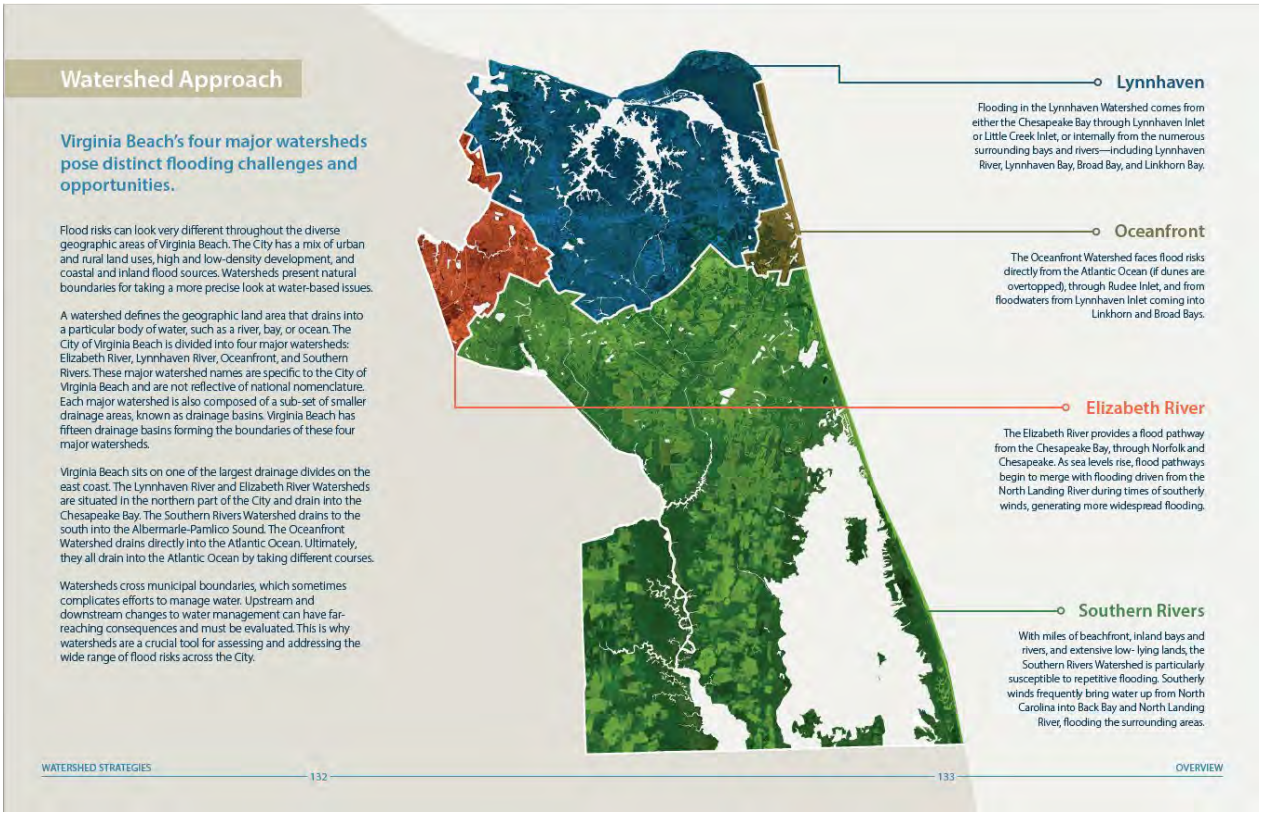
    Maps can help a community to better understand flood risk and resilience. The following example shows a map that was developed by a locality displaying the Special Flood Hazard Areas, the locally mapped floodplains, and the areas that are experiencing recurrent flooding and repetitive losses. This map helps the locality visualize the areas of concern within their community so that they can prioritize projects appropriately based on their specific community needs.

Appendix 2: Flood Zones with Repetitive Loss & Recurrent Flood Areas Map



Henrico County Department of Public Works. *Local Resilience Plan*. August 2021. County of Henrico, Virginia

The excerpt below is a map of another locality with each watershed broken out. In each watershed, the locality has outlined the specific flooding issues that are experienced within each individual watershed.



Virginia Beach. *Sea Level Rise: Adaption Strategy*. March 31, 2020. Virginia Beach, Virginia

Finally, a table or spreadsheet can help summarize the specific flood-control projects that address the unique issues found within individual watersheds displayed in various maps. The example table below summarizes a locality's community-wide approach, which ensures that its resilience plan focuses on more than one location, or specific project or type of flooding within the community. The goal for this resilience plan is to acknowledge and develop a plan of action for all unique flooding issues present within the community.

Projects focused on flood control and resilience include:

Neighborhood	Flood Control Project
Elizabeth River	City-wide alignment, living shoreline, marsh restoration, land conservation
Lynnhaven	Chesapeake Bay alignment, Lesner Bridge Neighborhood alignment (East & West), beach & dune nourishment, ecological revetments, shellfish reef restoration, seagrass restoration
Oceanfront	Atlantic Oceanfront alignment, Rudee Heights alignment
Southern Rivers	West Neck Creek city-wide alignment, Muddy Creek Road city-wide alignment, Sandbridge city-wide alignment

**additional projects listed within the Sea Level Wise Adaptation Strategy.*

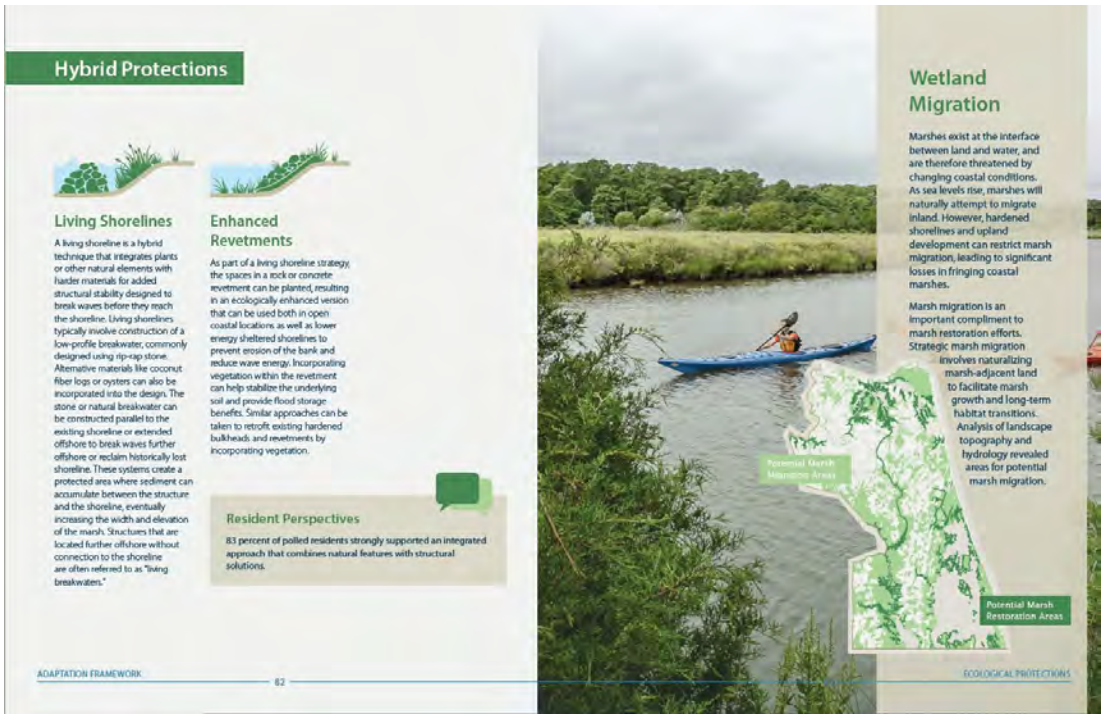
2. *Flood mitigation projects throughout the locality should incorporate nature-based solutions, and these must be identified for the maximum use possible within each specific watershed.*

   Certain types of projects are better suited than others for nature-based solutions, and for some projects, this approach is not a viable option. The goal when developing a resilience plan is to assess the needs for the entire community, and the criteria ensure that the community also considers and incorporates nature-based options to the maximum extent possible. Note that when a community applies under the project category through the CFPF, the match requirement is tiered based on the incorporation of nature-based solutions. Accounting for nature-based solutions in earlier stages, such as the development of the resilience plan, allows the community to benefit from a reduced match requirement for project funding applications.

   An example of a plan in which a community incorporates nature-based solutions to the maximum extent possible is one locality's green infrastructure plan. This plan evaluates projects for land and for water. The primary focus for the land component is to "protect, connect and re-green the landscape to provide pathways for people and wildlife, treat stormwater and reduce flooding, and beautify the city." The primary focus for the water component is to "restore shoreline habitats to support aquatic life, buffer areas from storm surge, and foster recreation, including birding, boating and fishing." This plan emphasizes evaluating green infrastructure for the community, just as it evaluates its gray infrastructure--both are equally important as part of the locality's overall infrastructure (see https://www.norfolk.gov/DocumentCenter/View/38067/Norfolk-Green-Infrastructure-Plan--Action-Plan-Appendix-for-Endangered-Species?bidId)

The following two examples contain excerpts from a plan that incorporated several nature-based solutions. This plan includes different types and descriptions of nature-based solutions along a coastline, including hybrid solutions. Understanding the different options that are available and the pros and cons of each makes it easier for the community to incorporate the most beneficial solution for each project.

Virginia Beach. *Sea Level Rise: Adaption Strategy*. March 31, 2020. Virginia Beach, Virginia



Virginia Beach. *Sea Level Rise: Adaption Strategy*. March 31, 2020. Virginia Beach, Virginia

3. *It must include considerations of all parts of a local government regardless of socioeconomics or race.*

    - Consider all parts of a locality; be sure to include and address all watersheds and the entirety of the jurisdictional boundary.
    - Focus on equity and prioritize vulnerable populations that are subjected to flooding, not just populations that are vulnerable to flooding.
    - Conduct a demographic analysis and include it in the plan.
    - Identify social vulnerability and document social vulnerability, providing for social implications of flood hazards, and analysis of at-risk populations. There is no way to ensure that vulnerable populations are being considered or prioritized without looking at the demographics and socioeconomics of the community.

    The AdaptVA viewer is a fairly simple tool to assess social vulnerability using the Virginia Social Vulnerability Index Score, which evaluates vulnerability at a census tract level. This tool was created by the Virginia Institute of Marine Science (VIMS) and can be found at: http://cmap2.vims.edu/AdaptVA/adaptVA_viewer.html

    When applying for funding on behalf of an entire community, all the scores for each census tract must be added up and the average taken to determine the social vulnerability index score for the entire community. However, if the application is only focused on a small subset of the community population, impacting one or two census tracts for example, then this subset will be the reference point for the overall social vulnerability index score, not the overall community score. As an example of vulnerability analysis, Dewberry, Inc. conducted an excellent demographic and population vulnerability analysis for a locality that shows a thorough review of a locality's demographics and social vulnerability: https://www.vbgov.com/government/departments/public-works/comp-sea-level-rise/Documents/new%20PWCN-15-0014_WO12B_SocialVulnerability_Final_20180913.pdf

Another locality developed a scoring matrix to assess vulnerability. The locality partnered with a university to create a Flood Risk Score system to determine vulnerability and allow the community to prioritize projects based on need. This Flood Risk Score sheet was modeled from an existing Flood Risk Assessment tool used in a neighboring state. The scoring system accounts for different flood risk factors (such as if a property, structure, and/or driveway would be impacted by floodwater), to establish an overall Impact Base Score. Multipliers are then added based on certain location-based hazards and the social vulnerability index score. The social vulnerability is based on the Virginia Social Vulnerability Index Score created by the VIMS that was previously mentioned. At the end, the property receives a flood risk score which corresponds to a flood risk level. This score can be used internally by the community to prioritize projects based on relative flood risk.

Appendix 3: Flood Risk Score Breakdown

Table 1: Flood Risk Score – Impact Based Scoring Matrix

Criteria	Property Flood Impacts	Base Points	Points Assigned Per Storm Event Recurrence Interval	
			100-yr (1% annual chance)	500-yr (0.2% annual chance)
A	Flooding of any portion of the **property**	250	2.5	0.5
B	Flooding of any portion of the **driveway**	250	2.5	0.5
C	**Driveway** is completely surrounded by floodwater	750	7.5	1.5
D	Flood water is touching a portion of the **structure**	1000	10	2
E	**Property** is completely surrounded by flood water	1100	11	2.2
F	**Structure** is completely surrounded by flood water	500	5	1
G1	**Structure** is completely surrounded by flood water AND is residential		500	5
G2	**Structure** is completely surrounded by flood water AND is commercial		300	3
G3	**Structure** is completely surrounded by flood water AND is a critical facility		2700	27
G4	**Structure** is completely surrounded by flood water AND is a multi-family residential		1400	14

Note: Can only select one of the following per property: G1, G2, G3, G4.

Table 2. Location Based Multipliers

Structure located near area impacted by storm drainage overflows*	1.3
Structure located in floodway	1.1
Structure is located within a dam inundation zone*	1.4
Structure is in a repetitive loss area	1.5
*Note: * indicates that this multiplier has not yet been implemented*	

Table 3. Social Vulnerability Multipliers

Property SoVI Score: High social vulnerability	1.5
Property SoVI Score: Moderate Social Vulnerability	1.3
Property SoVI Score: Not Socially Vulnerable or Not Included in Analysis	1

Table 4: Flood Risk Level Based on Score

Flood Risk Score (FRS)	Flood Risk Level
≤ 3.25	Low
≤ 15	Medium
≤ 40	High
> 44	Very High

Henrico County Department of Public Works. *Local Resilience Plan*. August 2021. County of Henrico, Virginia

The following example applies the flood risk score (shown above) to an example property. In this example, the structure is in an AE zone. According to the scoring sheet the structure is also located in a repetitive loss area and is in a high social vulnerability area. The resulting flood risk score is calculated based on those base points and assigned multipliers and is classified as very high for this property. This approach enables the community to determine the associated hazard in relation to the community's rating methodology and allows the community to prioritize how to proceed with projects relating to this property.

Appendix 4: Flood Risk Score – Property Example

GPIN: 783-744-4862

Property Flood Impact Base Score			
Criteria	Property Flood Impacts	Storm Event*	Points
A	Flooding of any portion of the property	100	2.5
B	Flooding of any portion of the driveway	NA	0
C	Driveway is completely surrounded by floodwater	NA	0
D	Flood water is touching a portion of the structure	100	10
E	Property is completely surrounded by flood water	100	11
F	Structure is completely surrounded by flood water	100	5
G1	Structure is completely surrounded by flood water AND is residential	100	5
G2	Structure is completely surrounded by flood water AND is commercial	NA	0
G3	Structure is completely surrounded by flood water AND is a critical facility	NA	0
G4	Structure is completely surrounded by flood water AND is a multi-family residential	NA	0
*Storm event for which this first occurs.			
		Total Impact Based Score	33.5

Location Based Factor			
Criteria	Multiplier	Applicability	Points
~~Structure located near area impacted by storm drainage overflows~~	~~1.3~~	N/A	0
Structure located in floodway	1.1	NO	0
~~Structure is located within a dam inundation zone~~	~~1.4~~	N/A	0
Structure is in a repetitive loss area	1.5	YES	1.5
*Only the highest factor is selected if the property meets more than one criterion.			
		Location Based Factor	1.5
		Property Score Before Social Vulnerability	50.25

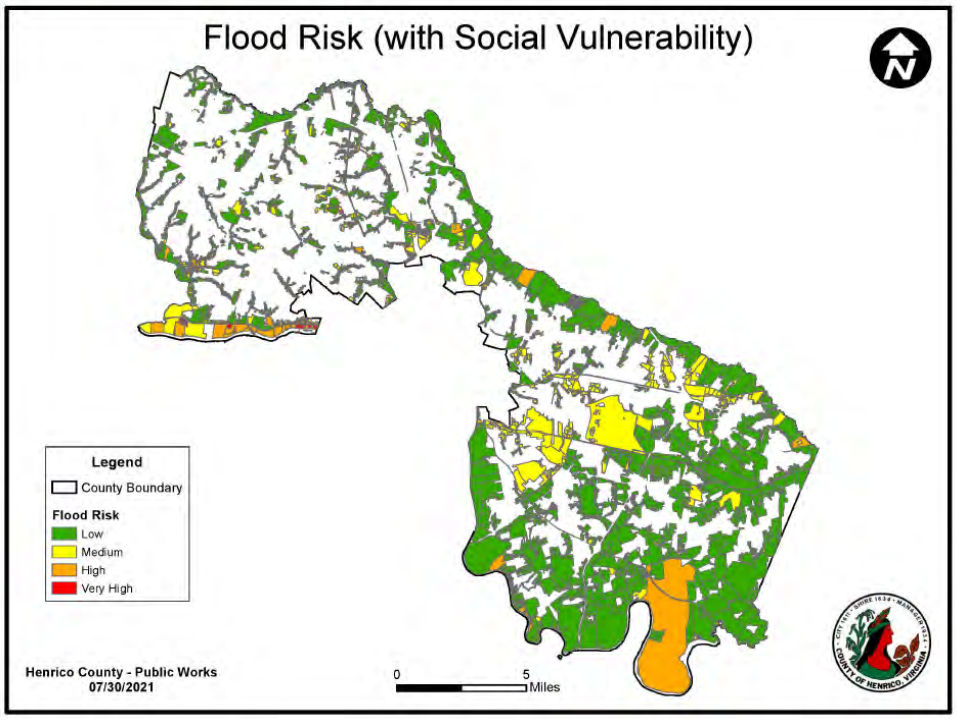
Social Vulnerability Factor			
Criteria	Multiplier	Applicability	Points
Property SoVI Score: High social vulnerability	1.5	YES	1.5
Property SoVI Score: Moderate Social Vulnerability	1.3	NO	0
Property SoVI Score: Not Socially Vulnerable or Not Included in Analysis	1	NO	0
*Property can only fall into one of the three categories			
		Social Vulnerability Factor	1.5

Property Flood Risk Score	75.4
	Very High
*Property Flood Risk Score = Total Impact-Based Score * Location-Based Factor * Social Vulnerability Factor*	

Henrico County Department of Public Works. *Local Resilience Plan*. August 2021. County of Henrico, Virginia

A final example shows a map developed by this same community displaying flood risk with social vulnerability included. This visualization helps to identify the priority needs within the community to ensure that these areas are considered when building community-wide resilience.

Appendix 6: Flood Risk Score Map – With Social Vulnerability Included



Henrico County Department of Public Works. *Local Resilience Plan*. August 2021. County of Henrico, Virginia

4. *It includes coordination with other local and inter-jurisdictional projects, plans, and activities and has a clearly articulated timeline or phasing for plan implementation.*

    - Document coordination with other projects, plans, and activities.
    - Include the planning processes and frameworks which outline local and regional plans used by the locality to address resilience; and how these have been integrated for flood adaptation planning.
    - Check with all other local and inter-jurisdictional agencies to ensure cooperation amongst all agencies and maintain cohesiveness amongst overlapping plans.
    - When thinking of capacity building and resilience plan development, consider clarity and consistency within local policies and procedures. For example, it may be beneficial to update existing ordinances to reflect changes in policy or adopt higher standards. The community may need to develop or edit substantial damage administrative procedures for the Substantial Damage Estimate (SDE) process, they may need to create a debris management plan, or build an SOP for what to do after a disaster. Considering these issues during the resilience plan development stages can ensure that these overlapping processes are cohesive.
    - Provide a clearly articulated timeline or phasing for plan implementation. Timelines for the project can be detailed with finite dates or can consist of phasing plans that do not have specific dates for individual project completion.

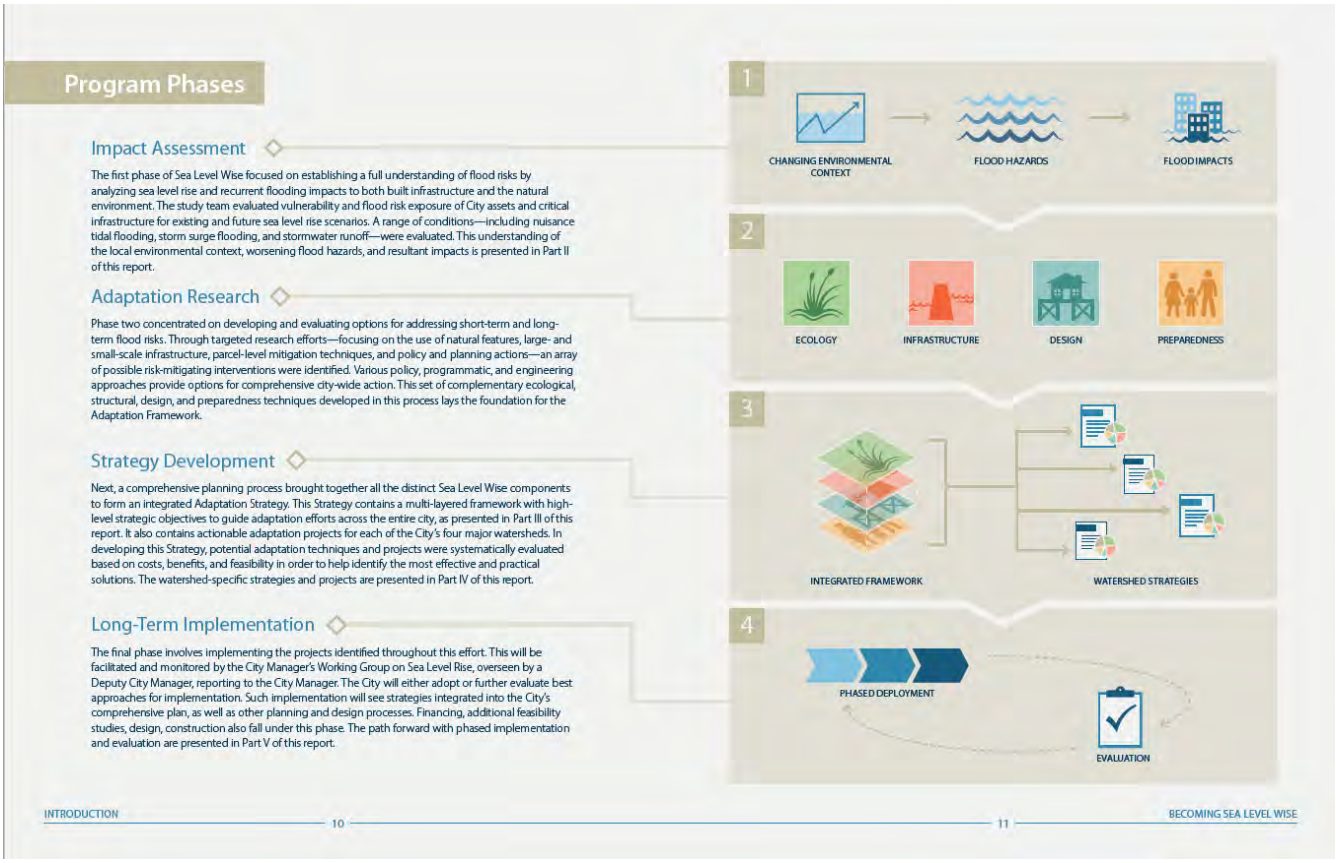
The following example timeline outlines project information such as name and description, the current project status, and the estimated completion date for each of the proposed projects.

Appendix 9: Resilient Project List

Project Name	Project Description	Project Status	Anticipated Completion Date
Water Reclamation Facility Stream Restoration	Utilize natural channel design to recreate natural and stable cross sections and profile of stream system, stabilize eroding stream banks, reconnect streams with their floodplains, Reestablish the stream with buffer.	Under Construction	2021
Old Nine Mile Landfill Stream Restoration	Utilize natural channel design to recreate natural and stable cross sections and profile of stream system, stabilize eroding stream banks, reconnect streams with their floodplains, Reestablish the stream with buffer.	Design (100%)	2022
Deitrick Rd Outfall Restoration	restore actively eroding outfall channels by utilizing stream restoration or hard armoring techniques, depending upon the site parameters.	Preliminary Design	2022
Graham Meadows Buffer Restoration	protect water resources and improve water quality by replacing maintained vegetation (lawns) with native trees, shrubs, and groundcovers.	Preliminary Design	2022
Wilder Middle Stream Restoration	Utilize natural channel design to recreate natural and stable cross sections and profile of stream system, stabilize eroding stream banks, reconnect streams with their floodplains, Reestablish the stream with buffer.	Design (70%)	2023
Three Lakes Park Stream Restoration	Utilize natural channel design to recreate natural and stable cross sections and profile of stream system, stabilize eroding stream banks, reconnect streams with their floodplains, Reestablish the stream with buffer.	Design (70%)	2024
Hidden Cr Park Stream Restoration	Utilize natural channel design to recreate natural and stable cross sections and profile of stream system, stabilize eroding stream banks, reconnect streams with their floodplains, Reestablish the stream with buffer.	Design (70%)	2023
Adams Elem Stream Restoration	Utilize natural channel design to recreate natural and stable cross sections and profile of stream system, stabilize eroding stream banks, reconnect streams with their floodplains, Reestablish the stream with buffer.	Design (70%)	2024
Meadowview Park Stream Restoration	Utilize natural channel design to recreate natural and stable cross sections and profile of stream system, stabilize eroding stream banks, reconnect streams with their floodplains, Reestablish the stream with buffer.	Preliminary Design	2026
JSRCC Stream Restoration	Utilize natural channel design to recreate natural and stable cross sections and profile of stream system, stabilize eroding stream banks, reconnect streams with their floodplains, Reestablish the stream with buffer.	Preliminary Design	2027

Henrico County Department of Public Works. *Local Resilience Plan*. August 2021. County of Henrico, Virginia

A final example shows how a phased plan could be developed. Although it can be difficult to put finite dates on projects when assessing community-wide resilience, a phased plan can show the progression of projects in the absence of firm dates. This example proposes a program as individual phases of a larger overarching plan. Details are provided as to what is to be completed within each phase. Assessing the overall resilience plan in phases also allows the locality to break projects into to more manageable pieces.



Virginia Beach. *Sea Level Rise: Adaption Strategy*. March 31, 2020. Virginia Beach, Virginia

5. *It is based on the best available science, and incorporates climate change, sea level rise, and storm surge (where appropriate), and current flood maps.*

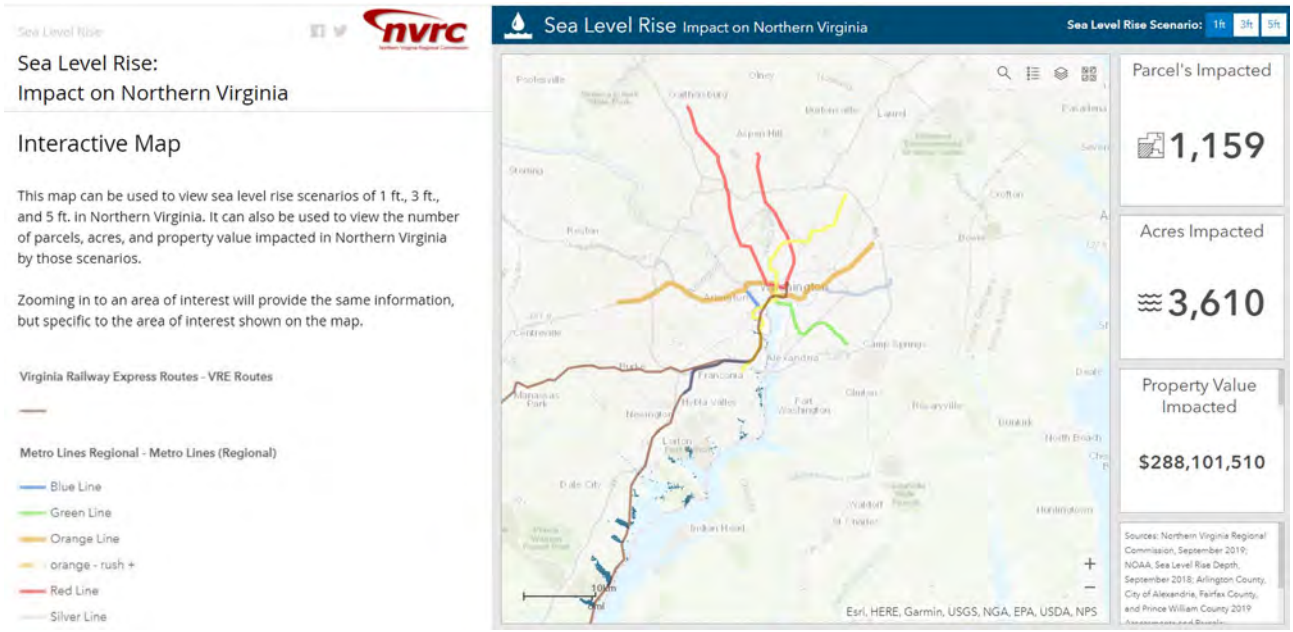
    - Provide a technically backed, water-resource analysis when available.
    - Incorporate sea level rise projections and climate change data into the strategic approach.
    - Include storm surge data if it is available.
    - Use the most current flood maps.

    Additional resources for data to meet this criteria include current FEMA flood maps (https://msc.fema.gov/portal/home) and sea level rise inundation zones available on the Virginia Flood Risk Information System (https://consapps.dcr.virginia.gov/VFRIS/).

    An example of using best available science is found in one locality's extensive plan to addresses sea level rise. This plan incorporates the best available science in building resilience for the community. Not all communities can develop information to this degree, however this plan offers a useful reference for one approach in creating resiliency and prioritizing the reality of sea level rise. See *Living with Water Hampton: A Holistic Approach to Addressing Sea Level Rise and Resiliency* (https://hampton.gov/DocumentCenter/View/20644/Resilient-Hampton-Phase-I-Report?bidId=).

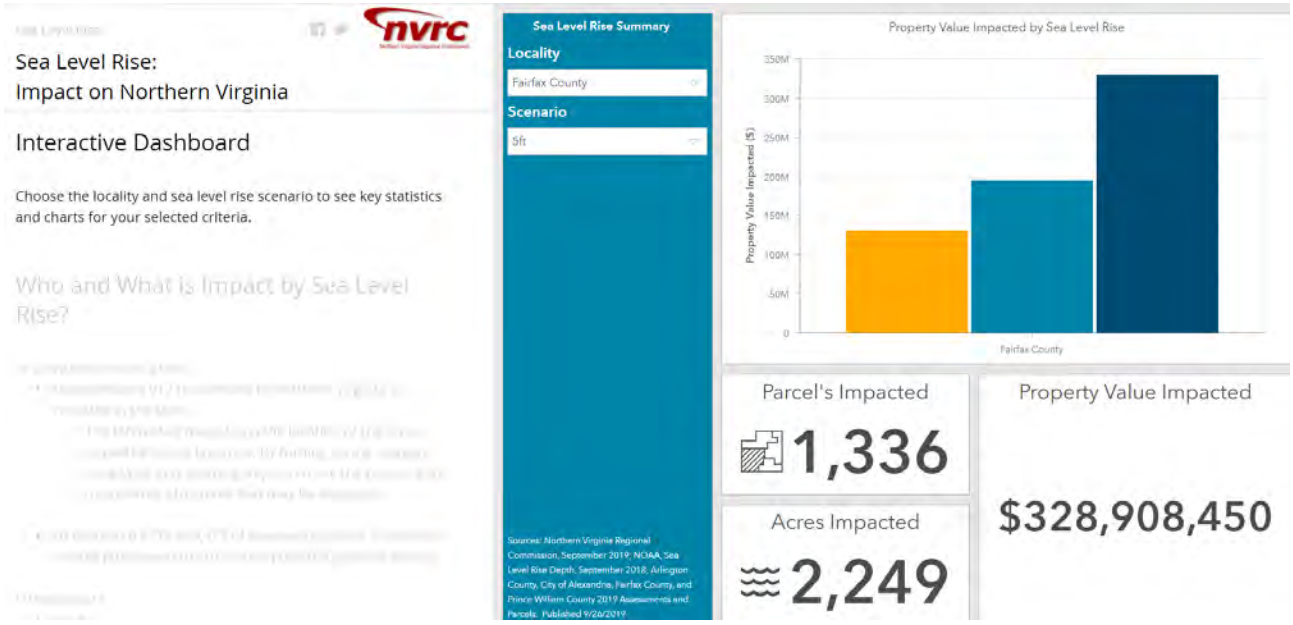
    Another approach is the interactive map and dashboard that was created to show the impact of sea level rise in Northern Virginia (Sea Level Rise: Impact on Northern Virginia). This example not only shows the impacts of sea level rise within a community, but also shows how a community can use outside plans or resources to get information and meet the criteria for their resilience plan. Not all communities are expected to develop information to this degree, however this approach is effective for the specific needs of the Northern Virginia region and offers ideas for projects elsewhere.

    The dashboard screenshot below shows the impact to Northern Virginia for a 1-foot rise in sea level, highlighted using the dark teal blue areas along the waterways. In the upper right corner, the Sea Level Rise Scenario can be changed to reflect a 3-foot rise as well as a 5-foot rise. As the scenario changes, the numbers for impacted parcels, acres, and property value will change to coincide with the new selection.



Northern Virginia Regional Commission. *Sea Level Rise: Impact on Northern Virginia*. 2019. <https://www.arcgis.com/apps/MapJournal/index.html?appid=d36a7c30fbe3436e8ce5ceb91b38c3af#:~:text=Warmer%20ocean%20temperatures%20and%20melting,in%20global%20sea%20level%20rise.&text=The%20National%20Climate%20Assessment%20and,rise%20an%20additional%206.6%20feet.>.

Another dashboard screenshot shows a 5-foot sea level rise selected within Fairfax County. The impacts of this selection to the parcels, acres, and property value are reflected as a dashboard.



Northern Virginia Regional Commission. *Sea Level Rise: Impact on Northern Virginia*. 2019. <https://www.arcgis.com/apps/MapJournal/index.html?appid=d36a7c30fbe3436e8ce5ceb91b38c3af#:~:text=Warmer%20ocean%20temperatures%20and%20melting,in%20global%20sea%20level%20rise.&text=The%20National%20Climate%20Assessment%20and,rise%20an%20additional%206.6%20feet.>.

IV. Conclusion

The Department of Conservation and Recreation's Division of Dam Safety and Floodplain Management Team is happy to assist with any questions with regards to the development of a resilience plan that meets the criteria as outlined within the Grant Manual. Please reach out to one of our team members should you have any questions or would like to arrange a meeting to discuss developing a resilience plan for your community.

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