Frederick County

Hazard Mitigation and Climate Adaptation Plan

March 2022

Participating Jurisdictions and Institutions:

Frederick County, Maryland

City of Brunswick

City of Frederick

Town of Burkittsville

Town of Emmitsburg

Town of Middletown

Town of Mount Airy

Town of Myersville

Town of New Market

Town of Thurmont

Town of Walkersville

Town of Woodsboro

Town (Village) of Rosemont

Frederick Community College

Hood College

Mount St. Mary’s University

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ABREVIATIONS

Abbreviation	Definition
AMS	Autonomous Modular System
BCEGS	Building Code Effectiveness Grading Schedule
BFE	Base Flood Elevation
BRIC	Building Resilient Infrastructure and Communities
CAV	Community-Assisted Visit
CDBG	Community Development Block Grant
CDC	Centers for Disease Control and Prevention
CPT	College Planning Team
CRS	Community Rating System
DEM	Digital Elevation Model
DNR	Department of Natural Resources
DOT	Department of Transportation
EAP	Emergency Action Plan
EF	Enhanced Fujita
EMS	Emergency Medical Services
FCC	Frederick Community College
FCG	Frederick County Government
FEMA	Federal Emergency Management Agency
FMA	Flood Mitigation Assistance
GHG	Greenhouse Gas
GIS	Geographic Information Systems
HC	Hood College
HIRA	Hazard Identification and Risk Assessment

HMA	Hazard Mitigation Assistance
HMCAP	Hazard Mitigation and Climate Adaptation Plan
HMGP	Hazard Mitigation Grant Program
ICC	International Code Council
MCS	Mesoscale Convective Systems
MMI	Modified Mercalli Intensity (Scale)
MSM	Mount St. Mary's University
NCEI	National Centers for Environmental Information
NFIP	National Flood Insurance Program
NID	National Inventory of Dams
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
PDD	NWS Product Description Document
PDM	Pre-Disaster Mitigation
SFHA	Special Flood Hazard Area
SRL	Sea Level Rise
SVI	Social Vulnerability Index
TBD	To-Be Decided
UA	Unincorporated Areas
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WTP	Water Treatment Plant
WUI	Wildland Urban Interface
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

In 2005, Frederick County approved its first Hazard Mitigation Plan to help reduce risk and protect life and property. Since then, the Plan has been routinely updated through 2016. **In this third iteration, the Plan has progressed into the Frederick County Hazard Mitigation and Climate Adaptation Plan (HMCAP) to more thoroughly address the evolving risks posed by natural hazards.** The purpose of the HMCAP is to prevent future damage by assessing the communities' vulnerabilities to natural hazards and preparing a long-term strategy that takes into account climate change to adequately address those hazards. The Plan relies on active participation from county and municipal officials, residents, and stakeholders.

Frederick County has 12 municipalities: the City of Brunswick, the City of Frederick, the Town Emmitsburg, the Town of Burkittsville, the Town of Middletown, the Town of Mount Airy, the Town of Myersville, the Town of New Market, the Town of Rosemont, the Town of Thurmont, the Town of Walkersville, and the Town of Woodsboro. Frederick Community College, Hood College, and Mount Saint Mary's University are also included in the HMCAP. Separate annexes were prepared for the colleges and are contained in appendices.

For the full Plan introduction, see Chapter 1.

Planning Process

The planning process involves six steps that ensure Frederick County is a safe and resilient community (Figure 1).

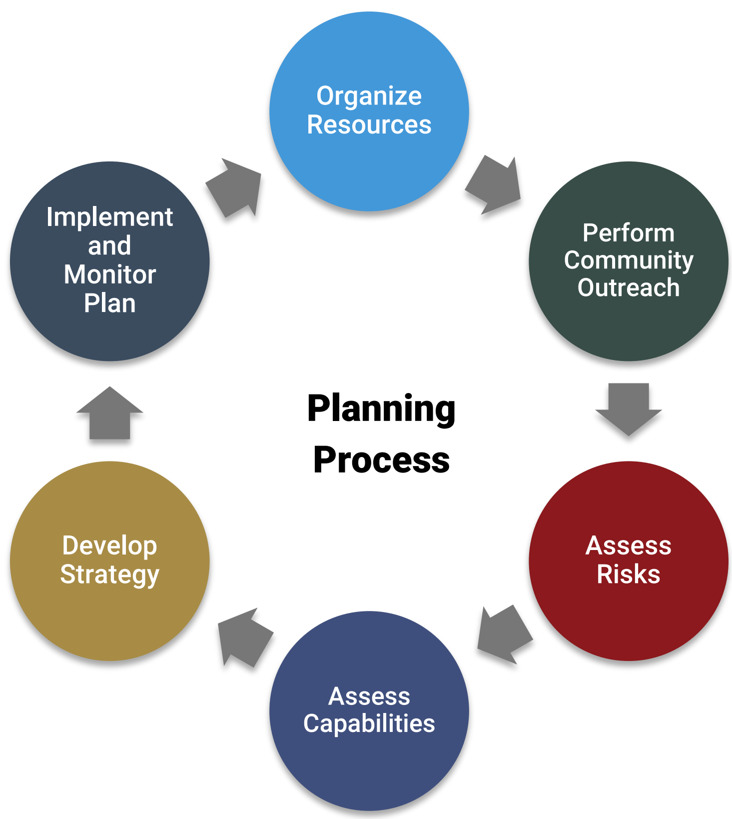

Figure 1. The Hazard Mitigation Planning Process

In compliance with Disaster Mitigation Act of 2000 requirements, public participation was encouraged throughout the Frederick County mitigation planning process. Frederick County formed a Hazard Mitigation Planning Committee composed of various county agencies, representatives from each participating community and education institution, and consultants from Dewberry Engineers, Inc.

The Hazard Mitigation Planning Committee was actively involved in identifying hazards in the communities, reviewing the County's risks from natural hazards, and making recommendations to reduce and prevent potential damage from these hazards. The committee then selected the most appropriate and feasible mitigation and adaptation actions that were included in the final strategy. The strategy will be implemented and monitored throughout the next five years until the following HMCAP update.

For more information on the planning process, see Chapter 2.

Planning Context

Frederick County is bound by Pennsylvania to the north, Carroll County to the east, Montgomery County to the south, Howard County to the southeast, Washington County to the west, and Virginia to the southwest. It is Maryland's largest county in terms of geographic area. The City of Frederick, the County seat, is intersected by 5 interstate and national highways that provide easy access to Baltimore (46 miles), Washington, DC (43 miles), Gettysburg, PA (32 miles), Harpers Ferry, WV (21 miles), and Leesburg, VA (25 miles). The County is home to the 5,700-acre Catoctin National Park, site of the Camp David Presidential Retreat; Fort Detrick; Mount Saint Mary's University; Hood College; the Emergency Management Institute; and the National Fire Academy. As of 2019, the population was 259,547, which is a 10% increase compared to 2010.

Frederick County has many valued community assets, including housing, transportation networks, utility infrastructure, higher education institutions, natural resources, its economy, and its people. **Of these assets, critical facilities, community lifelines, and people are especially prominent throughout the HMCAP.** All three are integral to allowing essential government and business operations to continue during and after a disaster. Social vulnerability is a new lens that the 2022 Plan update uses to paint a more complete picture of the community and its assets.

For more information on the planning context, see Chapter 3.

Hazard Identification and Risk Assessment Introduction

The hazard identification and risk assessment consists of three parts:

1. **Identify what hazards could affect the planning area,**
2. **Profile hazard events and determine what areas and community assets are the most vulnerable to damage from these hazards, and**
3. **Estimate losses and prioritize the potential risks to the community.**

The hazards are given priority levels as a part of the hazard profiling process. They are determined based on Hazard Mitigation Planning Committee input, as well as the five criteria to assign a quantitative ranking. Each criterion identifies and categorizes the comparative probability and potential vulnerability for the identified hazards. The framing criteria/questions are:

1. **Probability/History**: Has the hazard occurred in the area before, and if so, how often based on the historical record? Weighting Factor: 0.25
2. **Vulnerability**: If the expected event does occur, how many people might be killed, injured, or contaminated, and how much property might be damaged or destroyed (e.g., the percent of people or property vulnerable to the hazard)? Weighting Factor: 0.20
3. **Maximum Threat**: What is the worst-case scenario of the hazard and how bad can it get? What will the loss of life and property damage be if the worst-case scenario occurs (e.g., the percent of the community impacted by the hazard)? Weighting Factor: 0.10
4. **Warning Time**: How much time is the community given to prepare for an event? Weighting Factor: 0.10
5. **Ranking in Previous Plan**: The ranking from the 2011 Hazard Mitigation Plan (Significant, Moderate, Limited) was factored in the 2016 ranking. Weighting Factor: 0.35

For the full hazard identification and risk assessment introduction, see Chapter 4.

Hazard Risk Assessment

Each hazard from the 2016 plan was re-evaluated for the 2022 update based on the hazard priority criteria. The Plan further categorizes the hazards as high, medium-high, medium, medium-low, and low. Ultimately, the hazards listed in Table 0.1 were identified as relevant to Frederick County and incorporated into the risk assessment. They are the same hazards from the 2016 Plan. **Winter storm and flood are the highest ranked hazards in the County, followed by tornado, thunderstorm, and karst and land subsidence with a ranking of medium-high priority.**

Table 0.1. Hazards Identified as Relevant to Frederick County and Their Rankings

Hazards Type	2016 Priority Level	2022 Priority Level
Flood	High	High
Karst and Land Subsidence	Medium-High	Medium-High
Drought	Medium	Medium
Wildfire	Medium	Medium
Landslide	Medium-Low	Medium-Low
Dam and Levee Failure	Low	Low
Extreme Heat	Medium	Medium
Winter Storm	High	High
Thunderstorm	Medium-High	Medium-High
Tornado	Medium	Medium-High

Hazards Type	2016 Priority Level	2022 Priority Level
Tropical Cyclone	Medium	Medium
Earthquake	Medium-Low	Medium-Low

The risk assessment is primarily comprised of a hazard frequency analysis, loss estimates, a critical facility exposure analysis, and a vulnerability assessment. **Across all hazards in the plan, there have been 2,034 total events resulting in $131,263,350 in damages. This results in about $3,523,917 in damages every year.** The HMCAP aims to reduce this number by mitigating risks across the County, and especially to critical facilities, of which 378 are located in flood, wildfire, karst, and dam inundation hazard zones. Future development plans were also considered to provide an analysis of areas that should be moved or built to mitigate hazards during construction to prevent future loss and damages.

For the full hazard risk assessment, see Chapter 5.

Capability Assessment

Frederick County has a number of resources it can access to implement hazard mitigation initiatives. These resources include both private and public assets at the local, state, and federal levels. The capability assessment evaluates the current capacity of the communities of Frederick County to mitigate the adverse effects of the natural hazards identified in the hazard identification and risk assessment. By providing a summary of each jurisdiction's existing capabilities, the capability assessment serves as the foundation for designing an effective hazard mitigation strategy. **Overall, the County and the larger cities and towns prove to be capable of adequately carrying out mitigation and adaptation projects, but the smaller towns need substantial support from the County to accomplish the same.**

For the full capability assessment, see Chapter 6.

Mitigation and Adaptation Strategy

The Hazard Mitigation Planning Committee used the results of the hazard identification and risk assessment and the capability assessment to develop goals and objectives for the County. The committee members revised and streamlined the goals from the 2016 plan update into four goals, each with their own objectives. The goals in Table 0.2 represent Frederick County's vision for reducing damages due to natural hazards.

Table 0.2. Mitigation and Climate Adaptation 2022 Goals and Objectives

Mitigation Category	Goal	Objective
Physical Projects 	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
		Objective 2: Increase the resilience of critical facilities and infrastructure.
		Objective 3: Encourage property owners to maintain insurance that covers all hazards, including flood insurance through the National Flood Insurance Program.
		Objective 4: Prioritize equity and vulnerable populations in the implementation of physical hazard mitigation projects.
Capability and Capacity Building 	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
		Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance.
		Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
		Objective 8: Ensure County residents can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Public Awareness and Education	Goal C: Improve the public's awareness of potential hazards, education on	Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events.

Mitigation Category	Goal	Objective
	resilience planning, and incentives for mitigation actions.	Objective 10: Increase the public's awareness of their natural hazard risks. Objective 11: Provide the public with more opportunities to actively participate and provide input regarding hazard mitigation and climate adaptation activities.
Forward-Looking Policy and Planning 	Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.	Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts.
		Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
		Objective 14: Plan to retrofit infrastructure to make it resilient to future climate impacts.

In addition, the Committee identified and prioritized actions for the County and each jurisdiction within it. **Each jurisdiction's actions were developed based on past damages, existing risk and vulnerabilities, community input, and current capabilities.** The STAPLE/E methodology was used to capture these values consistently. It allows for the Hazard Mitigation Planning Committee to take social, technical, administrative, political, legal, economic, and environmental considerations into account when reviewing potential actions for inclusion in the strategy.

For the full mitigation and adaptation strategy, see Chapter 7.

Implementation and Maintenance

The HMCAP identifies procedures for implementing and maintaining the Plan as a living document that continuously guides actions within the Frederick County. The Frederick County Division of Emergency Management and the Hazard Mitigation Planning Committee will submit a 5-year written update to the State and FEMA Region III, unless a disaster or other circumstances lead to a different time frame. In the interim, the HMCAP will be integrated into county plans, municipal plans, and other documents as applicable and the Committee will hold an annual meeting to evaluate and monitor progress.

Since feedback from residents, businesses, and other stakeholders is a critical part of hazard mitigation planning, public notice of the annual review will be given and public participation will be actively invited. The County will post a link to the HMCAP on the Frederick County Division of Emergency Management's website. It is recommended that the County's website serve as a means of facilitating outreach by providing information about mitigation initiatives and updates to the projects and the HMCAP itself.

For the more information on plan implementation and maintenance, see Chapter 8.

CHAPTER 1. INTRODUCTION

In 2005, Frederick County approved its first Hazard Mitigation Plan to help reduce risk and protect life and property. Since then, the Plan has been routinely updated through 2016. In 2022, the Plan has progressed into the Frederick County Hazard Mitigation and Climate Adaptation Plan (HMCAP) to more thoroughly address the evolving risks posed by natural hazards.

Frederick County has 12 municipalities: the City of Brunswick, the City of Frederick, the Town of Burkittsville, the Town of Emmitsburg, the Town of Middletown, the Town of Mount Airy, the Town of Myersville, the Town of New Market, the Town of Rosemont,[1] the Town of Thurmont, the Town of Walkersville, and the Town of Woodsboro. Frederick Community College, Hood College, and Mount Saint Mary's University are also included in the HMCAP. Separate annexes were prepared for the colleges and are contained in appendices.

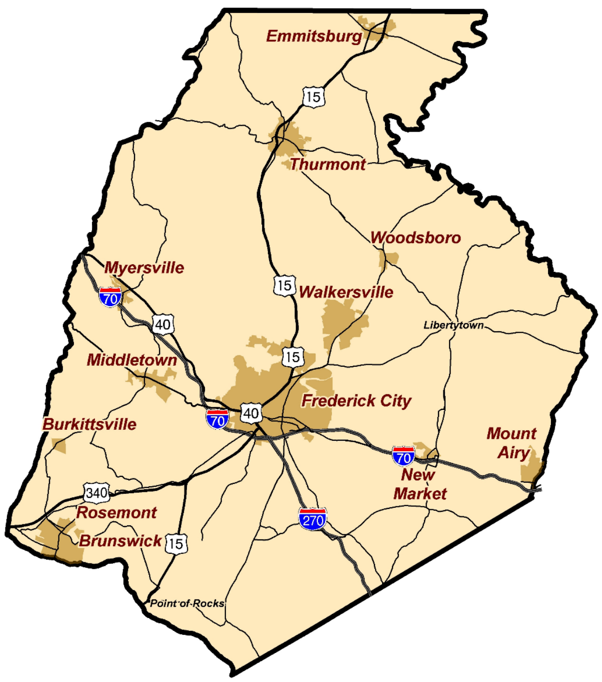

Figure 1.1. Frederick County and its Municipalities

Purpose

The purpose of the HMCAP update is to assess the communities' vulnerabilities to natural hazards and prepare a long-term strategy that takes into account climate change to adequately address these hazards and prevent future damage and loss of life. The Plan relies on active participation from county officials, municipality officials, residents, and stakeholders.

Hazard mitigation is any action taken to permanently reduce or eliminate long-term risks to people and their property from the effects of natural hazards. Climate adaptation goes hand-in-hand with hazard mitigation—requiring that mitigation is performed for current natural hazard threats, as well as for how those threats will

[1] Throughout this plan, Rosemont is referred to as a "Village" as it is historically and colloquially known as one, though technically it is a town.

evolve in the future. Natural hazards come in many forms: tornadoes, floods, hurricanes, severe storms, winter freezes, droughts, landslides, and dam failures. Communities can take steps to prepare and implement mitigation techniques for almost any type of hazard that may threaten their citizens, businesses, and institutions.

This HMCAP establishes an ongoing hazard mitigation planning program by identifying and assessing potential natural hazards that may threaten life and property, evaluating local mitigation measures that should be undertaken, and outlining procedures for monitoring the implementation of mitigation and adaptation actions. The Plan guides county officials and encourages the most effective and appropriate activities to mitigate and adapt to the effects of all identified natural hazards.

Why Plan for Mitigation?

In the past, federal legislation has provided funding for disaster relief, recovery, and some hazard mitigation planning. The Disaster Mitigation Act of 2000, enacted in October 2000, improved this planning process. This legislation reinforced the importance of mitigation planning and emphasized planning for disasters before they occur. As such, Disaster Mitigation Act of 2000 established the Pre-Disaster Mitigation (PDM) program (now replaced by Building Resilient Infrastructure and Communities [BRIC] program) and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP). Disaster Mitigation Act of 2000 was intended to facilitate cooperation between state and local authorities, prompting them to work together and encouraging and rewarding local and state pre-disaster hazard mitigation planning. The goal of the planning process was to enable local and state governments better to articulate mitigation needs, thus resulting in the faster allocation of funding and more effective risk reduction projects.

The Frederick County Hazard Mitigation and Climate Adaptation Plan is multi-jurisdictional (i.e., a plan that includes municipalities and unincorporated areas of the County). Any future Federal Emergency Management Agency (FEMA) funding for mitigation projects is contingent upon plan approval and adoption. Any jurisdiction that does not participate in the planning process and adopt the Plan will not be eligible for pre- and post-disaster FEMA Hazard Mitigation Assistance (HMA) program funds.

Consistency with State and Federal Mitigation and Climate Policies

The plan's goals, objectives, and policies intend to implement the national and state directives to mitigate natural hazards through local strategies.

Mitigation planning begins locally; however, the benefits accrue to the American people as a whole. According to FEMA, "mitigation efforts provide value to the American people by (1) creating safer communities by reducing loss of life and property, (2) enabling individuals to recover more rapidly from floods and other disasters, and (3) lessening the financial impact on the treasury, states, tribes, and communities."[2]

The State of Maryland's Hazard Mitigation Goal is:

"To protect life, property, and the environment from hazard events through:

- Increased public awareness of hazard events, mitigation, and preparedness.
- Enhance coordination with jurisdictions to develop a relationship at the state- and local-levels.

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[2] FEMA. *FEMA's Mitigation Directorate Fact Sheet*. Spring/Summer 2008.

- Efficient use of State resources."

Where possible, the goals, objectives, and strategies selected by Frederick County align with the State plan's goals and objectives.

Existing Studies and Plans Reviewed

Planning documents, studies, guides, regulations/ordinances, and policies were reviewed and incorporated during the initial plan and subsequent updates. The plans included FEMA documents and emergency services documents, county and local general plans, community plans, local codes and ordinances, state plans, and other similar documents. They include:

- Frederick County and municipal comprehensive plans
- County and municipal codes and ordinances, including floodplain ordinances
- State and local mitigation planning guidance
- FEMA CRS-Disaster Mitigation Act of 2000 Mitigation Planning Requirements
- 2009 Maryland Emergency Management Agency and FEMA Crosswalk Comments
- FEMA RiskMAP Monocacy Watershed Discovery Report, September 2014
- Climate Emergency Mobilization Workgroup Final Report (2021)
- Metropolitan Washington Council of Governments 2030 Climate and Energy Action Plan (2020)

Additional plans reviewed can be found in Chapter 6.

Relationship to the Livable Frederick Master Plan

The Livable Frederick Master Plan is a new approach to comprehensive planning in Frederick County, MD. It is a long-term planning tool that will guide Frederick toward sustained livability through a framework of attitudes and actions that support the County's vision.

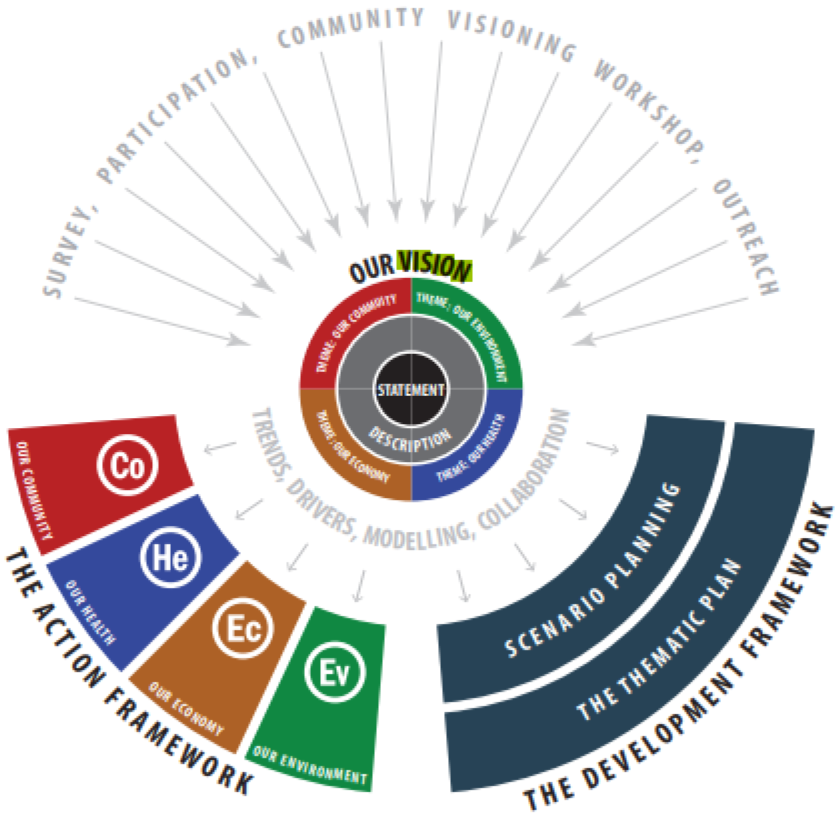


Figure 1.2. The Three-Part Structure of the Livable Frederick Master Plan

Livable Frederick Comprehensive Planning values integration, so it was necessary for this hazard mitigation plan update to follow the lead of the Master Plan and continue to build toward livability. The Hazard Identification and Risk Assessment contains a future development that utilizes the Livable Frederick Comprehensive Map data to enhance our understanding of how spatial hazards may affect the County's future development. This is a foundational step that can help guide future planning. The HMCAP reflects the hazard-related positions, policies, and actions as outlined in the "Our Environment" vision theme of the Action Framework. The Mitigation and Adaptation Strategy in the HMCAP contains the activities integrated and adapted from the Livable Frederick Master Plan.

Relationship to the Forthcoming Frederick County Climate Action Plan

As of February 2022, Frederick County is in the development stages of a Climate Action Plan for County Operations. The Plan will outline specific actions that the County will take to reduce county emissions and increase its resilience in the face of climate change. The Plan covers government operations such as buildings, facilities, infrastructure, and equipment. Alternatively, the HMCAP does not focus on emissions and is inclusive of both public and private property throughout the County, as well as county planning, policy, and public outreach.

Plan Organization

The remaining chapters comprise the updated HMCAP:

- **Chapter 2** outlines the planning process;
- **Chapter 3** contextualizes the Plan by providing background on Frederick County;
- **Chapter 4** identifies the hazards covered in the Plan and introduces the fundamentals of the risk assessment;
- **Chapter 5** presents the risk assessment, which includes the loss estimation and vulnerability analysis;
- **Chapter 6** illustrates the capabilities that Frederick County currently has to carry out the mitigation and adaptation strategy;
- **Chapter 7** states the goals and objectives, then discusses the mitigation and adaptation actions that support achieving those goals and objectives; and
- **Chapter 8** contains the procedure for maintenance, including monitoring and evaluation of plan implementation.

To help with document navigation, the bars on the bottom left of the document are coordinated to the color assigned to each chapter as show in the bulleted list above. The chapter title is also listed in the bottom left corner of every page.

Throughout the individual hazard sections in Chapter 5, hazard icons are contained in the top left or right corner of the page. The colors of these icons represent the hazard's ranking as determined by the hazard prioritization process. The hazard rankings and their associated colors are shown in the graphic below, but they are also discussed and explained in Chapter 4 and Chapter 5.

Low	Medium - Low	Medium	Medium - High	High

The HMCAP also has appendices in a separate document that provide supplementary details and materials. The appendices are:

- Appendix A: Pluvial Flooding Analysis
- Appendix B: 2016 Mitigation Actions Update
- Appendix C: Hazard Histories
- Appendix D: Critical Facility Hazard Analysis Results
- Appendix E: Maps
- Appendix F: Internal Planning Meeting Materials
- Appendix G: Public Outreach Materials
- Appendix H: HAZUS Reports

CHAPTER 2. PLANNING PROCESS

In compliance with Disaster Mitigation Act of 2000 requirements, public participation was encouraged throughout the Frederick County mitigation planning process. Frederick County formed a Hazard Mitigation Planning Committee, composed of various county agencies and representatives from each participating community.

The Hazard Mitigation Planning Committee was actively involved in identifying hazards in the communities, reviewing the County's vulnerabilities to natural hazards, and making recommendations to reduce and prevent potential damage from these hazards. The committee then selected the most appropriate and feasible mitigation measures.

The planning process involves six steps that ensures Frederick County is a safe and resilient community (Figure 3).

Figure 3. The Hazard Mitigation Planning Process

Resources

Even before the Hazard Mitigation Planning Committee was formed, the County organized its resources to ensure adequate technical assistance and expertise to create a hazard mitigation committee. Once created, the Hazard Mitigation Planning Committee included representatives from key functional areas such as planning, emergency management, GIS, public works, and representatives from each incorporated municipality.

Leadership

The HMCAP was led and created by the County, municipal, college, and university officials tied to emergency management and hazard mitigation activities and planning. They constituted the Hazard Mitigation Planning Committee and the Local/College Planning Teams. Additionally, Frederick County worked with consultants from Dewberry to facilitate the Plan update.

The Hazard Mitigation Planning Committee, Local Planning Teams, and College Planning Teams met several times throughout the hazard mitigation planning process, as shown in Table 2.1.

Table 2.1. Meetings Throughout the Hazard Mitigation Planning Process

Meeting	Date	Purpose	# of Attendees
Steering Committee Kick-Off	June 23, 2021	Coordinate on hazard mitigation planning process	8
Hazard Mitigation Planning Committee Kick-Off	July 13, 2021	Review the hazard mitigation planning process and discuss new hazard issues/mitigation needs	31
Local/College Planning Team Update Workshops	August 25 – September 16, 2021	Collect updates on hazard mitigation needs, completed projects, 2016 strategy progress, capability assessment, etc. since the 2016 plan	1-17 (varied on specific meeting)
Hazard Identification and Risk Assessment (HIRA) Workshop	October 14, 2021	Review findings from the risk assessment and discuss new goals/objectives	31
Public Meeting #1	October 28, 2021	Provide an overview of the hazard mitigation planning process, solicit input through the Story Map and Survey, review high-level findings from the risk assessment	11
Resilience Strategy Coordination Meeting #1	November 9, 2021	Discuss opportunities for information sharing between the hazard mitigation plan update and the upcoming operations resilience plan	10
Local/College Planning Team Strategy Workshops	November 30 – December 2, 2021	Provide final feedback on the goals/objectives and make decisions on mitigation and adaptation actions for each town, city, college, university, and county	34 (total)
Community Rating System (CRS) Workshop	December 8, 2021	Complete a CRS toolkit activity and discuss current potential standing and path forward for the County	10
Public Meeting #2	December 9, 2021	Review hazard mitigation planning process until this point, review goals/objectives/actions highlights, review public feedback received,	Aired on TV

Meeting	Date	Purpose	# of Attendees
		review risk assessment highlights, provide information on the upcoming plan review period	
Resilience Strategy Coordination Meeting #2	December 14, 2021	Discuss feedback on the climate impacts section, HIRA, new goals/objectives, and mitigation and adaptation actions	9
Hazard Mitigation Planning Committee Plan Review Workshop	January 26, 2022	Reviewed the draft plan, discussed major changes, and provided further feedback on final changes	24

Hazard Mitigation Planning Committee

Representatives of the local municipalities and the County were invited to serve on the Hazard Mitigation Planning Committee, tasked with conducting a Disaster Mitigation Act of 2000-compliant hazard mitigation planning process and updating the hazard mitigation plan. Table 2.2. identifies the members of the committee, the agencies they represent, and their participation. It is not noted in the table, but some Hazard Mitigation Planning Committee members were also present during the public meetings as passive viewers.

Table 2.2. Frederick County Hazard Mitigation Planning Committee Members

Name	Position/Role	Agency or Municipality	Participation
Jack Markey	Director of Division of Emergency Management	Frederick County Division of Emergency Management	• Steering Committee Kick-Off • Hazard Mitigation Planning Committee Kick-Off • HIRA Workshop • Frederick County Local Planning Teams Strategy Workshop • Resilience Plan Coordination Meetings
Anthony (Tony) Rosano	Deputy Director of Division of Emergency Management	Frederick County Division of Emergency Management	• Steering Committee Kick-Off • Hazard Mitigation Planning Committee Kick-Off • Frederick County Local Planning Teams Update Workshop • HIRA Workshop

Name	Position/Role	Agency or Municipality	Participation
			• Frederick County Local Planning Teams Strategy Workshop • Public Meetings Presenter • Resilience Plan Coordination Meetings • CRS Workshop • Final Draft Review Workshop
Dennis Dudley	Director of Department of Emergency Preparedness	Frederick County Division of Emergency Management	• Steering Committee Kick-Off • Hazard Mitigation Planning Committee Kick-Off • Frederick County Local Planning Teams Update Workshop • HIRA Workshop • All Local Planning Teams Strategy Workshops • Public Meetings Presenter • CRS Workshop • Final Draft Review Workshop
Rohan Brown	Planner, Emergency Preparedness	Frederick County Division of Emergency Management	• Steering Committee Kick-Off • Hazard Mitigation Planning Committee Kick-Off • Frederick County Local Planning Teams Update Workshop • HIRA Workshop • Frederick County Local Planning Teams Strategy Workshop • CRS Workshop
Mary Domer	Executive Assistant	Frederick County Division of Emergency Management	• Steering Committee Kick-Off • Hazard Mitigation Planning Committee Kick-Off

Name	Position/Role	Agency or Municipality	Participation
			• HIRA Workshop
Sharon Riddell	Administrative Specialist, Emergency Preparedness	Frederick County Division of Emergency Management	• Steering Committee Kick-Off • Hazard Mitigation Planning Committee Kick-Off • Frederick County Local Planning Teams Update Workshop • HIRA Workshop • Final Draft Review Workshop
Jon Newman	Battalion Chief 902, Emergency Services	Frederick County Division of Fire & Rescue Services	• Frederick County Local Planning Teams Update Workshop • Frederick County Local Planning Teams Strategy Workshop • Final Draft Review Workshop
Jason Stitt	Department Head, Department of Engineering and Construction Management	Frederick County Division of Public Works	• Hazard Mitigation Planning Committee Kick-Off • Frederick County Local Planning Teams Update Workshop • Frederick County Local Planning Teams Strategy Workshop
Dave Ennis	Department Head Department Highways and Facilities Maintenance	Department of Highway Operations	• Frederick County Local Planning Teams Update Workshop • HIRA Workshop • Frederick County Local Planning Teams Strategy Workshop • CRS Workshop • Final Draft Review Workshop
Tyler Muntz	Department Head of Professional Services	Frederick County Division of Public Works	• Frederick County Local Planning Teams Update Workshop

Name	Position/Role	Agency or Municipality	Participation
Kendra Lindenberg	Grant Manager	Frederick County Emergency Management	• Hazard Mitigation Planning Committee Kick-Off
Todd Johnson	Public Health Emergency Planner/SNS Coordinator Public Health Preparedness Division of Health Care Connection and Preparedness	Frederick County Health Department	• Hazard Mitigation Planning Committee Kick-Off • Frederick County Local Planning Teams Update Workshop • HIRA Workshop • Frederick County Local Planning Teams Strategy Workshop
Shannon Moore	Director, Environmental Sustainability	Frederick County Office of Sustainability and Environmental Resources, Office of County Executive	• Hazard Mitigation Planning Committee Kick-Off • Frederick County Local Planning Teams Update Workshop • Frederick County Local Planning Teams Strategy Workshop • Resilience Plan Coordination Meetings
Donald Dorsey	Sustainability Project Manager IV	Frederick County Office of Sustainability and Environmental Resources, Department of Stormwater, Office of County Executive	• Hazard Mitigation Planning Committee Kick-Off • Frederick County Local Planning Teams Update Workshop • HIRA Workshop • Frederick County Local Planning Teams Strategy Workshop • Resilience Plan Coordination Meetings • CRS Workshop • Final Draft Review Workshop
Dawn Ashbacher	Sustainability Program Manager	Frederick County Division of Planning and Permitting	• Hazard Mitigation Planning Committee Kick-Off • Frederick County Local Planning Teams Update Workshop • HIRA Workshop

Name	Position/Role	Agency or Municipality	Participation
			• Frederick County Local Planning Teams Strategy Workshop • Resilience Plan Coordination Meetings • CRS Workshop • Final Draft Review Workshop
Kimberly Brandt	Director Planning, Livable Frederick	Frederick County Office of County Executive	• Hazard Mitigation Planning Committee Kick-Off • Frederick County Local Planning Teams Update Workshop • HIRA Workshop
Abby Ingram	Planning & Zoning, Project Coordinator	City of Brunswick	• Hazard Mitigation Planning Committee Kick-Off • City of Brunswick Local Planning Teams Update Workshop • Final Draft Review Workshop
Zach Kershner	Director, Division of Public Works	City of Frederick	• City of Frederick Local Planning Teams Update Workshop
Tracey Coleman	Deputy Director, Division of Public Works	City of Frederick	• Hazard Mitigation Planning Committee Kick-Off • City of Frederick Local Planning Teams Update Workshop • HIRA Workshop • City of Frederick Local Planning Teams Strategy Workshop • Final Draft Review Workshop
Joe Lindstrom	Risk, Safety, and Emergency Manager	City of Frederick	• City of Frederick Local Planning Teams Update Workshop
Paul Beliveau	Security and Emergency Preparedness Specialist	City of Frederick	• City of Frederick Capability Assessment Worksheet Input

Name	Position/Role	Agency or Municipality	Participation
			•
Robin Shusko	Director of Campus Safety and Emergency Management, Security and Emergency Preparedness	Frederick Community College	• Hazard Mitigation Planning Committee Kick-Off • FCC College Planning Team Update Meeting • HIRA Workshop • FCC College Planning Team Strategy Workshop
Thurmond Maynard II	Director and Chief of Campus Safety	Hood College	• Hazard Mitigation Planning Committee Kick-Off • HC College Planning Team Update Workshop • HIRA Workshop • Final Draft Review Workshop
Rowela Lascolette	Risk Manager	Hood College	• Hazard Mitigation Planning Committee Kick-Off • HIRA Workshop • Final Draft Review Workshop
Ron Hibbard	Director of Public Safety	Mount Saint Mary's University	• Hazard Mitigation Planning Committee Kick-Off • MSM Local Planning Teams Update Workshop • MSM Local Planning Teams Strategy Workshop • Final Draft Review Workshop
Kevin Fox	Training and Emergency Management Coordinator	Mount Saint Mary's University	• Hazard Mitigation Planning Committee Kick-Off • MSM Local Planning Teams Update Workshop • HIRA Workshop • MSM Local Planning Teams Strategy Workshop • Final Draft Review Workshop
Deborah (Debby) Burgoyne	Mayor	Town of Burkittsville	• Town of Burkittsville Local Planning Teams Update Call

Name	Position/Role	Agency or Municipality	Participation
			• Town of Burkittsville Local Planning Teams Strategy Workshop
Cathy Willets	Town Manager	Town of Emmitsburg	• Town of Emmitsburg Local Planning Teams Update Workshop • HIRA Workshop • Town of Emmitsburg Local Planning Teams Strategy Workshop
Andrew (Drew) Bowen	Town Administrator	Town of Middletown	• Town of Middletown Local Planning Teams Update Workshop • HIRA Workshop
David Warrington	Town Administrator	Town of Mount Airy	• Hazard Mitigation Planning Committee Kick-Off
Kristin Aleshire	Town Manager	Town of Myersville	• Hazard Mitigation Planning Committee Kick-Off • Town of Myersville Local Planning Teams Update Workshop
Brandon Boldyga	Planning & Zoning Adm.	Town of Myersville	• Town of Myersville Local Planning Teams Update Workshop
Shawn Burnett	Town Engineer	Town of New Market	• Town of New Market Local Planning Teams Strategy Workshop
Jim Humerick	Chief Administrative Officer	Town of Thurmont	• Hazard Mitigation Planning Committee Kick-Off • Town of Thurmont Local Planning Team Update Workshop • Town of New Market Local Planning Teams Strategy Workshop • Final Draft Review Workshop
Sean Williams	Town Manager	Town of Walkersville	• Hazard Mitigation Planning Committee Kick-Off

Name	Position/Role	Agency or Municipality	Participation
			• Town of Walkersville Local Planning Teams Update Workshop • HIRA Workshop • Final Draft Review Workshop
Joe Birch	Planning & Zoning	Town of Walkersville	• Town of Walkersville Local Planning Teams Update Workshop • HIRA Workshop • Final Draft Review Workshop
Mary Rice	Town Manager	Town of Woodsboro	• Town of Woodsboro Mitigation Goals and Strategy Input (email)
Tom Watson	Burgess	Village of Rosemont	• Village of Rosemont Local Planning Teams Update Email • Village of Rosemont Local Planning Teams Strategy Workshop • Town of Woodsboro Local Planning Teams Strategy Input
Christine Gentry	Maryland Division of Emergency Preparedness	National Capital Regional Planner	• Hazard Mitigation Planning Committee Kick-Off
			•

Local Planning Teams

In addition to the Hazard Mitigation Planning Committee described above, Dewberry consultants held one-on-one meetings with representatives each town, city, college, university, and county to help them gather the information needed for the Plan update. These smaller planning groups were referred to as Local Planning Teams/College Planning Teams.

Select members from the Hazard Mitigation Planning Committee were a part of their respective jurisdiction or institution's Local Planning Teams/College Planning Team, along with other key officials that could provide the level of detail and input necessary to update the plan's information, share developments since the 2016 plan, and determine a final mitigation and adaptation strategy. Two Local Planning Teams/College Planning Team workshop series were held, as described in Table 2.1 above. Participation in these teams is described in Table 2.3. Local Planning Teams/College Planning Teams members would reach out to other officials for input when necessary, and they may not be named below.

Table 2.3. Local Planning Teams/College Planning Teams Membership

Jurisdiction, College, or University	Local Planning Team/College Planning Team	Members
Frederick County	Local Planning Teams	Jon Newman, Jason Stitt, Dave Ennis, Tyler Muntz, Jack Markey, Anthony (Tony) Rosano, Dennis Dudley, Rohan Brown, Sharon Riddell, Rebecca Rogers, Todd Johnson, Shannon Moore, Donald Dorsey, Dawn Ashbacher, Rachel Elizabeth Rosenberg Goldstein, Kimberly Brandt
City of Brunswick	Local Planning Teams	Abby Ingram, Bruce Dell, John Gerstner, Captain Matthew Lynch, Jeremy Mose, Matt Campbell, Chief Andy Smothers, Todd Shepherd, Vaughn Ripley, Andrew (Andy) St. John, Nathan Brown
City of Frederick	Local Planning Teams	Tracey Coleman, Zach Kershner, Joe Lindstrom, Paul Beliveau, Nathan Hupp
Town of Burkittsville	Local Planning Teams	Debby Burgoyne
Town of Emmitsburg	Local Planning Teams	Cathy Willets, Dan Fissel, Jared Brantner, Zach Gulden
Town of Middletown	Local Planning Teams	Andrew (Drew) Bowen
Town of Mount Airy	Local Planning Teams	John Breeding
Town of Myersville	Local Planning Teams	Kristin Aleshire, Brandon Boldyga
Town of New Market	Local Planning Teams	Shawn Burnett
Town of Thurmont	Local Planning Teams	Jim Humerick, John Kinnaird, Kelly Duty

Jurisdiction, College, or University	Local Planning Team/College Planning Team	Members
Town of Walkersville	Local Planning Teams	Sean Williams, Joe Birch
Town of Woodsboro	Local Planning Teams	Heath Barnes, Mary Rice, Shawn Burnett
Village of Rosemont	Local Planning Teams	Tom Watson
Frederick Community College	College Planning Team	Robin Shusko, Lewis Godwin, John Anzinger
Hood College	College Planning Team	Thurmond Maynard II, Rowela Lascolette
Mount St. Mary's University	College Planning Team	Ron Hibbard, Kevin Fox

Data

The mitigation plan update began with data collection. A kick-off meeting was held on July 13, 2021, with the Frederick County Division of Emergency Management and representatives from the County's Division of Public Works, Division of Planning& Permitting, and the Division of Fire & Rescue Services. The planning process and proposed deliverables were discussed in detail.

Community, county, state, federal, and college/university resources were identified and contacted to collect pertinent policy and regulatory information from each community and the County. This information included comprehensive plans, floodplain ordinances, zoning ordinances building codes, GIS data, and other reports and plans since 2016 (see Chapter 6 for a list). The Hazard Mitigation Planning Committee provided information about critical facilities, assets, and natural hazards, including past occurrences and anticipated hazard issues.

Specific local sources are listed in Chapter 6 and in the annexes; state/national sources include:

- State of Maryland Hazard Mitigation Plan (2016 and 2021 draft update)
- Frederick County GIS Database
- State of Maryland GIS Database
- Maryland Department of the Environment dam data
- Maryland Department of Natural Resources wildfire data

- FEMA mitigation planning guidance
- FEMA Disaster Mitigation Act of 2000 planning requirements
- FEMA Benefit Cost Analysis (BCA) Toolkit Technical Flood Manuals
- 2010 and 2020 U.S. Census Data
- 2015 – 2019 US Census Bureau American Community Survey
- US Department of Commerce data
- United States Geological Survey Engineering Aspects of Karst data and County historical data
- United States Geological Survey Landslide susceptibility data
- United States Geological Survey Earthquake Hazards Program data
- National Center for Environmental Information (NCEI) Storm Events Database
- Autonomous Modular System (AMS) fire data

High hazard potential dam sources included:

- 2021 Draft Maryland State Hazard Mitigation Plan
- 2016 Maryland State Hazard Mitigation Plan
- FEMA's Monocacy and Portion of Middle Potomac-Catoctin Watersheds Study: Flood Risk Report
- Frederick County GIS Database
- United States Army Corps of Engineers' National Inventory of Dams data
- Stanford University's National Performance of Dams Program Dam Incident Database
- Dam Safety Permits Division of the Stormwater, Dam Safety, and Flood Management Program within the Maryland Department of the Environment's data
- Emergency Action Plans for the following dams: Lake Heritage, Holly Hills, Monocacy Boulevard No. 440, Mason-Dixon Farms Irrigation Pond, Lake Linganore, Lake Merle, Rainbow Lake, Fishing Creek, and Hunting Creek CFSP
- Frederick County Dam Ratings List
- Town of Thurmont – Areas of Potential Inundation from Dam Failure During Probable Maximum Flood Map

Public Involvement

The public involvement element of the planning process involved a hazard mitigation survey, two virtual public meetings, and a draft review period. The hazard mitigation survey was available online to the public from September 20 – November 5, 2021. The survey was promoted via social media (Appendix G) and shared through the following local community channels:

- Church groups (email),
- Hood College (email),
- Mount St. Mary's University (email),
- Frederick Community College (email),
- Fort Detrick employees (email), and
- Frederick County Chamber of Commerce Newsletter (90,000-person reach).

The first public meeting was held virtually on October 28, 2021, through Microsoft Teams. A second meeting was held virtually on December 9, 2021, through Frederick County's FCG TV channel and online stream. Representatives from Frederick County Division of Emergency Preparedness were available to address questions and solicit input regarding the type of mitigation measures the Hazard Mitigation Planning Committee should pursue. Questions and comments could be submitted during the meeting or (for the second meeting only) before it through an online submission form or a call-in number. Public notices announcing the meetings were posted online and circulated through social media (Appendix G). A draft of the HMCAP was distributed to priority groups and posted online for public and stakeholder comment from January - February 2022, along with a survey to gather questions and feedback.

The Maryland Department of Emergency Management served as the state review agency for this mitigation plan. FEMA Region 3 and the Maryland Department of the Environment received a draft of the Plan for review and comment.

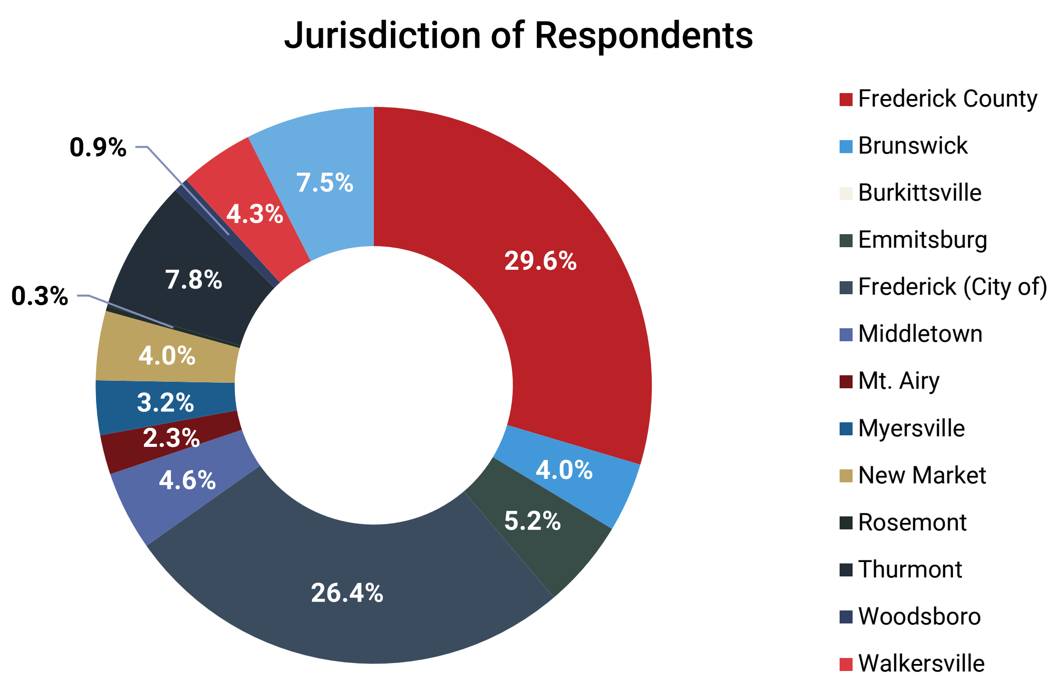
Virtual Outreach

Due to the COVID-19 pandemic, public involvement and engagement were entirely virtual. The hazard mitigation survey, public meetings, and draft review were made available online to promote widespread access and maintain safe social distancing practices. This made the promotion of the opportunities even more critical, so increased social media outreach was done. Existing local groups on Facebook and Reddit were used for advertising, specifically the Frederick County MD Events and Activities Facebook Group and the Frederick County subreddit. This allowed for outreach to community members that aren't reached through normal emergency management channels and an opportunity for direct feedback and questions on the posts.

Public Survey Results

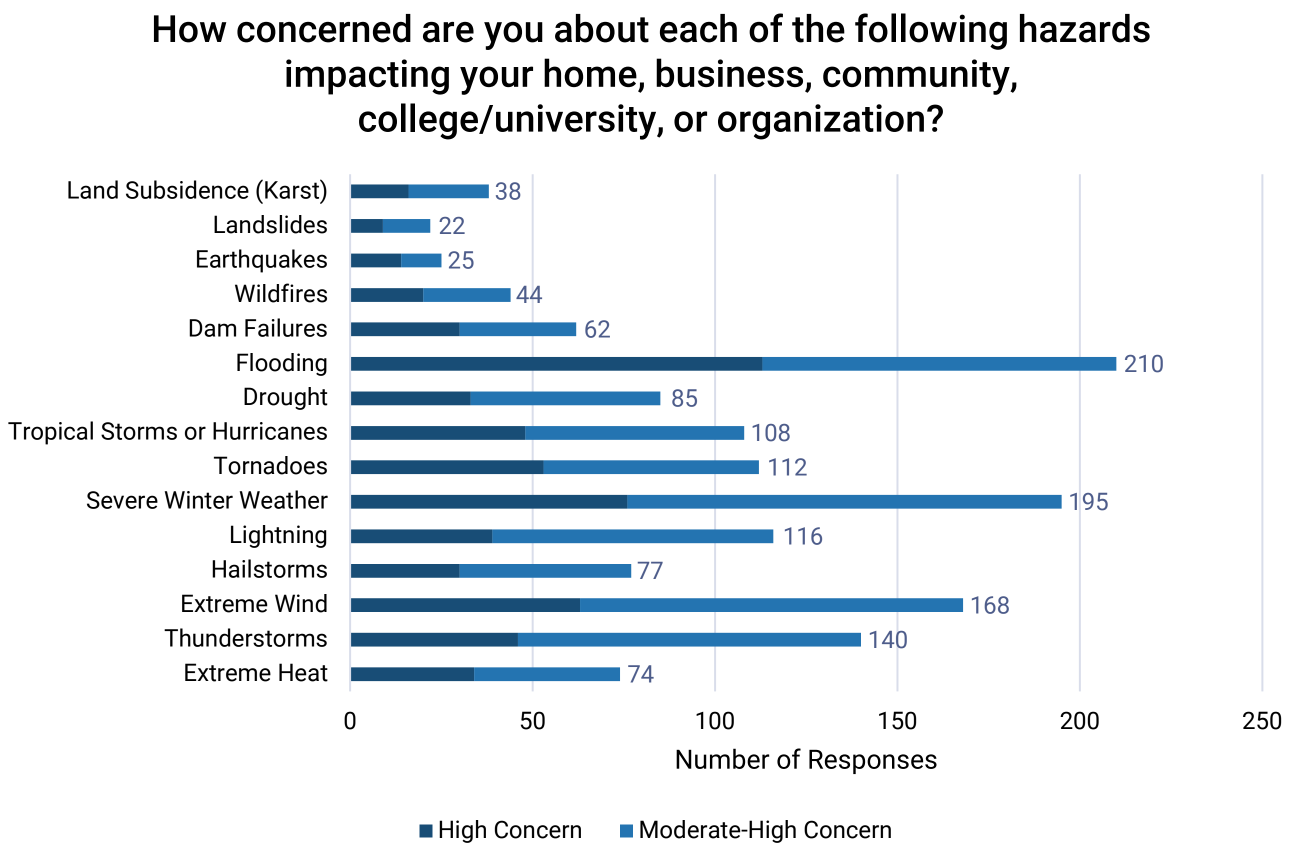
The public survey collected a total of 684 responses from Frederick County residents, business owners, workers, and students, faculty, and staff of colleges and universities in the jurisdiction. The survey was conducted from September to October of 2021 and included several questions on hazard awareness, hazard mitigation techniques, and hazard mitigation preferences. More than half of the participants responded to the survey based on their experiences as a resident of Frederick County. Aside from residents, almost 40% of respondents participated as a student, faculty member, or staff member of a college or university in Frederick County.

More than one-quarter of respondents that reside in the County reported that they live in the City of Frederick, the most of any locality. The survey collected responses from residents in all County localities, except for Burkittsville where no responses were received.

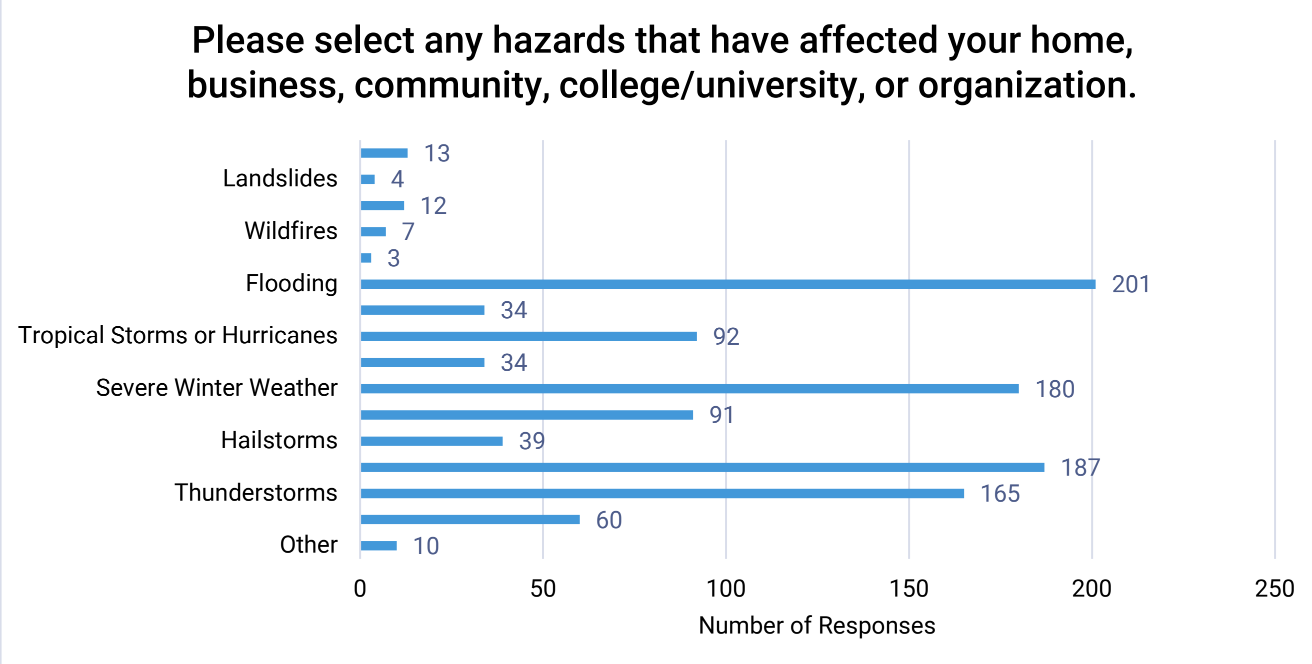


Overall, survey respondents seemed less aware of the County's hazard mitigation efforts than emergency communications. Less than half of survey respondents said they knew that Frederick County maintains a hazard mitigation plan. Still, more than two-thirds had signed up for or knew about the Alert FC emergency notification system.

Flooding is a top concern to Frederick County residents. More than half (57%) respondents reported that they have high or moderate-high concerns about flooding affecting their home, business, or community, the most of any hazard. Other hazards residents cited moderate-high to high concerns about include severe winter weather and extreme wind. Fewer Frederick County residents are as severely concerned about earthquakes or landslides: less than 10% of residents reported either one as a moderate-high or high concern.



In line with these concerns, more than half of residents reported that their home, business, community, college or university, or organization had been previously affected by either a flood, extreme wind, or severe winter weather. In comparison, few residents reported prior experiences being affected by wildfires, landslides, or dam failures. Residents who cited "other" hazards reported experiences with sustained power outages, fallen or damaged trees, and burst pipes due to extremely cold temperatures.



More than three-fourths of participants said recent events have made them more aware of the danger of hazards. Of those that cited specific events, majority reported flooding, rain, and hurricanes raised their awareness of related dangers.

Majority (75%) of survey respondents reported that they had taken actions to reduce the risk or vulnerability to hazards of their family, home, business, organization. The top three most cited risk reduction actions taken included maintaining disaster supply kits, developing disaster plans, and purchasing generators for one's home. Despite cited concerns and experiences with flooding, few residents reported purchasing either flood insurance (7%) or enhanced homeowner insurance coverage (7%). Further, perceptions of hazards do not appear to affect residents' decisions to live in the area: more than half (54%) of respondents said they would repair or rebuild their property in the same location if a disaster substantially damaged their home.

Community Comments

"The recent flash floods have me concerned. This year is the first time since I have lived and worked in the county that a heavy storm lead to flash flooding that caused work (FCC campus) to shut down early."

"The most recent rainstorms that were within a week or two of each other and brought a massive amount of rainfall. I have not seen it rain like that outside of a tropical system before at my house and I experienced minor basement flooding from the rain."

Survey participants were asked what they believed the most important actions that Frederick County could take to mitigate hazards and become more resilient over time. Residents could select multiple important actions. More than two-thirds of respondents cited localized flood-risk reduction projects, the most of any action. Other commonly cited actions included public outreach and education (61%), a public warning system (58%), and technical assistance for residents, businesses, jurisdictions, and organizations to execute their own mitigation projects (49%). When asked to identify one mitigation action Frederick County could take, many respondents provided open-ended answers related to flood and stormwater mitigation projects, public education and outreach about hazards, and emergency services and notifications.

Overall, the hazard mitigation survey illustrated Frederick County residents' high concern for flooding, severe winter weather, and high winds. Much of the work that residents have done personally in response to this perceived risk are preparedness activities, such as buying emergency kits or making plans in case of a hazard or emergency. This highlights the need for a strong hazard mitigation effort in Frederick County that is responsive to the risks and vulnerabilities outlined later in this plan, as well as the concerns of residents, especially flood-risk reduction projects.

Stakeholder Engagement

The stakeholder review was conducted in January and February of 2022. A copy of the Plan and appendices were emailed to select priority stakeholders and also posted online for the public. A survey was used as a feedback collector for half the feedback, and documents containing direct edits and comments in context were utilized by the participating jurisdictions. In total, 34 sets of comments were received from participating jurisdictions, neighboring counties, dam stakeholders, college/university stakeholders, and the general public. The breakdown of responses is show in Figure 4.

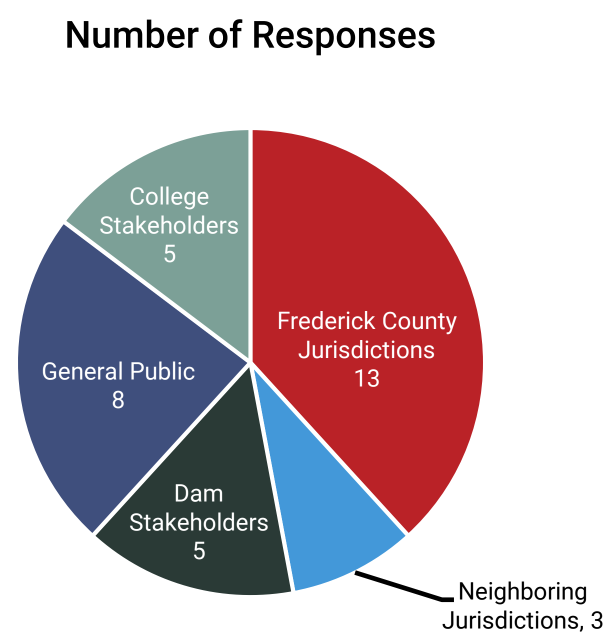


Figure 4. Stakeholder Review Responses by Stakeholder Type

In addition, the public hazard mitigation survey was circulated to stakeholders via email and newsletters in early Fall, 2021 during the beginning of the planning process.

The Maryland Department of Emergency Management served as the state review agency for this mitigation plan. FEMA Region 3 and the Maryland Department of the Environment received a draft of the Plan for review and comment.

Frederick County Cities and Towns

The participating cities and towns were involved throughout the entirety of the planning process through the Hazard Mitigation Planning Committee, Local Planning Teams, public meetings, and direct email and phone discussions. However, they were also included in the final stakeholder review to provide any final edits, especially from local government representatives that were not able to be as heavily involved.

Edits and feedback consisted of minor corrections to contextual information, final updates on mitigation strategies from the 2016 Hazard Mitigation Plan, and minor requests to improve readability once the HMCAP is released the general public, such as the addition of a graphic to better illustrate topics.

Neighboring Jurisdictions

Three neighboring counties reviewed and commented on the final draft of the HMCAP: Montgomery County Office of Emergency Management and Homeland Security, Loudoun County Office of Emergency Management, and Franklin County Department of Emergency Services. This is of immense help, as hazards do not discriminate based on political boundaries, and cross-county coordination is highly values in Frederick County.

The counties provided information of the most prominent hazard they face (severe storms, flooding, and winter weather) and expressed that all of these issues can have cross-county impacts between them and Frederick County, such as transportation issues and roadway flooding. It was expressed that the pluvial flood analysis was a strong addition to the HMCAP.

Frederick County would like to especially thank the Montgomery County Office of Emergency Management and Homeland Security for the detailed comments they provided which were very helpful in improving the HMCAP.

Dam Stakeholders

Dam owners and dam safety experts were both asked to provide input into the HMCAP as well as provide general feedback. The Dam Safety Permits Division of the Stormwater, Dam Safety, and Flood Management Program within the Maryland Department of the Environment reviewed the draft Dam and Levee Failure section in Chapter 5, dam-related mitigation and adaptation actions, and appendices for accuracy and completeness.

The Dam Safety Permits Division's comments consisted of the following items:

- Minor corrections to details in the list of dams in Frederick County,
- Addition of dam condition assessments from the National Inventory of Dams,
- Addition of secondary dam incident source: National Performance of Dams Program Dam Incident Database,
- Correction to dam failure table,
- Clarification on some listed dams being classified as "small ponds," and
- Context addition to two dam-related mitigation actions.

While all dam owners were reached out to, four provided feedback on the draft HMCAP. They were the:

- Managing Agent for the Holly Hills Residential Cluster Community Association,
- Lake Linganore Association,
- Maryland Park Service - Cunningham Falls State Park, and
- Property Management People, Inc.

The dam owners approved of the Plan and had no major concerns or comments; however, they did state interest in being included in any future planning or discussions regarding their affected dams.

College Stakeholders

A total of five college- or university- affiliated stakeholders provided feedback. Three commented on the Frederick Community College Annex and two commented on the Hood College Annex. Their details and feedback are shown in Table 2.4.

Table 2.4. College and University Stakeholder Response Overview

Affiliation	Title/Role	Review Comments

Frederick Community College	Digital Resources Librarian	Believed the Plan would encourage worthwhile hazard mitigation activities on campus
	Vice President, Marketing & Communications	Believed the Plan would encourage worthwhile hazard mitigation activities on campus
	Special Projects Manager	Raised a question about further integrating with the Livable Frederick Master Plan and adding new hazards that were not historically present in the plan Believed the Plan would encourage worthwhile hazard mitigation activities on campus
Hood College	Director of Athletics	Appreciated the explanations of complex concepts and availability of added details located in the appendices
	Special Programs Manager - MACEM&PS	Approved of the plan

General Public

The eight reviewers from the general public consisted of business owners, community organizations, and Frederick County residents. Notably, the Claggett Center, New Hope Church, and YMCA of Frederick were represented.

The comments provided were overall positive, and a few strongly believed the Plan would encourage worthwhile mitigation activities in the County. Projects to harden electrical infrastructure were requested.

Assess Risks

The next step in the planning process was to perform a hazard identification and risk assessment for the entire county. This process involved analyzing the County's greatest hazard threats and determining its most significant vulnerabilities with respect to natural hazards. Risk was determined by looking at the County's total threat and vulnerability for each hazard identified. The risk assessment was performed in large part using GIS data from the County, Hazus-MH 4.2 (a GIS-based FEMA loss estimation software that uses 2010 U.S. Census data), and state sources. At the October 14, 2021, meeting, the Hazard Mitigation Planning Committee reviewed the results, including a brief overview of methods and areas vulnerable to various hazards.

The hazards initially identified in the 2016 plan were discussed and re-prioritized at the July 2021 Hazard Mitigation Planning Committee Kick-Off meeting. The risk assessment was updated using the new prioritization. In addition, worksheets were provided to Local Planning Teams members to garner comments about past hazard events. Chapter 4 covers the hazard identification and risk assessment methods, and Chapter 5 outlines the risk assessment results.

Assess Capabilities

The third step was to assess the mitigation capabilities of the County and its municipalities. A capability assessment was performed to review the existing programs and policies addressing natural hazards. Hazard Mitigation Planning Committee members filled out capability assessment and plan identification questionnaires to allow for a thorough analysis of the adequacy of existing measures. Potential changes and improvements were identified based on a review of the non-hazard mitigation plans identified in the questionnaires. Chapter 6 shares the capability assessment findings.

Develop a Mitigation and Climate Adaptation Strategy

The Hazard Mitigation Planning Committee worked to develop a mitigation and climate adaptation strategy. With the results from the risk and capability assessments in mind, the committee identified goals and objectives for countywide mitigation efforts. These goals represent the County's and communities' vision for hazard mitigation and resilience.

After, the Hazard Mitigation Planning Committee identified and developed potential mitigation actions for implementation. The Hazard Mitigation Planning Committee considered issues related to potential damage from hazard events in the County. The committee also evaluated 2016 projects and helped draft an action plan to specify recommended projects, who is responsible for implementing the projects, and when they are to be completed.

It should be noted that the Plan recommends mitigation measures that should be pursued and implemented if funding becomes available. Implementation of these recommendations depends on adoption of the Plan by the County Executive and each of the municipalities, and the cooperation and support of the offices and contacts designated as being responsible for each action item. The mitigation and adaptation strategy can be found in Chapter 7.

Implement the Plan and Monitor Progress

The County will implement the Plan and perform monitoring through periodic reviews and revisions with consultation with the Hazard Mitigation Planning Committee. The Department of Emergency Preparedness will conduct an annual planning review of the mitigation plan, and public participation will be invited during the annual and 5-year review/update periods. Chapter 8 outlines plan implementation and maintenance.

CHAPTER 3. PLANNING CONTEXT

County Profile

Frederick County is bound by Pennsylvania to the north, Carroll County to the east, Montgomery County to the south, Howard County to the southeast, Washington County to the west, and Virginia to the southwest (Figure 3.1).

Figure 3.1. Frederick County in Geographic Context

Frederick County is Maryland's largest county in terms of geographic area. The City of Frederick, the County seat, is intersected by 5 interstate and national highways that provide easy access to Baltimore (46 miles), Washington, DC (43 miles), Gettysburg, PA (32 miles), Harpers Ferry, WV (21 miles), and Leesburg, VA (25 miles). The County is home to the 5,700-acre Catoctin National Park, site of the Camp David Presidential Retreat; Fort Detrick; Mount Saint Mary's University; Hood College; the Emergency Management Institute; and the National Fire Academy.

Community Assets

Community assets are anything that Frederick County and its municipalities deem important to the wellbeing of their communities. For this HMCAP, community assets are made up of the built environment, the natural environment, and the economy. This section identifies and maps community assets throughout the County. The impacts of hazards and climate change are not distributed equally and identifying assets that are the most vulnerable to natural hazards and changing future conditions will allow the County to create a more resilient region.

Built Environment

The built environment is everything that makes up the physical, manmade support structure for a community. This includes homes, critical facilities, infrastructure, and cultural resources. This section only includes existing structures, as future development is covered in a later section.

Overall, Maryland's manmade infrastructure is rated C by a committee of 25 civil engineers from the American Society of Civil Engineers.[3] Having older, damaged, or over-capacity infrastructure increases vulnerability to hazards—and therefore increases risk—due to its decreased likelihood to withstand hazard events or maintain functionality during or after a disaster. The most important pieces of infrastructure and facilities for community response and recovery from disasters, called critical facilities, are show in Figure 3.2. Further analysis can be done in the future to collect and detail the age, construction standards, and life expectancy of select critical facilities.

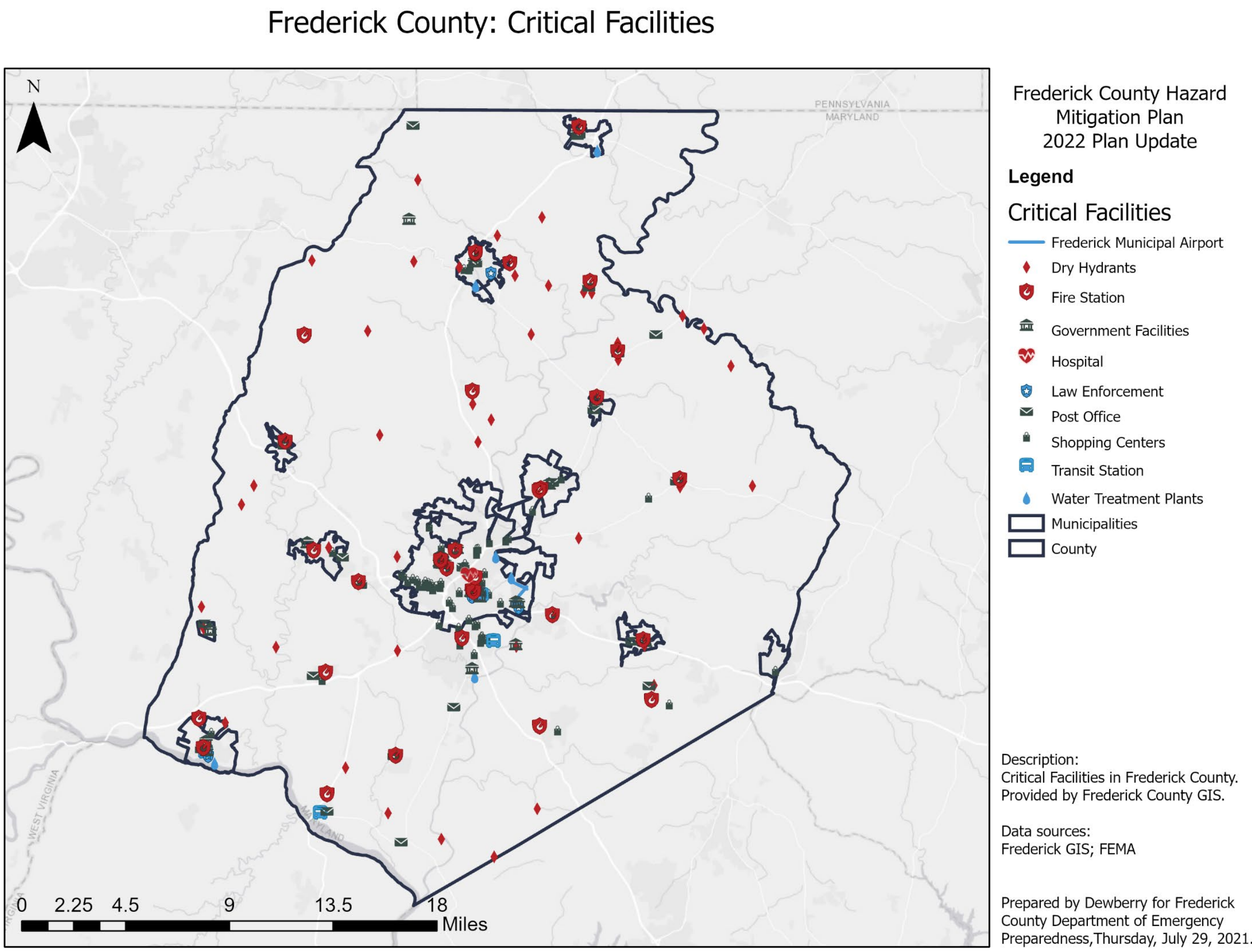


Figure 3.2. Critical Facilities in Frederick County

Although not typically used for recovery and response operations, cultural resources should also be considered for mitigation projects. Cultural and historic assets are often the most unique and irreplaceable buildings and places in communities. These tangible vestiges of our shared past help to define the character of communities. Their status and importance are determined by those who value them. Figure 3.3 depicts the cultural and historic resources in Frederick County.

[3] https://infrastructurereportcard.org/wp-content/uploads/2021/07/Maryland-ASCE-Report-Card-2020-Full-Sections.pdf

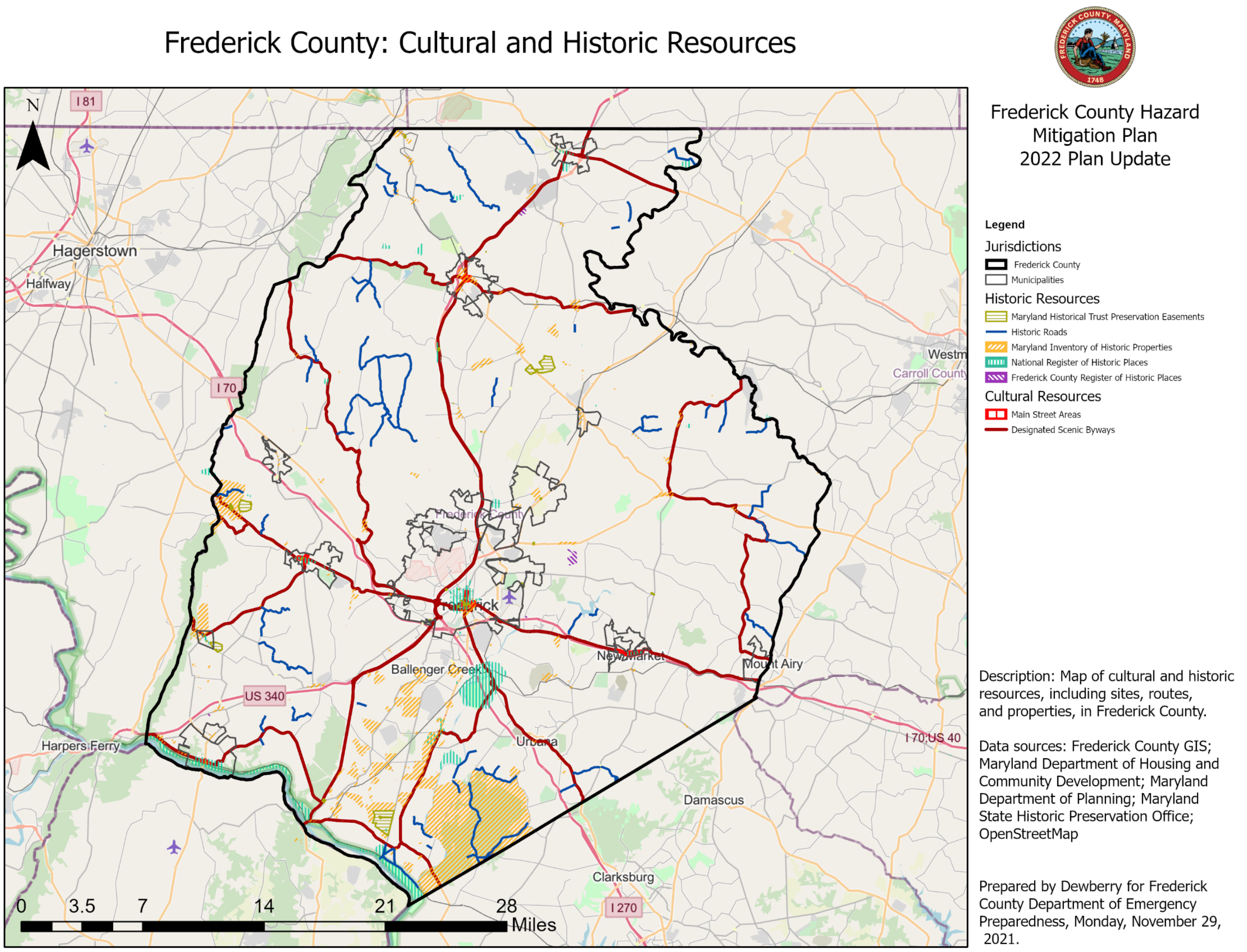


Figure 3.3. Cultural and Historic Resources in Frederick County

Housing

According to the U.S. Census, the total number of housing units in the County in 2019 was 100,803. Of the total occupied housing units, approximately 75.2% were owner-occupied. The median value of owner-occupied housing units in 2019 was $331,600. Frederick County's rapid growth is expected to continue. To keep pace with this growth, annual housing construction has also risen steadily over the past few decades.

Transportation

The highway network in Frederick County can be broken into 3 categories:

- Freeway: includes Interstate 70, Interstate 270, U.S. Route 15 inside the City of Frederick, and U.S. Route 340;
- Four-lane Rural Highway: U.S. Route 15 north of the City of Frederick; and
- Two-lane Rural Highway: includes the state secondary highways (i.e., Maryland Route 75, Maryland Route 355, etc.), Maryland Route 15 south of the Maryland Route 340 split, as well as county roads.

The Frederick Municipal Airport (FDK), a city owned and operated facility, is an integral component of the County's overall transportation system. The Federal Aviation Administration has designated the Frederick Municipal Airport as a "reliever airport," which is a general aviation facility designed to reduce congestion at airports that have substantial scheduled commercial passenger service (in this case, Dulles International (IAD), Ronald Reagan Washington National (DCA), and Baltimore Washington International Thurgood Marshall (BWI)). The Frederick Municipal Airport is the State's second busiest general airport with over 140,000 annual operations. Over 260 aircraft are based there.[4]

Rail transportation includes CSX Transportation and Maryland Midland Railway (short line service). In terms of mass transit, MARC (commuter rail) and Amtrak provide service to Washington, DC. The four MARC stations in Frederick County are Brunswick and Point of Rocks (on the Brunswick Line) and Monocacy and The City of Frederick (on the Frederick Line). Although there are no Amtrak stations in the County, Amtrak passes through the County on the line from Washington, DC, to Harpers Ferry, WV. Public bus transportation is available throughout the City of Frederick, connecting to other municipalities and multiple jurisdictions in the National Capital Region. The nearest major water port is the Port of Baltimore.

Utilities

Electricity is provided by Potomac Edison and Thurmont Municipal Light Company.

Natural gas is supplied by Frederick Gas Company, a division of Washington Gas. Baltimore Gas and Electric serves Mount Airy. Rocky Ridge and Emmitsburg are served by the South Penn Gas Company. Water and sewer services are provided by the Frederick County Division of Utilities and Solid Waste Management.

There are 27 public water service systems in the County; 7 of these systems are regional systems owned and operated by the County. There are also several small community systems and individual subdivision systems. Municipal water systems are located in Brunswick, Emmitsburg, Frederick, Middletown, Mount Airy, Myersville, Thurmont, Walkersville, and Woodsboro. The Potomac River provides approximately 80% of the County's public water supply, with the remaining 20% supplied by groundwater.[5] Two major institutional uses, Fort Detrick and Mount St. Mary's University, that maintain their own systems.

Municipal sewer systems are located in Brunswick, Emmitsburg, Frederick, Middletown, Mount Airy, Myersville, Woodsboro, and Thurmont. The County operates 16 plants serving a wide geographic area.

Higher Education Institutions

There are three higher education institutions in Frederick County: Frederick Community College, Hood College, and Mount St. Mary's University. As they function as standalone institutions, their hazard mitigation planning information is detailed in individual annexes to this plan.

Natural Resources and the Environment

Natural resources and assets can help protect communities from hazard events by reducing the magnitude of the hazard, such as an undeveloped floodway preventing increased flooding to the buildings nearby. Environmental resources also support the economy and ensure clean air and water for businesses and residents in the area.

The Livable Frederick Master Plan identifies natural resources in the County, as well as the plans that are in place to conserve and expand natural areas. Future updates of the HMCAP can include analyses that consider these areas and resources.

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[4] 2010 Frederick County Comprehensive Plan.
[5] Frederick County Water & Sewerage Plan, effective June 2, 2015. Retrieved from http://frederickcountymd.gov/DocumentCenter/View/283649.

Economy

Business is another critical asset for Frederick County. Keeping our people employed and a steady flow of income coming into our community allows residents to better prepare individually and helps ensure the County and municipalities have the means to fund hazard mitigation projects. The County's economic wellbeing also requires adequate protection.

Chapter 1 outlines the major employers throughout the County. The Livable Frederick Comprehensive Planning effort identifies important commercial centers within the County. Damage to these centers resulting in temporary closure or extended inoperability would have severe impacts on disaster recovery within the community, especially when it comes to finding materials to repair damage or buying food and supplies after a disaster. Future analysis could be done to assess the dependencies between businesses and the infrastructure needed to support them, as well as map the large economic drivers within the floodplain.

The County's private sector industries generate $11.0 billion in economic activity. Small business is the backbone of Frederick County's economy. The County's businesses employ more than 91,000 workers, and an estimated 98% of these businesses have under 100 workers. Frederick County's employers of 500 or more people include:

- Fort Detrick (including U.S. Army, National Cancer Institute and other tenants)
- Frederick County Board of Education
- Frederick Memorial Healthcare System
- Frederick County Government
- Leidos Biomedical Research
- Wells Fargo Home Mortgage
- Frederick Community College
- State Farm Insurance Co.
- City of Frederick Government
- United Health Care
- Wal-Mart
- Astra Zeneca
- National Emergency Training Center (U.S. Fire Academy, FEMA, and other tenants)
- Lonza Bioscience Walkersville, Inc.
- Mount Saint Mary's University
- Thermo Fisher
- Fannie Mae

Some recent development projects include new locations of Kite Pharma, Wilcoxon Sensing Technologies, a U.S. headquarters for a German-based company— Indivumed, HealthWell Foundation, TEI Electrical Solutions Stulz Air Technologies, Dairy Maid Dairy, and a Dunkin Donut Centralized Kitchen.

The County has experienced a significant increase in high-tech and bioscience companies, allowing more residents to work near where they live.[6] Frederick County is also Maryland's largest dairy producer, providing one-third of the State's milk production.

[6] Frederick County. Office of Economic Development. Retrieved from http://www.discoverfrederickmd.com/business_support/major_employers on January 18, 2016.

Community Lifelines

Lifelines are systems, like roads and power, that allow critical government and essential business operations to continue. Lifelines are essential to human health and safety, or economic security. The framework of lifelines was to give common definitions and terminology when talking about various hazards or incidents and what may or has been affected, and to help formulate both a response, but also prompt mitigation before such an incident. This framework allows emergency managers to:

- Characterize the incident and identify the root causes of priority issue areas.
- Distinguish the highest priorities and most complex issues from previous incident information.

A lifeline enables the continuing operation of critical government and business functions during a hazard or other incidents and is essential to human health and safety or economic security. Lifelines include police and fire departments, hospitals, power plants, arterial roads, grocery stores, and the cellular towers that connect everything. These often-interconnected systems are, simply put, essential for communities to keep the "lights on." Examples of this are:

- The most fundamental services in the community that, when stabilized, enable all other aspects of society to function.
- The integrated network of assets, services, and capabilities that are used day-to-day to support the recurring needs of the community.
- When disrupted, decisive intervention (e.g., rapid service re-establishment or employment of contingency response solutions) is required to stabilize the incident.

Figure 3.4. The seven community lifeline categories

BRIC and Community Lifelines

Resilient lifelines help build resilient communities. The goals and objectives of FEMA's Strategic Plan promote using mitigation to reduce risk to lifelines before a disaster and to quickly stabilize a community after disaster by preventing cascading impacts. BRIC mitigation grants can go toward projects which mitigate these structures, facilities, and systems. Lifeline-focused mitigation projects could involve a wide variety of public, private, and non-profit organizations. Framing mitigation projects in the terms of which community lifelines are being improved gives a mitigation project a higher chance to be awarded a BRIC mitigation grant.

Community Lifelines in Frederick County

FEMA developed the community lifelines focus to increase effectiveness in disaster operations and to better position the Agency to respond to catastrophic events. A lifeline enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security. Table 3.1. lists the facilities that are part of the community lifelines framework in Frederick County. In addition to the facilities listed, community lifelines in Frederick County also consist of infrastructure that is related to any of the community lifeline categories shown in Figure 3.4, such as power lines.

Table 3.1. Community Lifelines in Frederick County from Frederick County GIS Data

Facility Name	Jurisdiction	Community Lifeline(s)
Adamstown Vol Fire Company Station 14	Frederick County	Safety and Security
Advanced Life Support Station	City of Frederick	Safety and Security
Ballenger Creek Center	City of Frederick	Health and Medical
Ballenger Creek Wastewater Treatment Plant	Frederick County	Food, Water, Shelter
Bethany Living II	Frederick County	Health and Medical
Blossom Place at Edenton	Frederick County	Health and Medical
Braddock Heights Vol Fire Co Station 12	Frederick County	Safety and Security
Brunswick Vol Ambulance Co Station 19	City of Brunswick	Health and Medical; Safety and Security
Brunswick Police Department	City of Brunswick	Safety and Security
Brunswick Volunteer Fire Company Station 5	City of Brunswick	Safety and Security
Brunswick Wastewater Treatment Plant	City of Brunswick	Food, Water, Shelter
Buckingham's Choice	Frederick County	Health and Medical
Citizens Care and Rehabilitation Center of Frederick	Frederick County	Health and Medical
Citizens Truck Company Station 4	City of Frederick	Safety and Security
College View Center	City of Frederick	Health and Medical
Country Meadows of Frederick	Frederick County	Health and Medical
Cozy Care	Frederick County	Health and Medical
Devotion Assisted Living LLC	Frederick County	Health and Medical
Fiddler's Green at Edenton	Frederick County	Health and Medical

Facility Name	Jurisdiction	Community Lifeline(s)
Fort Detrick (including U.S. Army, National Cancer Institute and other tenants)	Fort Detrick	Safety and Security; Health and Medical; Communications
Fort Detrick Wastewater Treatment Plant	City of Frederick	Food, Water, Shelter
City of Frederick Government	Frederick County	Safety and Security
City of Frederick Wastewater Treatment Plant	City of Frederick	Food, Water, Shelter
Frederick County Department of Fire and Rescue Services	Frederick County	Safety and Security; Communications
Frederick County Government	Frederick County	Safety and Security; Communications
Frederick County Health Department	Frederick County	Health and Medical
Frederick County Public Safety Training Center	Frederick County	Safety and Security
Frederick County Sheriff's Office	Frederick County	Safety and Security
Frederick County Volunteer Fire and Rescue Association - Headquarters	Frederick County	Safety and Security; Communications
Frederick Health & Rehabilitation Center	Frederick County	Health and Medical
Frederick Memorial Healthcare System	Frederick County	Health and Medical
Frederick Police Department	City of Frederick	Safety and Security
Garden House at Edenton	Frederick County	Health and Medical
Glade Valley Center	Town of Walkersville	Health and Medical
Golden Living Center	City of Frederick	Health and Medical
Graceham Vol Fire Company Station 18	Frederick County	Safety and Security
Green Valley Fire Station 25	Frederick County	Safety and Security

Facility Name	Jurisdiction	Community Lifeline(s)
Guardian Hose Company Station 10	Town of Thurmont	Safety and Security
Heartfields at Frederick	City of Frederick	Health and Medical
Homewood at Crumland Farms	City of Frederick	Health and Medical
Independent Hose Co Station 1	City of Frederick	Safety and Security
Integrace Buckingham's Choice	Frederick County	Health and Medical
Jefferson Vol Fire Company Station 20	Frederick County	Safety and Security
Junior Fire Co Station 2	City of Frederick	Safety and Security; Health and Medical
Lewistown District Vol Fire Company Station 22	Frederick County	Safety and Security
Libertytown Vol Fire Co Station 17	Frederick County	Safety and Security
Life in The Country	City of Brunswick	Health and Medical
Lonza Bioscience Walkersville, Inc	Frederick County	Health and Medical
Maryland Natural Resources Police - Western Region Echo Lake office (Area 7)	Frederick County	Safety and Security
Maryland State Police: Barrack B - Frederick	City of Frederick	Safety and Security
Middletown Volunteer Fire Company Station 7	Town of Middletown	Safety and Security; Health and Medical
Montevue Assisted Living	Frederick County	Health and Medical
Mount Airy Police Department	Town of Mount Airy	Safety and Security
Mount Airy Wastewater Treatment Plant	Town of Mount Airy	Food, Water, Shelter
Myersville Volunteer Fire Company Station 8	Town of Myersville	Safety and Security; Health and Medical

Facility Name	Jurisdiction	Community Lifeline(s)
Myersville Water Treatment Plant	Town of Myersville	Food, Water, Shelter
Myersville Wastewater Treatment Plant	Town of Myersville	Food, Water, Shelter
National Emergency Training Center (U.S. Fire Academy, FEMA, and other tenants)	Frederick County	Safety and Security
New Market District Vol Fire Co Station 15	Town of New Market	Health and Medical
New Midway Volunteer Fire Company Station 9	Frederick County	Safety and Security
Northampton Manor	City of Frederick	Health and Medical
Northgate Fire Station 29 (opening 2022)	City of Frederick	Safety and Security
Orchard Terrace at Edenton	Frederick County	Health and Medical
Point of Rocks Fire Station 28	Frederick County	Safety and Security
Record Street Home - Home for the Aged	City of Frederick	Health and Medical
Rocky Ridge Vol Fire Company Station 13	Frederick County	Safety and Security
Somerford House & Place	City of Frederick	Health and Medical
Spring Ridge Fire Station 33	Frederick County	Safety and Security
St Joseph's Ministries	Frederick County	Health and Medical
Sunrise of Frederick	City of Frederick	Health and Medical
Sunset Ridge Assisted Living, Inc.	Frederick County	Health and Medical
Thurmont Ambulance Company Station 30	Town of Thurmont	Health and Medical; Safety and Security
Thurmont Police Department	Town of Thurmont	Safety and Security
Thurmont Wastewater Treatment Plant	Town of Thurmont	Food, Water, Shelter

Facility Name	Jurisdiction	Community Lifeline(s)
Town of Emmitsburg Wastewater Treatment Plant	Frederick County	Food, Water, Shelter
Tranquility at Fredericktowne	City of Frederick	Health and Medical
United Health Care	Frederick County	Health and Medical
United Steam Fire Engine Station 3	City of Frederick	Safety and Security
Urbana Vol Fire Company Station 23	Frederick County	Safety and Security
Vigilant Hose Company Station 6	Town of Emmitsburg	Safety and Security
Vindobona Nursing and Rehabilitation Center	Frederick County	Health and Medical
Walkersville Vol Ambulance Company Station 24	Town of Walkersville	Health and Medical; Safety and Security
Walkersville Volunteer Fire Company Station 11	Town of Walkersville	Safety and Security
Wal-Mart	Frederick County	Food, Water, Shelter
Warm Heart Family Assistance Living II	City of Frederick	Health and Medical
Westview Fire Station 31	Frederick County	Safety and Security
Wolfsville Vol Fire Company Station 21	Frederick County	Safety and Security
Woodsboro Vol Fire Company Station 16	Town of Woodsboro	Health and Medical

Population and Population Trends

The people of Frederick County are its most critical assets. Without them, we would not have our wonderful community. Figure 3.5 shows population density throughout the County. Understanding where people are in relation to hazards areas helps to identify areas to prioritize for mitigation projects so that we can prevent the most loss of life. Figure 3.5 illustrates population density in the County.

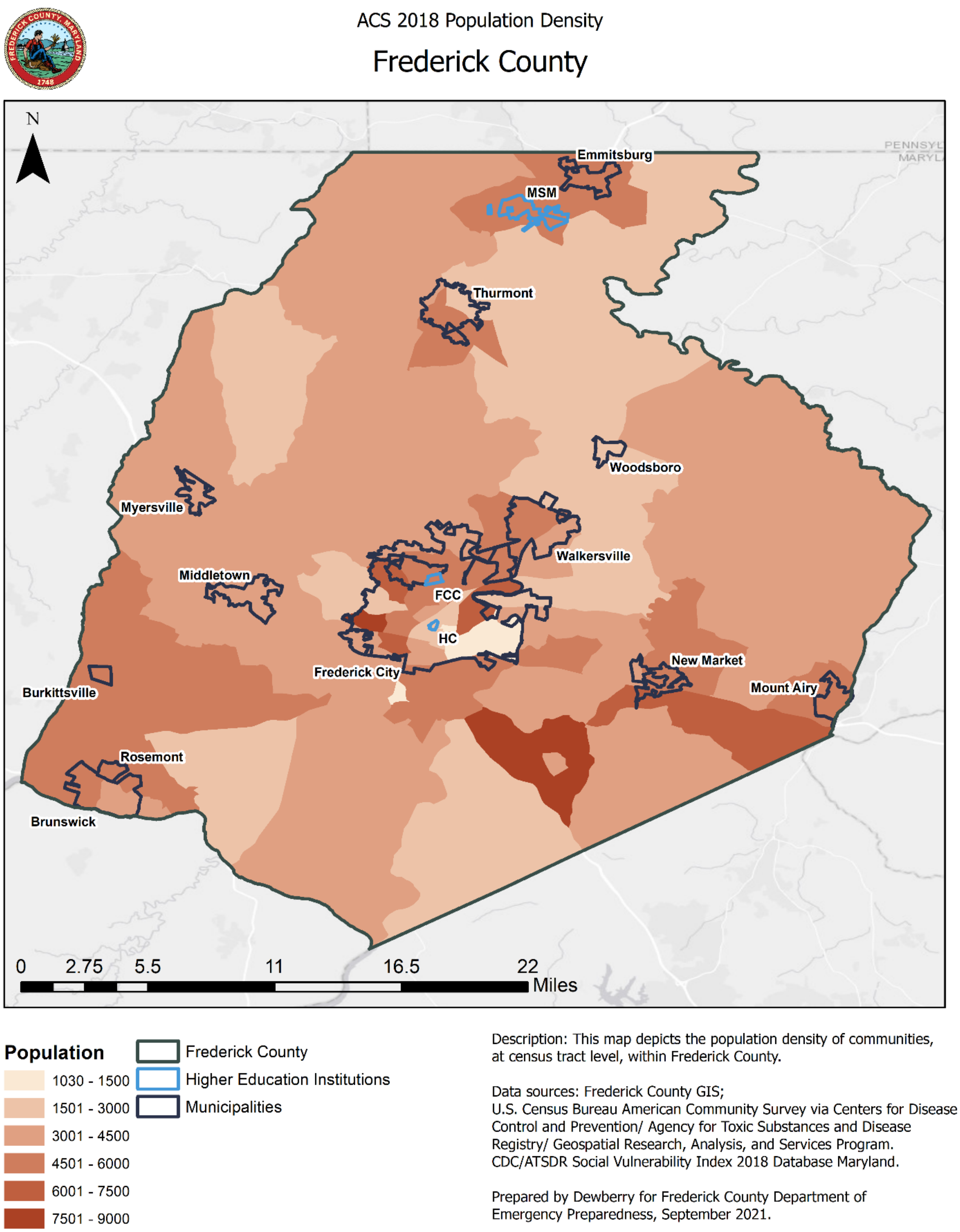

Figure 3.5. Population Density in Frederick County, MD

Frederick County encompasses a total of 662.7 square miles and contains approximately 391.7 persons per square mile.[7] Based on the most recent data available from the U.S. Census Bureau, the estimated population in 2019 was 259,547, an 11.2% increase since 2010.[8] Table 3.2. indicates recent and projected change in Frederick County population from 2020 to 2045.

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[7] Maryland Department of Commerce, "Brief Economic Facts: Frederick County, Maryland", 2021.
[8] U.S. Census Bureau, Quickfacts: Frederick County, Maryland Population Estimates, 2021.

Table 3.2. Population Projections in Frederick County (Source: Frederick County Planning Department, 2021)

Year	Household	Population	Employment
2020	98,400	263,900	117,300
2025	106,300	284,300	123,200
2030	115,400	304,500	128,600
2035	122,400	320,000	135,300
2040	128,100	334,600	141,100
2045	132,100	346,600	145,500

Table 3.3. shows the 2019 U.S. Census population estimates and the 2021 Frederick County Planning estimates for Frederick County municipalities.

Table 3.3. 2019 and 2021 Population Estimates (Source: U.S. Census Bureau Estimates 2019 and Frederick County Planning Department, July 2021)

Municipalities	2019 U.S. Census Population Estimates	2021 Frederick County Population Estimates
Brunswick	6,491	7,826
Burkittsville	165	151
Emmitsburg	3,198	2,866
City of Frederick	72,244	72,097
Middletown	4,792	4,516
Mount Airy	9,458	3,785*
Myersville	1,838	1,713
New Market	738	1,241
Rosemont	322	296
Thurmont	6,895	6,286
Woodsboro	1,269	1,161
Walkersville	6,415	6,182
Unincorporated Areas	145,722	86,191 “Other Small Areas” 77,189
Total	**259,547**	**271,500**

*portion within Frederick County

Social Vulnerability

It is important to acknowledge that our communities are made up of diverse groups with varying degrees of social vulnerability. Social vulnerability considers the social characteristics and conditions of people, such as socioeconomic status, household composition, disability, minority status, language barriers, housing type, and transportation access. These factors can influence a person's ability to mitigate and recover from hazard events, so Frederick County is including them in the hazard risk assessment to help identify communities that will most likely need support before, during, and after a disaster. Figure 3.7 depicts the Center for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI) in Frederick County.

CDC Social Vulnerability Index

The CDC's SVI uses U.S. Census data to determine vulnerability on a census tract level. Each tract is ranked on 15 social factors that are grouped into four related themes, that when combined, create the overall SVI ranking (Figure 3.4).

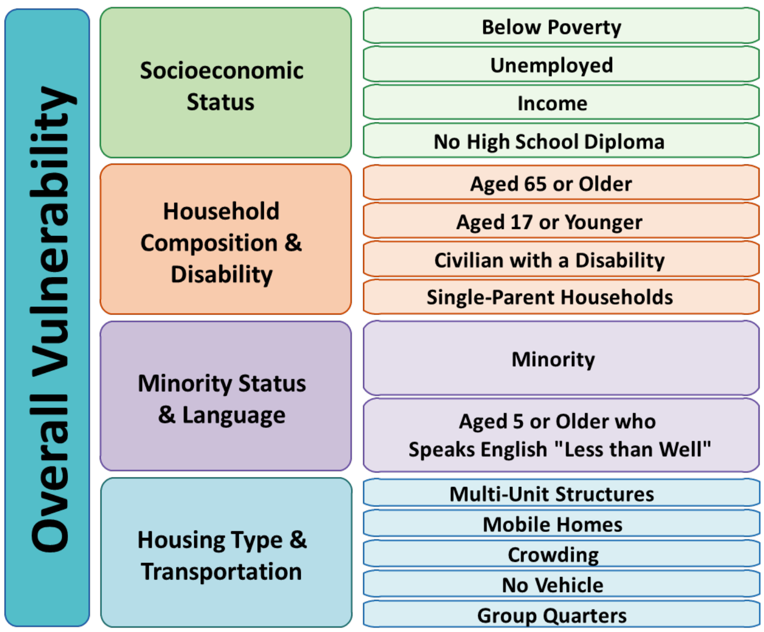

Figure 3.6. American Community Survey, 2014-2018, data and how it is categorized to create CDC SVI themes[9]

[9] https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/SVI_documentation_2018.html

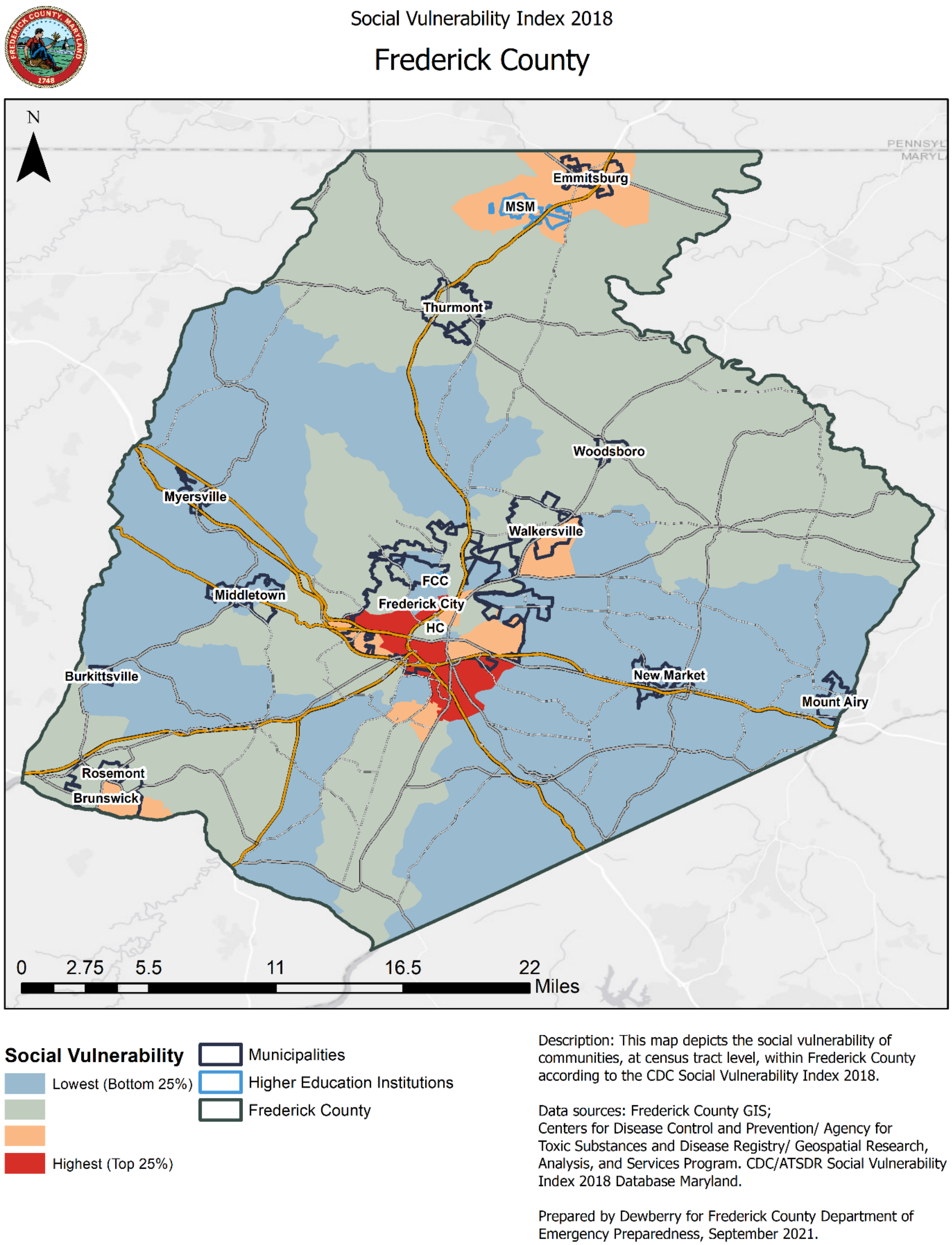

Figure 3.7. CDC Social Vulnerability Index Map for Frederick County, MD

Future analyses can be done to dive deeper into populations that may pose unique vulnerabilities (e.g., visitors and temporary residents, such as large event attendees or college students). They can often lead to high concentrations of people who are not accounted for in usual population density maps, less familiar with the area and its hazard risks, and less prepared for hazard events. A map of recurring events that bring large numbers of people into one area could be helpful.

CHAPTER 4. HAZARD IDENTIFICATION AND RISK ASSESSMENT INTRODUCTION

Hazard Identification

Hazard identification for Frederick County has involved investigating various types of natural hazards faced by the County since the process began around 1900. Information on past hazards was based on research from historical documents and newspapers, county plans and reports, conversations with county residents and public officials, and websites. Data and maps were gathered online from sources such as the U.S. Geological Survey (USGS) and the National Centers for Environmental Information (NCEI) Storm Events Database (part of the National Weather Service), as well as from the Frederick County GIS Department, Public Health Department, and Division of Public Works.

Hazard profiling involves determining the frequency or probability of future events, their severity, and factors that may affect their severity. Each hazard type has unique characteristics that determine impact; for example, no two flood events will impact a community in the same manner. The unique characteristics of the community (geography, development, population distribution, age of buildings, etc.) also influence the potential impact of the hazard. Developing hazard event profiles enables Frederick County to anticipate the potential extent of the impact of each hazard.

The hazards are given priority levels as a part of the hazard profiling process. They are determined based on Hazard Mitigation Planning Committee input as well as the five criteria summarized below to assign a quantitative ranking. Each criterion identifies and categorizes the comparative probability and potential vulnerability for the identified hazards. The framing criteria/questions are shown in the list below and Table 4.1 provides the thresholds for each of the risk levels.

The five main parameters include:

6. **Probability/History**: Has the hazard occurred in the area before, and if so, how often based on the historical record? Weighting Factor: 0.25
7. **Vulnerability**: If the expected event does occur, how many people might be killed, injured, or contaminated, and how much property might be damaged or destroyed (e.g., the percent of people or property vulnerable to the hazard)? Weighting Factor: 0.20
8. **Maximum Threat**: What is the worst-case scenario of the hazard and how bad can it get? What will the loss of life and property damage be if the worst-case scenario occurs (e.g., the percent of the community impacted by the hazard)? Weighting Factor: 0.10
9. **Warning Time**: How much time is the community given to prepare for an event? Weighting Factor: 0.10
10. **Ranking in Previous Plan**: The ranking from the 2011 Hazard Mitigation Plan (Significant, Moderate, Limited) was factored in the 2016 ranking. Weighting Factor: 0.35

Table 4.1. Hazard Priority Ranking Criteria

Probability / History	Vulnerability	Maximum Threat (Geographic Area Affected)	Warning Time	2016 Ranking
Weighting Factor: 0.25	*Weighting Factor: 0.20*	*Weighting Factor: 0.10*	*Weighting Factor: 0.10*	*Weighting Factor: 0.35*
Unlikely No documented occurrence with annual probability <0.01	**Negligible** 1 to 10% of people or property	**Isolated** < 5% of community impacted	**Extended** More than 3 days	**Low**
Somewhat Unlikely Infrequent occurrence with at least one documented event and annual probability between 0.5 and 0.01	**Slight** 10% to 20% of people or property	**Minor** 5 to 15% of community impacted	**Slight** 3 days	**Medium-Low**
Somewhat Likely Moderate occurrence with at least two documented events and annual probability between 0.5 and 0.01	**Limited** 20 to 30% of people or property	**Small** 15 to 25% of community impacted	**Limited** 2 days	**Medium**
Likely Frequent occurrence with at least three documented events and annual probability between 1 and 0.5	**Critical** 25 to 50% of people or property	**Medium** 25 to 50% of community impacted	**Minimal** 1 day	**Medium-High**
Highly Likely Common events with annual probability >1	**Catastrophic** > 50% of people or property	**Large** > 50% of community impacted	**No Notice** < 24 hours	**High**

All hazards from the Maryland State Hazard Mitigation Plan were considered for inclusion in the HMCAP. Ultimately, the hazards listed in Table 4.2 have been identified as relevant to Frederick County and incorporated into the risk assessment. They are the same hazards from the 2016 Plan.

Table 4.2. Hazards Identified as Relevant to Frederick County

Hazards Type	2016 Priority Level	2022 Priority Level
Flood	High	High

Hazards Type	2016 Priority Level	2022 Priority Level
Karst and Land Subsidence	Medium-High	Medium-High
Drought	Medium	Medium
Wildfire	Medium	Medium
Landslide	Medium-Low	Medium-Low
Dam and Levee Failure	Low	Low
Extreme Heat	Medium	Medium
Winter Storm	High	High
Thunderstorm	Medium-High	Medium-High
Tornado	Medium	Medium-High
Tropical Cyclone	Medium	Medium
Earthquake	Medium-Low	Medium-Low

Climate Change and Natural Hazard Taxonomy

The risk assessment is organized by the primary climate change interaction each hazard faces. Unlike how 2016 Plan was organized by hazard type (i.e., atmospheric, hydrologic, wildfire, geologic), the 2022 Plan sets each hazard in the context of climate change will allow for a better understanding of how risk from each hazard may change in the future. The primary climate change interactions that are included are:

- Changes in precipitation,
- Rising temperatures, and
- Extreme weather.

Earthquake is organized under a 'non-climate-influenced-hazard' category as it is a hazard that is not largely driven by a climate change interaction.

Climate Change Projections

Overview

Governments throughout the United States share a common goal of ensuring the safety, health, and welfare of their communities. Meeting this goal and maintaining the integrity of essential public services requires that governments anticipate trends and changes that could affect their environment, economy, and community wellbeing. Climate change will affect communities and government functions in a variety of ways, and government services, assets, operations, and policies may all be affected to some extent. More obvious impacts may include an increased risk for extreme events such as drought, storms, flooding, landslides, and wildfires; more heat-related stress; the spread of existing or new food-, water-, and vector-borne disease into a community; and increased erosion and inundation of low-lying areas along river shorelines.[10] Working proactively to address the anticipated impacts to these extreme events can help mitigate against future damages to both infrastructure and human life.

According to the American Planning Association, new conditions and certain extreme events in recent years have brought the issue of climate change into the forefront for planners, lawmakers, and the public. Clear evidence exists of climate change leading to specific, measurable effects ranging from Arctic melting and sea level rise to heightened storm and drought frequency and/or severity. These conditions make it imperative that planners and policymakers work immediately to implement new policies to address climate change.[11]

The effects of climate change may be felt through any of the atmospheric, wildfire, hydrologic, and geologic hazard categories detailed within this hazard mitigation plan. Climate change can amplify the hazards that currently exist and introduce new hazards not previously experienced in the County. As such, it is imperative that Frederick County continue to be proactive by including climate change as an amplifier that may exacerbate natural hazards.

> ***"A changing climate leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events."***
>
> *– Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, Special Report of the Intergovernmental Panel on Climate Change (IPCC)*

Regional and Local Climate Change Trends and Projections

In 2018, the United States Global Change Research Program prepared the Fourth National Climate Assessment. The Fourth National Climate Assessment includes regional chapters that include descriptions of observed historical climate trends, as well as future projections and scenarios for each of the 10 specified regions. In this context, Maryland is included as part of the Northeast Region (which also includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, West Virginia, and Washington D.C.). The Fourth National Climate Assessment findings and projections, alongside state- and county-specific climate data that have been gathered from the National Oceanic and Atmospheric Administration Climate Explorer website, the NOAA State Summary for Maryland, and the University of Massachusetts Amherst (UMass Amherst) State Summary for Maryland, support the trends and projections discussed below.

[10] National Climate Assessment. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. 2018. U.S. Global Change Research Program, Washington, DC, USA. Retrieved from https://doi.org/10.7930/NCA4.2018

[11] American Planning Association. Climate Change Policy Guide. 2020. Retrieved from https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/Climate-Change-Policy-Guide.pdf

Temperature

According to the Fourth National Climate Assessment, by 2035, average temperatures in the Northeast Region are projected to rise more than 3.6°F (2°C) compared to the preindustrial era.[12] Increases have been observed in every season, although the most significant upward trend has been during the winter months: winter temperatures have warmed three times faster than those recorded in the summer. Additionally, more frequent, intense, and longer heat waves are projected to increase over the next century in the Northeast.

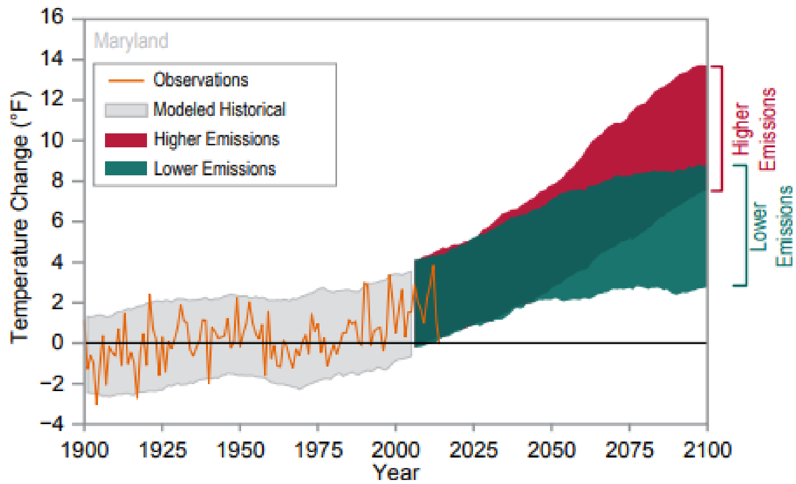

Figure 4.1. Graph of observed and projected temperature change data for the State of Maryland[13]

In Maryland specifically, average annual temperatures have risen by more than 1.5°F since the beginning of the 20th century, and by the end of the 21st century, the State may experience historically unprecedented warming under a higher emissions pathway (Figure 4.1).[14] Heat waves are projected to be more intense while cold waves are projected to be less intense.[15] According to the UMass Amherst State Summary for Maryland, in the next 50-60 years, as global temperatures cross the 2°C threshold, Maryland's average summer and winter temperatures are projected to increase by over 6°F (3.3°C) relative to preindustrial levels (Figure 4.2).[16]

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[12] National Climate Assessment. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. 2018. U.S. Global Change Research Program, Washington, DC, USA, pp. 669–742. Retrieved from https://doi.org/10.7930/NCA4.2018.CH18.
[13] NOAA. State Summary for Maryland. 2017. Retrieved from https://statesummaries.ncics.org/chapter/md/
[14] NOAA. State Summary for Maryland. 2017. Retrieved from https://statesummaries.ncics.org/chapter/md/
[15] NOAA. State Summary for Maryland. 2017. Retrieved from https://statesummaries.ncics.org/chapter/md/
[16] Bradley, Raymond, Ambarish Karmalkar, and Kathryn Woods. Climate System Research Center (CSRC). University of Massachusetts Amherst. Maryland State Climate Report: https://www.geo.umass.edu/climate/stateClimateReports/MD_ClimateReport_CSRC.pdf

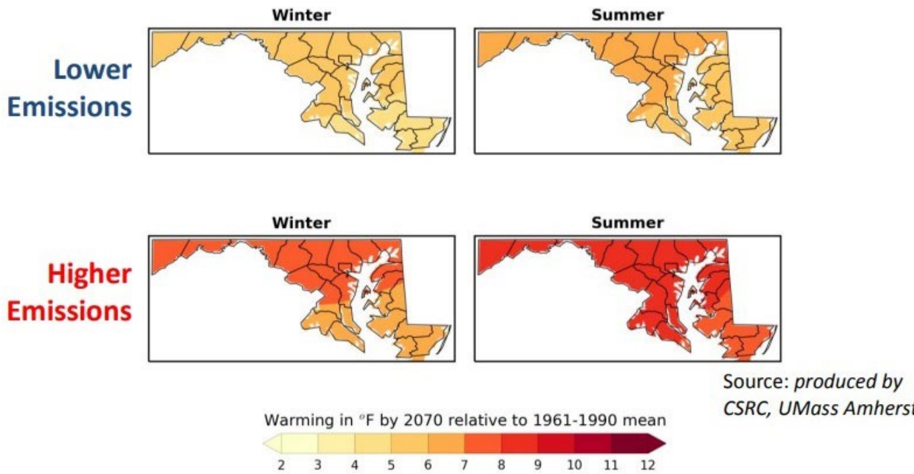

Figure 4.2. Seasonal warming in the State of Maryland by 2070 under lower and higher emission pathways[17]

Based on the National Oceanic and Atmospheric Administration Climate Explorer, by mid-century (2040-2059), Frederick County's projected average daily maximum temperature is projected to increase between 5.1°F to 6.0°F – reaching 69.0°F to 69.9°F – over historical temperatures observed between 1961 and 1990.[18] By late century (2080-2099), these increases may further rise by 6.5°F to 10.6°F – reaching 70.4°F to 74.5°F – over temperatures observed between 1961 and 1990.[19] By mid-century, Frederick County is projected to experience between 18.7 and 25.8 days where maximum temperatures exceed 95°F, and by late century, the number of days will rise to between 27.2 and 62.5—much higher than the historical observations of 2.8 days per year with maximum temperatures above 95°F.[20]

Similarly, historical data shows that minimum temperatures have increased, and projections indicate that they will continue to rise. Between 1950 and 2010, average daily minimum temperatures in Frederick County rose by 0.36°F every decade.[21] By mid-century (2040-2059), the average daily minimum temperature is projected to range from 47.5°F to 48.5°F, representing an increase of 4.8°F to 5.8°F compared to observations between 1961 and 1990. By late century (2080-2099), average daily minimum temperatures are projected to further increase by 6.3°F to 10.5°F relative to the historic baseline.

Precipitation

Precipitation assessments consider both the accumulation of liquid and the frequency of events. Accumulation across the region has been on the rise, particularly since 1970, and especially during the fall months. Frequency of extreme precipitation (heavy downpours) has also increased significantly over this time period. According to the Fourth National Climate Assessment, precipitation in the Northeast Region increased by approximately five inches, or more than 10%, between 1895 and 2011.[22] The Northeast has seen a greater recent increase in extreme precipitation than any other region in the United States: the region experienced more than a 70% increase in the amount of precipitation falling in "very heavy events" (defined as the heaviest 1% of all daily events) between 1958 and 2010.[23]

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[17] Bradley, Raymond, Ambarish Karmalkar, and Kathryn Woods. Climate System Research Center (CSRC). University of Massachusetts Amherst. Maryland State Climate Report: https://www.geo.umass.edu/climate/stateClimateReports/MD_ClimateReport_CSRC.pdf
[18] NOAA Climate Explorer: https://crt-climate-explorer.nemac.org/
[19] NOAA Climate Explorer: https://crt-climate-explorer.nemac.org/
[20] NOAA. The Climate Explorer: Frederick County, MD. Retrieved from https://crt-climate-explorer.nemac.org/
[21] NOAA. The Climate Explorer: Frederick County, MD. Retrieved from https://crt-climate-explorer.nemac.org/
[22] National Climate Assessment. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. 2018. U.S. Global Change Research Program, Washington, DC, USA, pp. 669–742. Retrieved from https://doi.org/10.7930/NCA4.2018.CH18.
[23] Ibid.

The frequency of heavy downpours is projected to continue to increase over the remainder of the century,[24] as well as seasonal drought risk in summer and fall due to warming temperatures and earlier snowmelt.[25] The NOAA State Summary for Maryland states that average annual precipitation and frequency of events are projected to increase over the 21st century, particularly during winter and spring (Figure 4.3).[26] In Frederick County, the region receives an average of 40.0 inches of precipitation every year, based on historical data. By the end of the century (2080-2099), the County is projected to receive up to 46.3 inches of annual precipitation, an increase of over six inches (or 16 percent).[27] This could elevate the risk of flooding: more intense extreme precipitation events will likely expand the flood hazard areas (areas that a flood event will inundate); compounding this intensity is the increase of the frequency of the 100-year rainstorm event, as defined by historical data, which is expected to occur every 20 to 50 years by the end of the century.[28]

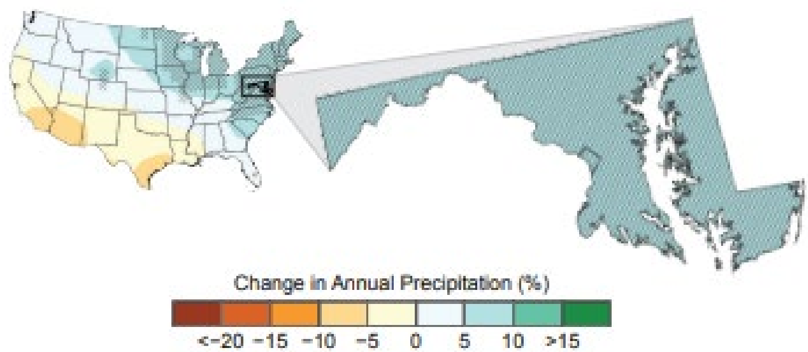

Figure 4.3. Projected change in annual precipitation in State of Maryland[29]

Even if precipitation patterns intensify, naturally occurring droughts will continue and potentially worsen.[30] Such droughts are projected to be more intense because higher temperatures will increase the rate of soil moisture loss during dry spells.[31] The Maryland Commission on Climate Change reported in their Comprehensive Assessment of Climate Change Impacts to Maryland noted that if emissions do not decrease, annual precipitation changes will be felt during both summer and winter seasons, with heavier precipitation occurring in the winter, and longer and dryer summer seasons occurring with decreased rainfall. The most noticeable percentage increase will occur during the winter months: according to UMass Amherst, increasing temperatures will lead to more rain and less snow at this time of year.[32] Given regional trends, changes to Frederick County's precipitation patterns may affect its vulnerability and the potential consequences of related hazards.

Maryland's and Metropolitan Washington Region's Efforts on Climate Change

Frederick County has a unique opportunity to address the issue of climate change and the potential affects it may have on the County. Both Maryland and the Metropolitan Washington Council of Governments have been

[24] NOAA. *State Summary for Maryland*. 2017. Retrieved from https://statesummaries.ncics.org/chapter/md/
[25] National Climate Assessment. *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, Volume II: [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. 2018. U.S. Global Change Research Program, Washington, DC, USA, pp. 669–742. Retrieved from https://doi.org/10.7930/NCA4.2018.CH18.
[26] NOAA. *State Summary for Maryland*. 2017. Retrieved from https://statesummaries.ncics.org/chapter/md/
[27] NOAA. *National Weather Service: Climate Prediction Center*. 2021. Retrieved from https://www.cpc.ncep.noaa.gov/
[28] NOAA. *State Summary for Maryland*. 2017. Retrieved from https://statesummaries.ncics.org/chapter/md/
[29] Ibid.
[30] Ibid.
[31] Ibid.
[32] Bradley, Raymond, Ambarish Karmalkar, and Kathryn Woods. Climate System Research Center (CSRC). University of Massachusetts Amherst. Maryland State Climate Report. Retrieved from https://www.geo.umass.edu/climate/stateClimateReports/MD_ClimateReport_CSRC.pdf

engaged in climate change initiatives. On April 20, 2007, then-Governor Martin O'Malley signed Executive Order 01.01.2007.07 establishing the Maryland Climate Change Commission.[33] In 2014, Executive Order 01.01.2014.14 expanded the Maryland Climate Change Commission's scope and membership to allow non-state government participants. In 2015, the Maryland General Assembly codified the Maryland Climate Change Commission, ensuring its work would continue under future administrations.

One of the early successes of the Maryland Climate Change Commission was the publication of the Climate Action Plan in August 2008. This report summarizes the impact of climate change on the State, establishes a greenhouse gas and carbon footprint reduction strategy, and discusses ways to decrease Maryland's vulnerability to climate change. Although much of the report's focus is on sea level rise and the potential impact to Maryland's coastal communities, the report also examines the issues surrounding Maryland's agricultural and forested communities. This, in particular, applies directly to Frederick County.

In 2009, Maryland passed the Greenhouse Gas Emissions Reduction Act. The law requires the State to develop and implement a Plan (the Greenhouse Gas Emissions Reduction Act Plan or the Plan) to reduce greenhouse gas (GHG) emissions 25% from a 2006 baseline by 2020. The Greenhouse Gas Emissions Reduction Act Plan, completed in 2012, put the State on track to achieve this reduction, while also creating jobs and improving the State's economy. In 2016, Governor Hogan signed an updated version of the law, which includes the same balanced requirements and safeguards as the original, such as additional reporting and a mid-course reaffirmation of goals by the Maryland General Assembly, as well as incorporating protection for jobs and the economy. The most significant enhancement was a new benchmark requiring a 40 percent reduction of emissions from 2006 levels by 2030. This additional benchmark was included in order to ensure continued progress after 2020 toward the State's long-term GHG emission reduction goals.[34] To achieve the 2030 goal, a statewide greenhouse gas reduction plan (2030 Greenhouse Gas Emissions Reduction Act Plan) was required.

In 2020, The Maryland Commission on Climate Change recommended in its Annual Report that Maryland increase the Greenhouse Gas Emissions Reduction Act of 2016 reduction goal from 40% to 50% compared to 2006 levels due to updated findings from the International Panel on Climate Change. In 2021, MDE released the 2030 Greenhouse Gas Emissions Reduction Act Plan. The 50% reduction goal was incorporated into the 2030 Greenhouse Gas Emissions Reduction Act Plan as a "stretch goal," but Maryland Department of the Environment's emissions analysis shows that Maryland will come very close to achieving a 50% reduction by 2030 without accounting for some anticipated new federal government policies to reduce emissions.[35]

The Metropolitan Washington Region has also made efforts to address climate change. In November 2020, the Metropolitan Washington Council of Governments released the Metropolitan Washington 2030 Climate and Energy Action Plan. The Plan builds on previous regional action plans and establishes priority collaborative actions for the MWCOG's Climate, Energy and Environment Policy Committee members to work on together over the next ten years to help move the region towards meeting its' 2030 goals. Since all the actions in the Plan are voluntary, the success of the Plan will depend on active regional collaboration and implementation.[36] The Plan covers greenhouse gasses, climate mitigation, climate risk and vulnerabilities, and climate resilience. Notably, it sets a greenhouse gas emissions reduction goal of 50% below 2005 levels by 2030 and 80% below by 2050. The success of the Plan relies entirely on extensive coordination between the jurisdictions, including

[33] Maryland Commission on Climate Change. 2021 Annual Report and Building Energy Transition Plan. 2021. Retrieved from https://mde.maryland.gov/programs/Air/ClimateChange/Maryland Climate Change Commission/Documents/2021%20Annual%20Report%20FINAL%20(2).pdf.

[34] Maryland Department of the Environment. 2011 Greenhouse Gas Emissions Reduction Act of 2009 (GGRA) Draft Plan. Retrieved from http://www.mde.state.md.us/programs/air/climatechange/pages/air/climatechange/index.aspx

[35] Maryland Department of the Environment. The Greenhouse Gas Emissions Reduction Act 2030 GGRA Plan. Retrieved from https://mde.maryland.gov/programs/air/ClimateChange/Documents/2030%20GGRA%20Plan/THE%202030%20GGRA%20PLAN.pdf

[36] Metropolitan Washington Council of Government's Climate, Energy and Environment Policy Committee. Metropolitan Washington 2030 Climate and Energy Action Plan (2020). Retrieved from https://www.mwcog.org/documents/2020/11/18/metropolitan-washington-2030-climate-and-energy-action-plan/.

evaluating project-level feasibility and cost-effectiveness of measures on a regional level. In recognition of the Plan and coordination efforts, the Global Covenant of Mayors recognized the MWCOG as fully compliant with the global standards of best practices for climate planning in 2021.

Frederick County's Efforts on Climate Change

As stated in Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments, an increasing amount of physical evidence points to the fact that climate change is already in motion as a result of the greenhouse gases accumulated in the atmosphere to date, particularly since the 1950s. It is projected that the climate through the middle of the 21st century will be driven by present-day greenhouse gas concentrations. Given these projections, reducing greenhouse gas emissions will limit the severity of long-term future impacts, but will do little to alter the near-term changes already set in motion.[37]

Recognizing its increasing vulnerability to climate change, the 2009 Frederick County Hazard Mitigation Plan Update was among the first at the time to include climate change, and this work was carried forward for inclusion in the 2016 plan update. This 2021 plan update attempts to further integrate climate considerations into the assessment of hazards and future occurrences. Several sectors of Frederick County may be directly impacted by the effects of climate change, including hydrology and water resources, agriculture, biodiversity, forests, recreation, energy, transportation, and human health and welfare.

When assessing the County's risk and vulnerability to the natural hazards analyzed in this plan, the County considered the potential impacts from exacerbated weather events on the sectors above. The National Capital Region's Climate Change Report looked specifically at jurisdictions in Maryland and rated the risks associated with severe weather events potentially worsened by climate change in 2008, but it has not updated the ratings since.[38] At the time, Frederick County was ranked high or medium-high for risks associated with severe weather events (except tidal/coastal flooding). Each of the events were analyzed and prioritized as hazards chosen by the Frederick County Hazard Mitigation Planning Committee for inclusion in the HMCAP.

In 2010, the Frederick County Board of Commissioners released the 2007 Greenhouse Gas Emissions Inventory Report, which addressed emissions attributed to county government operations, as well as the community at large. To expedite the County's emissions reductions in recognition of the growing risks of climate change, Frederick County Council approved a Climate Emergency Resolution in summer 2020.[39] The resolution committed the council to consider policy and legislative actions through the lens of climate change and reducing county-wide greenhouse gas emissions by 50% from 2010 levels by 2030 and 100% no later than 2050. It also established the Climate Emergency Mobilization Workgroup—in coordination with the City of Frederick—to make recommendations on how to achieve the emissions goals. In August 2021, the Workgroup submitted a draft Climate Response and Resilient Report to the Council, recommending a number of climate resilience strategies that would also reduce the risk of climate-related hazards.[40] Some of those strategies were considered throughout the 2022 plan update.

In 2021, the County Executive launched climate initiatives that were approved by the County council in January 2022. A comprehensive program to address climate change and make Frederick County more resilient and sustainable divides these initiatives into four categories: climate and energy actions plans, clean fleet and electric vehicle infrastructure, building energy and resiliency programs, and clean energy procurement. Funding

[37] Center for Science in the Earth System (The Climate Impacts Group). Preparing for Climate Change. A Guidebook for Local, Regional, and State Governments. 2007.
[38] Metropolitan Washington Council of Governments Climate Change Steering Committee. National Capital Region's Climate Change Report. Pg 27. 2008.
[39] The County Council of Frederick County, Maryland. Resolution No. 20-22: Climate Emergency. 2020. Retrieved from https://frederickcountymd.gov/ArchiveCenter/ViewFile/Item/11819
[40] Frederick County Climate Emergency Mobilization Workgroup. Climate Response and Resilience: Volume 1. 2021. Retrieved from https://frederickcountymd.gov/DocumentCenter/View/333505/824-CEMWGVOL1DRAFT

was approved to implement the initiatives, which will help the County government to meet its goal to reduce greenhouse gas emissions by 50% by 2030. Implementation will be led by the County's Office of Sustainability and Environmental Resources who were involved in the 2022 HMCAP update.

Frederick County is also a member of the Metropolitan Washington Council of Governments and approved the Metropolitan Washington 2030 Climate and Energy Action Plan in 2020, as described in the previous section. The County has worked with the Council's Built Environment and Energy Advisory Committee and Climate, Energy and Environment Policy Committee on a budget and work plan in support of the implementation of the Energy Action Plan to meet greenhouse gas reduction goals.

Notable Climate Impacts

Water Resources

Water quantity, quality, and infrastructure will be affected by climate change. Precipitation is expected to become more variable, which may impact water quality and stress water supply infrastructure. Although average precipitation is anticipated to increase slightly, this is most likely to occur in winter and not during summer months of maximum demand. As the climate changes, one of the more immediate impacts will be the change in Frederick County's water resources. Not only might it affect the overall water supply, it might also affect water quality and increase flood risks. According to the U.S. Environmental Protection Agency, evaluating the impacts of climate change on water resources is challenging because water availability, quality, and stream flow are sensitive to changes in temperature and precipitation. Additionally, seasonal fluctuations are a major factor in availability and stream flow in Frederick County. Other important factors include increased demand for water caused by population growth, changes in the economy, development of new technologies, changes in watershed characteristics, and water management decisions.[41] Mitigation measures that could reduce the potential impact to water resources include:

- Revising water storage and release programs for reservoirs
- Adopting crops and cropping practices that are robust over a wider spectrum of water availability
- Adjusting water prices to encourage conservation and the expansion of water supply infrastructure
- Supporting water transfer opportunities[42]

Additionally, in the Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change report, the Maryland Climate Change Commission recommends:

- Ensuring long-term safe and adequate water supply for humans and ecosystems through practices such as demand management and water conservation
- Reducing the impacts of flooding and stormwater through practices such as removal of vulnerable or high-hazard water supply and treatment infrastructure[43]

Flooding

As global temperatures increase, the atmosphere will contain more moisture, which will likely enhance the intensity of heavy downpours. More intense rainfall may increase peak flooding in urban environments, including

[41] U.S. Environmental Protection Agency. Addressing Climate Change in the Water Sector. n.d. Retrieved from https://www.epa.gov/climate-change-water-sector.
[42] Richard M. Adams and Dannele E. Peck. Effects of Climate Change on Water Resources. 2008.
[43] Maryland Department of Natural Resources. Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change. http://www.dnr.maryland.gov/climatechange/pdfs/climatechange_phase2_adaptation_strategy.pdf

areas of Frederick County.[44] An increase in rainfall may negatively affect infrastructure such as stormwater runoff, crop irrigation systems, the transportation network, and local housing developments.

Mitigation measures to reduce potential flooding impacts include:

- Conduct a detailed risk assessment of flood hazards modeling the potential effects of climate change
- Analyze stormwater management plans and predict changes in flood impacted areas
- Develop "future conditions" floodplain maps for climate change scenarios and use those maps for zoning and planning

Agriculture

Frederick County has a significant agricultural community. Warmer temperatures and more variable precipitation will likely lead to changes in crop and animal production and pest management. The impacts of climate change on the agricultural community of Frederick County could be economically devastating. Crop production may increase initially but decline later in the century if emissions are not reduced and more intense droughts occur. The longer growing season and higher carbon dioxide levels in the atmosphere are likely to increase crop production modestly during the first half of the century. Later, crop production is likely to decrease due to heat stress and summer drought.[45] As temperatures rise, some crops may experience a decrease in the length of the growing season resulting in less revenue for the County and its citizens. Increased temperatures also may increase crop water demand putting extra strain on the County's water resources. Prolonged periods of drought may negatively impact the growing season of some Frederick County crops, as well.

Measures to consider that could mitigate against the possible effects of climate change on the Frederick County agricultural community include:

- Conduct a detailed drought risk assessment accounting for the potential effects of climate change
- Educate the agricultural community about the benefits of growing crops that are more drought-resistant
- Adopt crops and cropping practices that are robust over a wider spectrum of water availability

Additionally, in the Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change report the Maryland Climate Change Commission recommends:

- Increasing crop diversity, protecting against pests and disease, and intensifying water management
- Strengthening applied research, risk communication, and technical support
- Enhancing existing Best Management Practices and land conservation targets[46]

Transportation Infrastructure

An area of public service that may be overlooked when mitigating against the impacts of climate change is transportation infrastructure. As temperatures rise and the severity and frequency of storm events increase, storm runoff may overwhelm various culverts and bridges throughout Frederick County, which could make roads and bridge impassable.

Strategies to mitigate against future damages to transportation infrastructure include:

- Consider climate change impacts on natural hazards in establishing design levels for new and replacement infrastructure

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[44] Maryland Commission on Climate Change. Comprehensive Assessment of Climate Change Impacts in Maryland. July 2008.
[45] Ibid.
[46] Maryland Department of Natural Resources. Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change. Retrieved from http://www.dnr.maryland.gov/climatechange/pdfs/climatechange_phase2_adaptation_strategy.pdf

- Perform routine maintenance and replacement of infrastructure components damaged by extreme temperatures and storms
- Provide opportunities to shift passenger trips from cars to public transportation, biking, and walking, and freight trips from trucks to rail (and possibly ships) to help to reduce on-road travel
- Develop infrastructure for cleaner and more climate-friendly fuels and engine technologies[47]

Human Health and Welfare

Climate change will likely cause increases in heat stress, reduced air and water quality, and shifts in vector-borne disease risk. The impacts of climate change on human health will vary and depend on, among other factors, an individual's sensitivity and exposure to a given threat and capacity to adapt. A warmer climate could result in increased cases of vector-borne diseases, such as West Nile virus, and stronger, more frequent heat waves. Locally, there is also a correlation between heat waves and the occurrence of high ozone days. Generally, the hotter the temperature, the more favorable the conditions are for ozone-producing chemical reactions in the air, which can lead to an increase in asthma cases and exacerbation of chronic respiratory diseases. Mitigation measures to consider should include:

- Encouraging private transportation users to reduce emissions of greenhouse gases
- Providing public education programs to warn of the dangers of extreme heat and high ozone conditions
- Monitoring the health status of the community

Additionally, in the Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change report the Maryland Climate Change Commission recommends:

- Conducting vulnerability assessments to gain a better understanding of risks and inform preventative responses
- Integrating impact reduction strategies into State and local planning practices
- Streamlining and revising data collection and information dissemination channels[48]

Table 4.3 cross-references the sectors discussed above to the natural hazards that may be exacerbated by climate change. The table shows how exacerbated hazards may manifest themselves as vulnerabilities for Frederick County.

Table 4.3. Climate Change Risks and Vulnerabilities

Natural Hazard	Relative Risk	Sector			
		Water Resources	Agriculture	Transportation Infrastructure	Human Health and Welfare
Drought/Extreme Heat	High	Strains on water supply Adverse water quality affects	Shorter growing season Reduced crop yield	Increased roadside erosion Failure of roadway asphalt	Increased food costs Food shortages Heat strokes Respiratory problems

[47] Professor Sudhakar Yedla. Climate Change Mitigation Initiatives in Urban Transportation – Strategies to Promote Non-Motorized Modes in Indian Cities. 2008.
[48] Maryland Department of Natural Resources. Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change. Retrieved from http://www.dnr.maryland.gov/climatechange/pdfs/climatechange_phase2_adaptation_strategy.pdf

Flash/River Flooding/ Thunderstorm	High				Reduced air quality
		Adverse water quality affects	Damage to crops Damage to irrigation systems	Increased roadside erosion Failure of roadway asphalt	Flooding deaths Injury from debris Population displacement
Winter Weather (Snow & Ice)	Medium-High	Groundwater availability	Damage to crops	Failure of roadway asphalt	Injury from debris Population displacement

Methodologies Used

Federal Disaster Declarations

Two important sources for identifying hazards that can affect a locality are the record of federal disaster declarations and historic storm data. According to FEMA, since 1962, there have been 25 major disaster declarations for Maryland, of which 13 have been declared for Frederick County. Nine of the declarations were for flooding/severe storm and four were for winter weather. In addition, there have been five emergency declarations in Maryland; Frederick County was included in all five declarations. Table 4.4 presents the declared disasters and available FEMA recovery programs since 1962.

Table 4.4. Presidentially Declared Disasters for Frederick County

Disaster Number	Incident Type	Incident Date	Programs Declared*			
			IH	IA	PA	HM
DR-309	Flooding, Severe Storm	8/17/1971		✓	✓	✓
DR-341	Flooding, Heavy Rains (Tropical Storm Agnes)	6/23/1972		✓	✓	✓
DR-489	Flooding, Heavy Rains	10/4/1975		✓	✓	✓
DR-522	Severe Storms, Flooding	10/14/1976		✓	✓	✓
DR-601	Severe Storms, Tornadoes & Flooding	9/14/1979		✓	✓	✓
EM-3100	Severe Snowfall & Winter Storm	3/13/1993			✓	✓
DR-1016	Severe Winter Weather & Ice Storm	2/8/1994			✓	✓
DR-1081	Severe Snowstorm (Blizzard of '96)	1/6/1996			✓	✓
DR-1094	Severe Storms, Flooding	1/19/1996		✓	✓	✓

Disaster Number	Incident Type	Incident Date	Programs Declared*			
			IH	IA	PA	HM
DR-1139	Severe Storms, Flooding (Tropical Storm Fran)	9/6/1996		✓		✓
DR-1324	Severe Winter Storm	1/25/2000			✓	✓
EM-3179	Severe Snowstorm	2/14/2003			✓	✓
DR-1492	Flooding, Severe Storms, Wind (Hurricane Isabel)	9/18/2003	✓	✓	✓	✓
EM-3251	Sheltering, Evacuation (Hurricane Katrina)	8/29/2005			✓	
DR-1910	Severe winter storms and snowstorms	2/5/2010			✓	✓
EM-3335	Hurricane (Irene)	8/26/2011			✓	
EM-3349	Hurricane (Sandy)	10/26/2012			✓	
DR-4091	Hurricane (Sandy)	10/26/2012	✓		✓	✓
DR-4261	Severe winter storms and snowstorms	1/22/2016			✓	✓
DR-4374	Severe Storms, Flooding	5/15/2018			✓	
EM-3430	COVID-19	1/20/2020			✓	
DR-4491	COVID-19 Pandemic	1/20/2020		✓		

*IH = Individual Housing IA = Individual Assistance PA = Public Assistance HM = Hazard Mitigation

Source: FEMA Declared Disasters (as of August 2021).

Additional notable events that have occurred in or near Frederick County, MD, provided by the Frederick County Division of Emergency Management, include:

- In April 2002, a prolonged drought strained water resources along the east coast, the effects of which were felt especially in Frederick, MD. [49]
- A tornado outbreak occurred on Friday, September 17, 2004 as Tropical Depression Ivan advanced northward up the spine of the Appalachians. Three tornados touched down in Frederick County.
- Between June 27 to 29, 2006, heavy rains caused significant flooding across much of the Mid-Atlantic region. In Frederick County, three people were killed when they attempted to cross the flood waters from Middle Creek and two teenagers drowned while swimming in a swollen creek that feeds into the Monocacy River.
- On December 19, 2009, the first of three major snowstorms of the season crippled much of the Mid-Atlantic region, dumping nearly two feet of snowfall across much of Frederick County. A second major snowstorm, which occurred February 5-6, 2010, is commonly referred to as “Snowmageddon.” On

[49] http://www.nytimes.com/2002/04/21/nyregion/extended-drought-strains-resources-along-east-coast.html

February 10, 2010, the third major snowstorm of the season dumped about two feet of snowfall across much of Frederick County.

- On June 29, 2012, a destructive complex of thunderstorms (derecho) moved through the Washington, DC metro area with winds of 60-80 mph, resulting in extensive damage and leaving more than 1 million area residents without power.
- On September 29, 2015, a heavy rainstorm dropped over 5 inches of rain in Frederick County and resulted in flash flooding in downtown City of Frederick and parts of the County. In total, 42 residents and 13 businesses reported damage from flooding. Radar estimated rainfall of 3 to 4 inches total in the city of Frederick, with 2 to 2.5 inches falling in one hour. Based on that 1-hour rainfall estimate, the event would be between a 10- and 25-year rainfall event for the area (4% to 10% chance of occurrence in any given year). The County has requested, via the State, a federal disaster declaration for the event.

National Centers for Environmental Information Storm Events Data

National Centers for Environmental Information (NCEI) storm events data is published by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The storm events database contains information on storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce from 1950 to March 2021. Records for the majority of weather events were reported starting in 1996, with the exception of tornado, thunderstorm, and hail. There has been a total of 1,248 events for the hazards profiled in this report. Total property damages from these events exceed $96 million (adjusted for inflation). Table 4.5 summarizes the County totals by hazard. The hazard-specific sections in this report profile the historic events and include, when applicable, narratives from this dataset.

Table 4.5. NCEI Storm Events for Frederick County[50]

Hazard Type	Period of Record	Total Events	Property Damage (2021$)	Crop Damage (2021$)	Injuries	Deaths
Primary Climate Change Interaction: Changes in Precipitation						
Flood	1996 - 2021	237	$83,237,213	$67,228	1	6
Dam and Levee Failure	Data not collected by NCEI. Analysis source to be used: United States Army Corps of Engineers National Inventory of Dams and Levees and Stanford University's National Performance of Dams Database.					
Karst and Land Subsidence	Data not collected by NCEI. Analysis source to be used: USGS Engineering Aspects of Karst data and County historical data.					
Drought	1996 - 2021	12	$0	$40,277,677*	0	0
Landslide	Data not collected by NCEI. Analysis source to be used: United States Geological Survey Landslide susceptibility data.					
Wildfire	Data not collected by NCEI. Analysis source to be used: Autonomous Modular System (AMS) fire database.					
Primary Climate Change Interaction: Rising Temperatures						

[50] NOAA NCEI Storm Events Database (as of March 2021).

Extreme Heat	1996 - 2021	44	$0	$0	6	2
Primary Climate Change Interaction: Extreme Weather						
Winter Storm	1996 - 2021	265	$406,988	$208,282	0	1
Thunderstorm**	1955 - 2021	496	$2,578,924	$115,983	7	2
Extreme Wind**	1996 - 2021	57	$2,174,353	$145,543	2	1
Hailstorms**	1955 - 2021	79	$6,124	$21,438	0	0
Lightning**	1996 - 2021	22	$1,788,766	$0	5	1
Tornado	1950 - 2021	36	$6,067,480	$84,034	1	0
Tropical Cyclone	1996 - 2021	2***	$5,863	$0	0	0
Non-Climate-Influenced Hazards						
Earthquake	Data not collected by NCEI. Analysis source to be used: United States Geological Survey Earthquake Hazards Program data.					
Total		**1,248**	**$96,265,711**	**$40,920,185**	**22**	**12**

* Zonal damages for three regional droughts spanning 1997 – 1999.

** Thunderstorms, extreme wind, hailstorms, and lightning are presented collectively under the Thunderstorm hazard profile. Previous plans, including the 2016 plan update, presented these hazards separately.

***There are tropical storm/hurricane events were categorized as floods or not recorded in the NCEI database, due to the kind of damage and if damages were recorded.

It should be noted that these estimates are believed to be an underrepresentation of the actual losses experienced because losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCEI database; this is especially true with crop damages. As shown in Table 4.5 above, several of the hazards are not collected in the NCEI storm events database. Each of the individual hazard sections uses the best available national and local data. In most cases, Frederick County departments have provided supplemental data for past events and damages.

Loss Estimation

Loss estimation involves estimating losses from hazard events and requires a full range of information and accurate data. The loss estimation process helps answer the question "How will the community's assets be affected by the hazard event?" The most convenient way to express the expected losses is in terms of dollars. Rough estimates are provided where available.

There are a number of site-specific and structure-specific characteristics that determine a building's ability to withstand hazards. Site-specific characteristics that have a direct impact on losses incurred can depend on the exposure to hazards, first-floor elevation, number of stories, construction type, foundation type, age and condition of structure, use of structure, and structure contents.

It should be noted that areas and total structures vulnerable to various hazards have been calculated based on best available county data and 2010 U.S. Census data since that is what Hazus-MH 4.2 uses.

Building Stock

Using 2010 U.S. Census data derived from Hazus-MH, there are an estimated 85,141 buildings in the County. The total building replacement value is $33.4 billion, with $20.4 billion in contents exposure. Approximately 91.2% of the buildings are residential housing (Table 4.6), with the dollar exposure estimated at more than $27.6 billion (Table 4.7). Commercial buildings in the County have a total dollar exposure of approximately $3.2 billion, as displayed in Table 4.7.

Approximately 56% of the County's building stock was built after 1980; 31.1% was built between 1940 and 1979, and the remaining 12.9% was built before 1940. The majority of the buildings in Frederick County are wood frame construction, but 25% are reinforced/unreinforced masonry.

Table 4.6. Building Count by Occupancy

Occupancy	Count	% of Total
Residential	77,638	91.2%
Commercial	4,574	5.4%
Industrial	1,544	1.8%
Agricultural	452	0.5%
Religious	559	0.7%
Government	203	0.2%
Education	171	0.2%
Total	**85,141**	**100%**

Source: Hazus-MH 4.2

Table 4.7. Building Exposure by Occupancy

Occupancy	Building Exposure ($1,000)	% of Total	Contents Exposure ($1,000)	% of Total
Residential	$27,645,779	82.8%	$13,824,480	67.7%
Commercial	$3,295,187	9.9%	$3,511,200	17.2%
Industrial	$1,311,273	3.9%	$1,818,997	8.9%
Agricultural	$117,472	0.4%	$117,472	0.6%
Religious	$471,199	1.4%	$471,199	2.3%
Government	$232,139	0.7%	$267,257	1.3%
Education	$327,822	1.0%	$404,783	2.0%
Total	**$33,400,871**	**100%**	**$20,415,388**	**100%**

Source: Hazus-MH 4.2

In addition to the building stock, building footprints were provided by the Frederick County GIS Department. According to this data, there are 182,121 structures in Frederick County with a total exposure value of $26.3 billion. Unincorporated areas have 128,674 structures with a total exposure value of $15.7 billion. The jurisdiction with the next largest number of structures is the City of Frederick, which has 31,252 structures with an exposure value of $7.5 billion. Table 4.8 summarizes the number of structures and exposure for each participating municipality.

Table 4.8. Building Footprints and Exposure

Municipality	Total # Building Footprints	Total Market Value Exposure
Brunswick	4,414	$596,543,300
Burkittsville	207	$11,657,200
Emmitsburg	1,451	$175,612,800
City of Frederick	31,252	$7,547,665,100
Middletown	2,502	$510,711,800
Mount Airy	2,151	$334,903,300
Myersville	1,043	$148,296,600
New Market	914	$163,661,700
Rosemont	326	$18,603,000
Thurmont	4,514	$465,555,110
Unincorporated Areas	128,674	$15,669,314,810
Walkersville	3,790	$578,212,000
Woodsboro	883	$94,704,300
Total	**182,121**	**$26,315,441,020**

Source: Frederick County GIS Database, 2021

Critical Facilities

To assess Frederick County's vulnerability, an inventory of its structures and critical facilities was performed. Critical facilities are those that warrant special attention in preparing for a disaster and that are vital in maintaining community function. Frederick County has prepared an inventory of critical facilities that includes emergency response facilities such as: dry hydrants, law enforcement, fire, and emergency medical services (EMS) stations; hospitals, nursing homes, and care facilities; schools; local government buildings; and important transportation facilities, transit stations, water treatment plants, and wastewater treatment plants.

Table 4.9 indicates a total of 381 facilities in Frederick County and its municipalities that are deemed critical. Of these, 125 facilities are located in the City of Frederick, and 161 facilities are dispersed in the unincorporated areas of the County. In terms of facility type, there are 32 medical and health care related facilities in the County and 67 schools. Appendix D provides detailed information for each facility in the hazard zones.

Appendix E shows all of the mapped critical facilities in the County. This information was provided by the Frederick County Division of Emergency Management and Interagency Information Technologies Division GIS team.

Table 4.9. Number of Critical Facilities Per Municipality by Type

Locality	Colleges and Universities	Dry Hydrant	Fire/EMS	Government Facility	Interchange	Landfill	Law Enforcement	Library	Medical Center	Post Office	School	Shopping Center	Transit Station	WTP/WWTP	Total
Brunswick	0	0	2	2	0	0	1	1	1	1	3	1	1	1	**14**
Burkittsville	0	1	0	1	0	0	0	0	0	1	0	0	0	0	**3**
Emmitsburg	0	0	3	1	1	0	0	1	0	1	1	0	0	1	**9**
City of Frederick	2	0	9	24	8	0	3	1	17	2	18	40	1	2	**125**
Middletown	0	1	3	1	0	0	0	1	0	0	4	1	0	0	**11**
Mount Airy	0	0	0	0	1	0	1	0	0	0	1	1	0	1	**5**
Myersville	0	0	2	1	1	0	0	1	0	1	1	0	0	2	**9**
New Market	0	1	2	1	0	0	0	0	0	1	1	1	0	0	**7**
Rosemont	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Thurmont	0	0	4	1	2		1	1	0	1	3	4	0	1	**18**
Walkersville	0	0	4	1	0	0	0	1	1	1	5	1	0	1	**15**
Woodsboro	0	0	2	1	0	0	0	0	0	1	1	0	0	2	**7**
Unincorporated Areas	1	38	24	3	16	1	1	2	13	13	30	18	1	1	**161**
Total	**3**	**42**	**55**	**37**	**29**	**1**	**7**	**8**	**32**	**23**	**67**	**67**	**3**	**7**	**381**

Source: Frederick County GIS Database, 2021

Lifeline Inventories

Table 4.10 shows the Transportation System Lifeline Inventory that was derived from the Hazus-MH 4.2 database. The replacement value for highways in the County was approximately $2 billion, and for airports, $322 million. The total transportation system lifeline replacement value was estimated at $2.4 billion.

Lifelines have been categorized as follows:

- A highway transportation system consists of roadways, bridges, and tunnels
- A railway transportation system consists of tracks, bridges, tunnels, stations, fuel, dispatch, and maintenance facilities
- A light railway transportation system consists of tracks, bridges, tunnels, stations, fuel, dispatch, and maintenance facilities; the major difference between light rail and rail systems is the power supply, where light rail systems operate with direct current substations
- A bus transportation system consists of urban stations, fuel facilities, and dispatch and maintenance facilities
- Port and harbor transportation systems consist of waterfront structures, cranes/cargo handling equipment, warehouses, and fuel facilities
- A ferry transportation system consists of waterfront structures, passenger terminals, warehouses, fuel facilities, and dispatch and maintenance facilities
- An airport transportation system consists of control towers, runways, terminal buildings, parking structures, fuel facilities, and maintenance and hanger facilities

Table 4.10. Transportation System Lifeline Inventory

System	Component	Locations/Segments	Replacement Value ($1,000)
Highway	Bridges	152	$197,782
	Segments	126	$1,803,406
	Tunnels	0	$0
	Sub Total	278	$ 2,001,188
Railways	Bridges	0	$0
	Facilities	1	Unavailable
	Segments	78	$107,119
	Tunnels	2	Unavailable
	Sub Total	81	$107,119
Light Rail		0	$0
Bus		1	$2,158
Ferry		0	$0
Port		0	$0
	Facilities	8	$43,164

System	Component	Locations/Segments	Replacement Value ($1,000)
Airport	Runways	9	$276,923
	Sub Total	36	$ 322,245
Total		**377**	**$2,430,552**

Source: Hazus-MH 4.2

Table 4.11 shows the Utility System Lifeline Inventory derived from Hazus-MH 2010 U.S. Census data. The replacement value for potable water facilities in the County is approximately $65.9 million, and that of wastewater facilities is $1.5 billion; the replacement value for each system's distribution lines is unknown. The total utility system lifeline replacement value is estimated near $1.6 billion (excluding distribution lines).

Utility systems addressed in the Hazus-MH methodology include potable water, wastewater, natural gas, oil, electrical power, and communication systems, which are defined as follows:

- A potable water system consists of pipelines, water treatment plants, control vaults and control stations, wells, storage tanks, and pumping stations
- A wastewater system consists of pipelines, wastewater treatment plants, control vaults and control stations, and lift stations
- A natural gas system consists of pipelines, control vaults and control stations, and compressor stations
- An oil system consists of pipelines, refineries, control vaults and control stations, and tank farms
- An electrical power system consists of generating plants, substations distribution circuits, and transmission towers
- A communication system consists of communications facilities, communications lines, control vaults, switching stations, radio/TV stations, weather stations, or other facilities.

Table 4.11. Utility System Lifeline Inventory

	Component	Locations/Segments (mi)	Replacement Value ($1,000)
Potable Water	Distribution Lines	7,927.5	Unknown
	Facilities	1.2	$65,934
Wastewater	Distribution Lines	4,756.5	Unknown
	Facilities	14.3	$1,516,482
Natural Gas	Distribution Lines	3,171.0	Unknown
Electrical Power	Facilities	0.6	$10,890
Communication	Facilities	6.8	$1,089
Total		**37 facilities** **15855.1 mi total distribution lines**	**$1,594,395**

Source: Hazus-MH 4.2

Vulnerability Assessment

The hazard identification for Frederick County indicates that some of the hazards warrant a vulnerability analysis because of their frequency of occurrence or because they have caused major damage in Frederick County and its municipalities. The vulnerability assessment uses the information generated in the hazard identification to identify locations in which residents of Frederick County could suffer the greatest injury or property damage in the event of a disaster. This assessment identifies the effects of hazard events by estimating the relative exposure of people, buildings, and infrastructure to hazardous conditions.

Each of the profiled hazards have been prioritized based on several factors (Table 4.12) including the frequency of occurrence (probability/history), amount of damage caused, potential for significant damage, and the committee's knowledge of the potential impacts of the hazard as part of the analysis. The extent of vulnerability analysis was driven by availability of data and established methodology for vulnerability analysis.

2022 Hazard Priority Update

During the 2021 update kick-off meeting, committee members discussed and identified hazards of concern. Each of the hazards profiled were considered using the hazard priority criteria. For this update, only one hazard, Tornado, was determined to have a higher hazard ranking than in 2016 due to the evolving risk of the hazard. The weighted hazard ranking criteria from 2016 was used again in 2021, which de-emphasized warning time and emphasized probability and vulnerability.

Priority Ranking Criteria

As discussed in the planning process, the final hazard rankings were updated using Hazard Mitigation Planning Committee feedback to appropriately apply the criteria summarized below. Each criterion identifies and categorizes the comparative probability and potential vulnerability for the identified hazards in Frederick County. The framing criteria/questions are shown in the numbered list below, and Table 4.12 provides the thresholds for each of the risk levels.

The five main parameters include:

1. **Probability/History**: Has the hazard occurred in the area before, and if so, how often based on the historical record? Weighting Factor: 0.35
2. **Vulnerability**: If the expected event does occur, how many people might be killed, injured, or contaminated, and how much property might be damaged or destroyed (e.g., the percent of people or property vulnerable to the hazard)? Weighting Factor: 0.25
3. **Maximum Threat**: What is the worst-case scenario of the hazard and how bad can it get? What will the loss of life and property damage be if the worst-case scenario occurs (e.g., the percent of the community impacted by the hazard)? Weighting Factor: 0.10
4. **Warning Time**: How much time is the community given to prepare for an event? Weighting Factor: 0.10
5. **Ranking in Previous Plan**: The ranking from the 2016 Frederick County Hazard Mitigation Plan was factored in the 2021 ranking. Weighting Factor: 0.20

Table 4.12. Hazard Priority Criteria

Probability/History	Vulnerability	Maximum Threat (Geographic Area Affected)	Warning Time	2022 Committee Ranking
Unlikely	Negligible	Isolated	Extended	Low

Probability/History	Vulnerability	Maximum Threat (Geographic Area Affected)	Warning Time	2022 Committee Ranking
No documented occurrence with annual probability <0.01	1 to 10% of people or property	< 5% of community impacted	Three days or more	
Somewhat Unlikely Infrequent occurrence with at least one documented event and annual probability between 0.5 and 0.01	**Slight** 10% to 20% of people or property	**Minor** 5 to 15% of community impacted	**Slight** 3 days	**Medium-Low**
Somewhat Likely Infrequent occurrence with at least one documented event and annual probability between 0.5 and 0.01	**Limited** 10 to 25% of people or property	**Small** 5 to 25% of community impacted	**Limited** 2 days	**Medium**
Likely Frequent occurrence with at least 2 documented events and annual probability between 1 and 0.5	**Critical** 25 to 50% of people or property	**Medium** 25 to 50% of community impacted	**Minimal** 1 day	**Medium-High**
Highly Likely Common events with annual probability >1	**Catastrophic** >50% of people or property	**Large** >50% of community impacted	**No Notice** < 24 hours	**High**

Each hazard was assessed based on the five criteria above and assigned an overall hazard priority based on a 5-point priority scale. The overall priority rankings include: Low, Medium-Low, Medium, Medium-High, and High.

CHAPTER 5. HAZARD RISK ASSESSMENT

Risk Assessment Summary

Hazard Prioritization

As discussed at the beginning of this chapter, each hazard was re-evaluated for the 2022 plan update based on the hazard priority criteria. The Plan further categorizes the hazards as high, medium-high, medium, medium-low, and low. As shown in Table 5.1., winter storm and flood are the highest ranked hazards in the County, followed by tornado, thunderstorm, and karst and land subsidence with a ranking of medium-high priority.

Previous plan hazard rankings changed based on the priority ranking criteria thresholds (Table 4.12. Hazard Priority Criteria). The scores for each criterion were reviewed across hazards in an effort to standardize the priority levels. Tornado, which was previously ranked as Medium, is now ranked as Medium-High.

Table 5.1. Hazard Priority Level Comparison

Hazards Type	Probability/ History	Vulnerability	Maximum Threat (Area Affected)	Warning Time	2016 Priority Level	2022 Priority Level
Primary Climate Change Interaction: Changes in Precipitation						
Flood	Highly Likely	Catastrophic	Small	Slight	High	High
Karst and Land Subsidence	Highly Likely	Limited	Isolated	No Notice	Medium-High	Medium-High
Drought	Likely	Negligible	Medium	Extended	Medium	Medium
Wildfire	Highly Likely	Negligible	Small	No Notice	Medium	Medium
Landslide	Unlikely	Limited	Small	No Notice	Medium-Low	Medium-Low
Dam and Levee Failure	Unlikely	Negligible	Small	No Notice	Low	Low
Primary Climate Change Interaction: Rising Temperatures						
Extreme Heat	Highly Likely	Negligible	Large	Extended	Medium	Medium
Primary Climate Change Interaction: Extreme Weather						
Winter Storm	Highly Likely	Critical	Large	Limited	High	High
Thunderstorm	Highly Likely	Limited	Small	Minimal	Medium-High	Medium-High

Hazards Type	Probability/ History	Vulnerability	Maximum Threat (Area Affected)	Warning Time	2016 Priority Level	2022 Priority Level
Tornado	Likely	Negligible	Isolated	No Notice	Medium	Medium-High
Tropical Cyclone	Somewhat Likely	Limited	Medium	Extended	Medium	Medium
Non-Climate-Influenced Hazards						
Earthquake	Unlikely	Limited	Small	No Notice	Medium-Low	Medium-Low

Hazard Frequency

Based on the hazard history and profiles of the aforementioned hazards, the hazard frequency (also called the expected annual number of events) was calculated based on the available data, as shown in Table 5.2. The hazard frequency was calculated by dividing the number of events observed by the number of years. The higher the number, the more likely an event (or multiple events) will happen in a given year.

Table 5.2. Historical Occurrence and Recorded Damage (as of July 2021)

Hazard Type	Period of Record	Total Events	Expected Annual Number of Events	Property Damage (2021$)	Crop Damage (2021$)	Total Damage (2021$)
Primary Climate Change Interaction: Changes in Precipitation						
Flooding	1996 - 2021 NCEI	237	9.48	$83,237,213	$67,228	$83,304,441
Karst and Land Subsidence	2004 - 2015 DPW*	300	25	$210,086	$0	$210,086
Drought	1996 - 2021 NCEI	12	0.48	$0	$40,277,677	$40,277,677
Wildfire	2010 - 2015 AMS	94	15.67	$0	$0	$0
	1998 - 2010 DNR	382	21.22	$0	$18,882	$18,882
Landslide	United States Geological Survey	0	0	$0	$0	$0
Dam and Levee Failure	United States Army	0	0	$0	$0	$0

Hazard Type	Period of Record	Total Events	Expected Annual Number of Events	Property Damage (2021$)	Crop Damage (2021$)	Total Damage (2021$)
	Corps of Engineers					
Primary Climate Change Interaction: Rising Temperatures						
Extreme Heat	1996 - 2021 NCEI	44	1.76	$0	$0	$0
Primary Climate Change Interaction: Extreme Weather						
Winter Storm	1996 - 2021 NCEI	265	10.6	$406,988	$208,282	$615,270
Thunderstorm	1950 - 2021 NCEI	654	24.14	$6,548,167	$282,964	$6,831,131
Tornado	1950 - 2021 NCEI	38	0.54	$6,067,480	$84,034	$6,151,514
Tropical Cyclone	1996 - 2021 NCEI	2	0.08	$5,863	$0	$5,863
Non-Climate-Influenced Hazards						
Earthquake	United States Geological Survey	0	0	$0	$0	$0
Total		**2,034**		**$90,408,317**	**$40,855,033**	**$131,263,350**

*Frederick County Division of Public Works only tracks sinkholes in the County right-of-way as of 2021

Loss Estimates

As described in the hazard-specific estimated loss sections, the County has experienced at least 1,250 hazard events since 1950, as recorded by NCEI, AMS, and Maryland Department of Natural Resources (DNR). Table 5.3. summarizes the estimated annualized damages. Damages included here are limited to reported damages and should be considered an underestimation. In addition to physical damages to buildings and infrastructure, secondary damages, such as disruption of commerce, increased public safety and public works expenditures, and unreported physical damages are not included.

Table 5.3. Annualized Events and Damages by Hazard Type

Hazards Type	Annualized Events	Annualized Reported Damages
Primary Climate Change Interaction: Changes in Precipitation		
Flood	9.48	$1,475,461

Hazards Type	Annualized Events	Annualized Reported Damages
Karst and Land Subsidence	25	$17,507
Drought	0.48	$1,611,107
Wildfire	21.2	$1,452
Landslide	0	$0
Dam and Levee Failure	0	$0
Primary Climate Change Interaction: Rising Temperatures		
Extreme Heat	1.76	$0
Primary Climate Interaction: Extreme Weather		
Winter Storm	10.6	$78,577
Thunderstorm	24.14	$252,939
Tornado	0.54	$86,641
Tropical Cyclone	0.08	$233
Non-Climate-Influenced Hazards		
Earthquake	0	$0
Total		**$3,523,917**

Critical Facilities

As described in each hazard-specific section, hazards with defined spatial extents were intersected with critical facility locations. Table 5.4. provides a summary by facility type of locations in the hazard zones. Location details, shown by jurisdiction, are provided in Appendix D. Facilities located in one or multiple hazard zones have been evaluated and used as the starting point for new mitigation actions for the Plan update.

Fifteen critical facilities were located in three hazard zones. One facility, the Thurmont Regional Library, is located in the intermix wildfire zone, in an area of high landslide vulnerability, and in the Hunting Creek dam inundation area. The remaining facilities are located in the unincorporated area of the County. These include:

- Wolfsville Volunteer Fire Company
- Sabillasville Post Office
- Myersville Highway Fleet Maintenance
- Sabillasville Elementary School
- Wolfsville Elementary School
- Tower Road Radio Tower
- Six Wastewater Treatment Plants
- Two Water Treatment Plants

Table 5.4. Critical Facilities Located in Hazard Zones

Facility Type	Total Count	Flood Zone	Wildland Urban Interface/Intermix	Karst Topography	Dam Inundation
Dry Hydrant	42	13	7	5	1
Fire/EMS	55	3	16	16	0
Government Facilities	37	1	2	18	0
Interchange	29	2	1	10	1
Landfill	1	0	1	0	0
Law Enforcement	7	0	0	4	0
Library	8	0	2	3	1
Medical Center	32	0	4	18	0
Post Office	23	1	6	8	0
School	67	0	10	23	0
Shopping Center	67	5	4	44	2
Transit Station	3	2	0	2	0
Wastewater Treatment Plant	7	4	1	4	1
Total	**378**	**31**	**54**	**155**	**6**

Risk Assessment Changes Since 2016

The 2022 plan consolidates and updates content from the 2016 loss estimation and vulnerability analysis, which built upon previous analyses conducted in 2009 and 2004. The 2016 plan update integrated climate considerations into the vulnerability analyses, but this 2022 process further emphasizes how climate change will affect the frequency and intensity of some hazards due to their interactions with climate-related factors, like precipitation and temperatures. The 2022 plan reorganizes hazards based on the primary climate factor that will affect future probability and severity of occurrences.

The 2022 plan considers all hazards previously assessed in the 2016 plan, as well as those included in the 2021 State of Maryland Hazard Mitigation Plan Update Draft as of Fall 2021. The foundation for the 2016 assessments remain valid, but each hazard was re-analyzed when updated data was available. All hazard sections received the following updates and changes:

- Updated hazard descriptions;
- Updated hazard histories;
- Broken out sections and expanded content for location, extent, and impacts;
- New tables and maps;
- Updated data for determining the probability of future occurrences;
- Updated climate interaction information; and
- Updated critical facilities assessment.

Other than general updates in the list above, specific new additions or significant changes to each hazard section are outlined in Table 5.5.

Table 5.5. Changes to Hazard Risk Assessments Since 2016

Hazard Type	New in 2022
Primary Climate Interaction: Changes in Precipitation	
Flood	• Added a Community Rating System overview • Added an asset exposure analysis using FEMA floodplain extents and using HAZUS-MH 4.2 • Added a population exposure analysis • Added a social vulnerability analysis • Augmented the flood hazard with a localized analysis of pluvial flooding • Added a cultural and historic resources exposure analysis using FEMA Flood Hazard Area extents • Added a development trends analysis using Livable Frederick Comprehensive Plan, frequently flooded roadways, and FEMA Hazard Zones data (separate section)
Karst and Land Subsidence	• Expanded the building exposure and loss estimation to include average exposure • Added a critical facilities exposure analysis • Added a cultural and historic resources exposure analysis using karst area extent • Added a population exposure analysis karst area extent
Drought	• Expanded the asset exposure analysis to show the number and types of farms • Added a reducing vulnerability section that discusses the Maryland Water Conservation Advisory Committee's recommendations based on drought stage
Wildfire	• Added a cultural and historic resources exposure analysis • Added a development trends analysis using Livable Frederick Comprehensive Plan and Wildland Urban Interface extent data (separate section)
Landslide	• Added narratives on asset and population exposure
Dam and Levee Failure	• Added levee information • Added information on risk types, dam hazard classification, and dam condition assessments • Added an asset exposure analysis based on inundation mapping • Added a cultural and historic resources exposure analysis based on inundation mapping • Added a population exposure analysis based on inundation mapping • Added a social vulnerability analysis based on inundation mapping • Added inundation mapping for all dams where data available • Added list of high hazard dams list • Updated section to meet FEMA HHPD requirements • Added a development trends analysis using Livable Frederick Comprehensive Plan and dam inundation data (separate section)

Hazard Type	New in 2022
Primary Change Interaction: Rising Temperatures	
Extreme Heat	• Added an assets exposure narrative • Added a population exposure narrative
Primary Change Interaction: Extreme Weather	
Winter Storm	• Expanded Public Assistance data and discussion • Added an assets exposure narrative • Added a population exposure narrative
Thunderstorm	• Combined the previous thunderstorm, hailstorm, extreme wind, and lightning hazards into "thunderstorm" with subsections for each hazard within it • Added a narrative and extent information on winds, such as downburst and straight-line winds • Added an assets exposure narrative • Added a population exposure narrative
Tornado	• Added an assets exposure narrative • Added a population exposure narrative
Tropical Cyclone	• Renamed "hurricane and tropical storm" to "tropical cyclone" • Added HAZUS-MH annualized analysis • Added an assets exposure narrative • Added a population exposure narrative
Non-Climate-Influenced Hazards	
Earthquake	• Added HAZUS-MH annualized analysis • Added an assets exposure narrative • Added a population exposure narrative

Primary Climate Change Interaction: Changes in Precipitation

The frequency, severity, and magnitude of the hazards in the following section – floods, dam and levee failures, karst and land subsidence, drought, landslides, and wildfires – are all affected by the amount of precipitation received in a region. As precipitation patterns change, so too does Frederick County's vulnerability to certain hazards. By the end of this century, Frederick County is projected to receive more than 46 inches of precipitation every year, an increase of roughly 16% compared to historical averages. [51] The region is also expected to experience more frequent and intense severe rainfall events. Given these projections, Frederick County's vulnerability to the following hazards may intensify in the coming decades.

[51] NOAA. National Weather Service: Climate Prediction Center. 2021. Retrieved from https://www.cpc.ncep.noaa.gov/

Flood

Hazard Identification

Hazard Description

Flooding is the most frequent and costly natural hazard in the United States. A majority of presidential disaster declarations result from weather events where flooding was a major component. Flooding, as defined by the National Flood Insurance Program (NFIP) for insurance purposes, is "a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from: overflow of inland or tidal waters, unusual and rapid accumulation or runoff of surface waters from any source, or a mudflow."

A flood occurs when an area that is normally dry becomes inundated with water. Flooding can occur at any time of the year, with peak volume in the late winter and early spring. Snowmelt and ice jam breakaway contribute to winter flooding, while seasonal rain patterns contribute to spring flooding. Torrential rains from hurricanes and tropical systems are more likely in late summer. Development of flood-prone areas tends to increase the frequency and degree of flooding.

According to FEMA, there are several different types of inland flooding:

- **Riverine Flooding**: Also known as overbank flooding, it occurs when channels receive more rain or snowmelt from their watershed than normal, or the channel becomes blocked by an ice jam or debris. Excess water spills out of the channel and into the channel's floodplain area.
- **Flash Flooding**: A rapid rise of water along a water channel or low-lying urban area, usually a result of an unusually large amount of rain and/or high velocity of water flow (particularly in hilly areas) within a very short period of time. Flash floods can occur with limited warning.
- **Shallow Flooding**: Occurs in flat areas where a lack of a water channel results in water being unable to drain away easily. The three types of shallow flooding include:
    - **Sheet Flow**: Water spreads over a large area at uniform depth.
    - **Ponding**: Runoff collects in depressions with no drainage ability.
    - **Urban Flooding**: Occurs when man-made drainage systems are overloaded by a larger. amount of water than the system was designed to accommodate.

Frederick County largely suffers from riverine and flash flooding. Flash flooding (stormwater or pluvial flooding) as the name suggests, occurs suddenly after an intense but brief downpour, generally less than 6 hours. They move fast and terminate quickly. Although the duration of these events is usually brief, the damages can be quite severe. Flash floods also result as a secondary effect from other types of disasters, including dam breaks and denuded ground from large wildfires. Wildfires remove vegetative cover and alter soil characteristics, increasing the quantity and velocity of storm water runoff, and dam breaks release large quantities of water into receiving drainage ways in a very short timeframe. Flash floods can also deposit large quantities of sediments on floodplains and can be destructive of vegetation cover not adapted to frequent flood conditions. Flooding is the second-leading weather-related cause of death in the country, and flash flooding in particularly is a leading cause of flood-related fatalities. Between 2010 and 2020, floods resulted in an average of 94 fatalities annually. [52] As of November 2021, 145 flood-related fatalities occurred this year, including at least one in Maryland. [53]

[52] National Weather Service. “80-Year List of Severe Weather Fatalities.” https://www.weather.gov/media/hazstat/80years_2020.pdf
[53] National Weather Service. “NWS Preliminary US Flood Fatality Statistics: 2021.” https://www.weather.gov/arx/usflood

Riverine (or fluvial) flooding occurs when a channel, such as a stream or river, receives more water than it can hold, and the excess water overflows the channel banks, flooding the surrounding area. Heavy rain and large amounts of snow melt can cause riverine flooding. Riverine flooding is a longer-term event than flash flooding, maybe lasting days or weeks. Riverine floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies use historical records to determine the probability of occurrence for different extents of flooding. The probability of occurrence is expressed as the percentage chance that a flood of a specific extent will occur in any given year. On the other hand, flash floods are more difficult to predict accurately and happen whenever there are heavy storms (Table 5.6.).

Overall, flood damage to residences can be devastating, both emotionally and financially. Flood damage to businesses could result in loss of income, wages, and tax revenues. Other effects include outbreaks of disease, widespread animal illnesses, disrupted utilities, water pollution, fire, and washed out roads and culverts.

Table 5.6. Causes of Flooding vs. Flash Flooding

Causes of Flooding	External Issues that Exacerbate Flash Flooding
Low lying, relatively undisturbed topography	Hilly/mountainous areas
High water tables	High velocity flows
Soil characteristics	Short warning times
Constrictions in the floodway or floodplain (filling)	Steep slopes
Obstructions in the floodway or floodplain (bridges)	Narrow stream valleys
Excess paved surfaces	Parking lots and other impervious surfaces
Poor drainage	Improper drainage

Location

According to FEMA, most municipalities in the United States have at least one clearly recognizable area at risk of flooding around a river, stream, or large body of water. In support of the NFIP, FEMA identifies and maps areas of flood risk (floodplains). The floods are often described in terms of annual percentage chance of occurrence. Floodplains have been delineated by FEMA to reflect the 1% and 0.2% annual flood events previously known as 100-year and 500-year floods, respectively. The area that has a 1% -annual-chance to flood each year is delineated as a Special Flood Hazard Area (SFHA) for the purposes of the NFIP. This flood is often referred to as the “base flood” or “100-year flood.” The 0.2%-annual-chance floodplain indicates areas of moderate flood hazard.

However, because the 1% floodplain (or any percent floodplain) reflects the percentage chance that area will be inundated in any given year, it is possible to observe a 1% flood more than once every 100 years. For example, FEMA notes that a structure located within a 1%-annual-chance flood zone has a 26% chance of suffering flood damage during the term of a 30-year mortgage. Furthermore, the 1% floodplain is based on empirical evidence. If more or fewer floods of a certain magnitude are observed, FEMA may restudy the floodplains and update corresponding insurance maps. This means that there can be a lag between the official risk and the empirical risk.

Coordinated Needs Management Strategy (CNMS)

The Coordinated Needs Management Strategy (CNMS) is a nationwide program to identify and manage flood hazard mapping needs. The goal is to identify areas where existing flood maps are not based on data that can be validated against today's standards. In the CNMS, studied stream miles are classified as Valid, Unverified, or Unknown based on whether the underlying engineering methods meet validation criteria. According to the FEMA RiskMAP Monocacy Watershed Discovery Report (2014), Frederick County has 1 Unverified mile and 145 Valid miles of detailed study in the Monocacy Watershed. There are 57 Unverified miles and 167 Valid miles of approximate study in the Monocacy Watershed. Generally, this means that Frederick County's flood maps are based on data in line with today's engineering standards.

Special Flood Hazard Areas (SFHAs) in the County are delineated on a Flood Insurance Rate Map (FIRM) produced as part of a Flood Insurance Study. Major watercourses in Frederick County typically have SFHAs mapped as Zone AE while smaller tributary streams are mapped as Zone A. Other small streams have shading as Zone X, and other classifications are also possible. Table 5.7. Description of FEMA Flood Zones presents the various flood hazard zones (including coastal zones which will be discussed in the subsequent section) mapped on FIRM panels in Frederick County.

Table 5.7. Description of FEMA Flood Zones

Zone	Description
A	An area with a 1% chance of flooding in any given year for which no base flood elevations (BFEs) have been determined.
AE	An area with a 1% chance of flooding in any given year for which base flood elevations have been determined. This area may include a mapped floodway.
AO	An area with a 1% chance of flooding in any given year where average depths of flooding are between one and three feet.
X (Shaded)	An area with a 0.2% chance of flooding in any given year for which no base flood elevations have been determined.
X (Unshaded)	An area that is determined to be outside of the 1% and 0.2%-annual-chance floodplains.

Figure 5.1 shows the flood hazard areas in Frederick County. A map of frequently flooded roadways in Frederick County and additional figures with the flood hazards for each jurisdiction can be found in Appendix E.

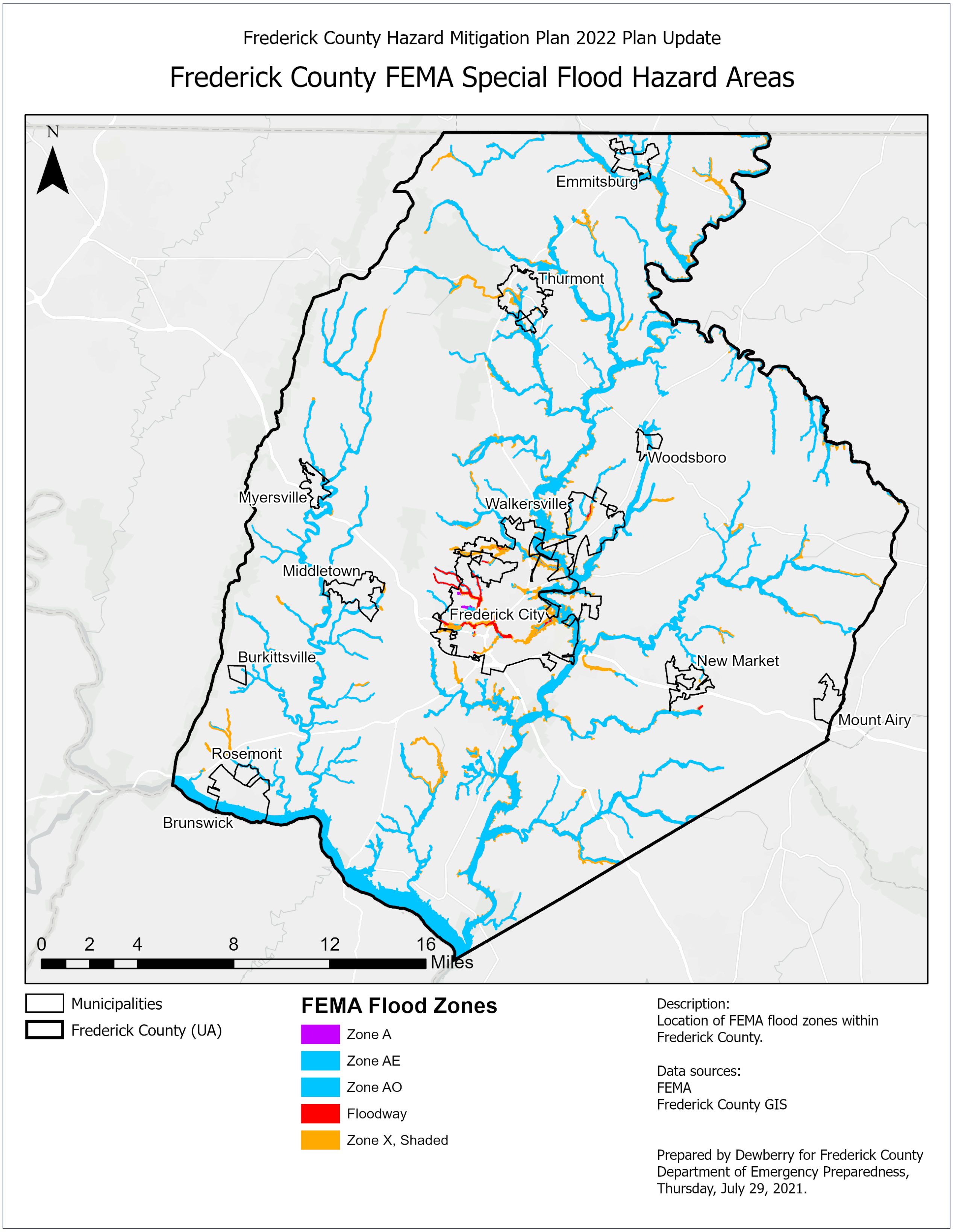

Figure 5.1. Flood Hazard Areas in Frederick County

Many communities also have localized flooding areas outside the Special Flood Hazard Area (SFHA). These floods tend to be shallower and chronically reoccur in the same area due to a combination of factors, such as ponding, poor drainage, inadequate storm sewers, clogged culverts or catch basins, sheet flow, obstructed drainageways, sewer backup, or overbank flooding from minor streams.

Extent

A number of factors contribute to the extent of a flood and the relative vulnerabilities of certain areas in the floodplain. Development, or the presence of people and property in the hazardous areas, is a critical factor in determining vulnerability to flooding. Additional factors that contribute to flood extent and vulnerability include:

- **Flood depth**: The greater the depth of flooding, the higher the potential for significant damages.
- **Flood duration**: The longer duration of time that floodwaters are in contact with building components, such as structural members, interior finishes, and mechanical equipment, the greater the potential for damage. Floodwaters may linger because of the low relief of the area, but the degree varies.
- **Velocity**: Flowing water exerts force on the structural members of a building, increasing the likelihood of significant damage. A one-foot depth of water, flowing at a velocity of five feet per second or greater, can knock an adult over and cause significant scour around structures and roadways.
- **Elevation**: The lowest possible point where floodwaters may enter a structure is the most significant factor contributing to its vulnerability to damage due to flooding. Data on the specific elevations of structures in Frederick County has not been compiled for use in this analysis.
- **Construction type**: Certain types of construction are more resistant to the effects of floodwaters than others. Masonry buildings, constructed of brick or concrete blocks, are typically the most resistant to flood damages simply because masonry materials can be in contact with limited depths of water without sustaining significant damage. Wood frame structures are more susceptible to flood damage because the construction materials used are easily damaged when inundated with water. The type of construction throughout Frederick County varies.

The strength or magnitude of a flood hazard is dependent on the factors above. For example, during a riverine flood, water slowly climbs over the edges of a stream or riverbed and spreads to the surrounding area. Observing the slow rise of water along with an area-wide flood warning usually gives adequate time to evacuate; however, because the rainfall associated with flash flooding is so intense and fast moving, it is not as easy to predict when a flash flood will occur. Specific extent of flash flooding is difficult to determine in advance because local terrain, soil conditions, and construction play a role in how much stormwater can percolate into the soil, be accommodated by waterways, or cause flash flooding.

Previous Occurrences

There have been seven Presidential disaster declarations related to flooding in Frederick County (not including those associated with tropical systems). These include May 2018, September 1996, January 1996, September 1979, October 1976, October 1975, and August 1971.

Frederick County typically experiences 9 to 10 flood events each year, however statistically only 1 event a year caused damage. Of these damaging events, 76% were related to flash flooding. Events prior to 2016 are summarized in Appendix A. The County has experienced three main events since 2016:

- On July 8, 2019, around 6.3 inches of rainfall fell in less than a few hours in Frederick County. [54] The heavy rainfall led to the overflowing of Carroll Creek, which resulted in the flooding of 20 different

[54] Bohnel, S. "Heavy rain causes flooding throughout Frederick." July 8, 2019. *The Frederick News-Post*. https://www.fredericknewspost.com/news/disasters_and_accidents/heavy-rain-causes-flooding-throughout-frederick/article_68954d6c-eb99-5182-b255-d05558eff066.html

roadways and stranding of 11 vehicles in standing water.[55] Roadways were closed for several hours due to floodwaters, but in general, no significant damage occurred.

- On August 4, 2018, Sams Creek rapidly exceeded its banks, causing flash flooding near the intersection of Oak Orchard Road and Sams Creek Road. The force of the water caused damage to the roadway, scouring out a portion of the road. Gas House Pike, Stauffer Road, Water Street Road, and MD-75 South Main Street were closed due to flooding, not only in Sams Creek, but in Linganore Creek, Walkersville, and near Harp Road. The stream gauge at Frederick along the Monocacy River crested at 15.74 feet, above the flood stage of 15 feet. Both banks of the river were flooded. Water flooded low-lying fields at Monocacy National Battlefield. Water reached the access road of the City of Frederick Wastewater Treatment Plant. No injuries or deaths were reported.
- On May 15, 2018, heavy rain led to multiple flash flood events. A cold front slowly sagged southward through Pennsylvania during the afternoon hours of May 15. A line of storms spread ahead of this front, causing a widespread 1-3 inches of rain across North Central and Northeast Maryland. The western end of this line stalled, producing 3-6 inches of rain in a relatively short period of time in Frederick County, prompting numerous water rescues and causing somewhat significant damage. The front stalled, and the next evening (May 16th), a second round of extreme rainfall struck much of the same area, with 3-6 inches of rain observed again in Frederick County. Renewed flooding ensued which continued into the morning hours of May 17. A passenger train was surrounded by floodwaters as it moved westward between Point of Rocks and Brunswick. Water never entered the train, but eyewitnesses reported water up to the bottom step and partial undermining of the tracks. Renewed flooding ensued which continued into the morning hours of May 17. The stream gage on the Potomac River at Point of Rocks exceeded the 16-foot flood stage during the indicated times. The peak level of 17.39 feet occurred at 11:00am EST on May 20. The Brunswick campground, parts of the C and O Canal, the lower parking lot of the Point of Rocks boat ramp, and the parking lot of the Brunswick and Nolands Ferry boat ramps all flooded. No injuries or deaths were reported.
- On February 24, 2016, strong low pressure moved from the deep south to the Great Lakes. Strong warm air advection coupled with moisture led to showers and thunderstorms across the area. Activity strengthened in the afternoon and multiple rounds of heavy rain moved across the area. Many rivers reached flood stage across the Mid-Atlantic. An SUV was stranded in high water on Gas House Pike from Linganore Creek. The vehicle was slowly being drifted downstream. A water rescue was conducted, and the occupant was rescued. Maryland route 550 was flooded and closed in both directions at Council Drive. No injuries or deaths were reported.

According to the NCEI, 230 flood events were reported in Frederick County from 1996 to March 2021. Of these, 75 events were classified as flash floods. These events have resulted in at least $36.8 million of property damages and $67,228 in crop damages. NCEI only accounts for reported events and damages, so there is very likely to be events and damages that are not captured. A record of NCEI events by jurisdiction is in Table 5.8.. All values have been converted into 2021 dollars.

Table 5.8. NCEI Record of Frederick County Flooding Events

Jurisdiction	Events	Property Damage (2021$)	Crop Damage (2021$)	Total Damage (2021$)
City of Brunswick	7	$203,557	$0	$203,557
City of Frederick	18	$133,576	$0	$133,576

[55] Dacey, K., Melser, L., and Pann, T. "Heavy rainfall floods roads, parks across Maryland." July 8, 2019. *WBAL 11*. https://www.wbaltv.com/article/heavy-rainfall-floods-roads-frederick/28320217#

Jurisdiction	Events	Property Damage (2021$)	Crop Damage (2021$)	Total Damage (2021$)
Town of Burkittsville	0	$0	$0	$0
Town of Emmitsburg	21	$0	$0	$0
Town of Middletown	3	$0	$0	$0
Town of Mount Airy	0	$0	$0	$0
Town of Myersville	1	$0	$0	$0
Town of New Market	0	$0	$0	$0
Town of Thurmont	9	$0	$0	$0
Town of Walkersville	8	$0	$0	$0
Town of Woodsboro	3	$0	$0	$0
Village of Rosemont	1	$5,251	$0	$5,251
Unincorporated Areas	159	$36,476,908	$67,228	$36,544,136
Frederick County (Total)	**230**	**$36,819,292**	**$67,228**	**$36,886,520**

Probability and Severity of Future Occurrences

All jurisdictions in the region are vulnerable to some degree of flooding. There is always a risk for flash floods, along with other riverine and stream flooding. While climate change impacts are expected to impact precipitation patterns, the probability of future floods can be discussed in relation to the benchmark flood, or the "1%-annual-chance" flood.

In addition to this statistical probability, there is also an increased chance of flooding in communities that are not maintaining natural floodplains and infrastructure. Urban flooding can often be minimized or avoided with consistent drainage system maintenance. In addition, by working to maintain clean floodways, natural floodplains will be allowed to flood normally, minimizing adjacent property damage. Table 5.9. shows the flood probability for the region.

Table 5.9. Flood Probabilities for the Region

Recurrence interval (years)	Probability of occurrence in any given year	Chance of occurrence in any given year
500	1 in 500	0.2%
100	1 in 100	1%
50	1 in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1 in 5	20%

Recurrence interval (years)	Probability of occurrence in any given year	Chance of occurrence in any given year
2	1 in 2	50%

It is important to note that although a recurrence interval is given for a storm of a certain magnitude, that does not mean this size storm only occurs once in a certain number of years. For example, a 1%-annual-chance flood, or 100-year flood, has a 1% chance of occurring each year. There is always a chance that a storm of the same magnitude can occur in the same year.

Looking at the flooding events listed in the NCEI database, there were 25 events that have any recorded damage within a 25-year period, between 1996-2021. That would indicate one damaging flood event every year. Table 5.10. lists all flooding events for Frederick County and the number of annualized events per jurisdiction. There was a total of 230 events in the same 25-year period, meaning that according to the NCEI, only 10.9% of flooding events produced damages that were reported.

Table 5.10. Annualized NCEI Flood Events for Frederick County

Jurisdiction	Events	Annualized Events	Total Damages (2021$)	Annualized Damages (2021$)
City of Brunswick	7	0.28	$203,557	$8,142
City of Frederick	18	0.72	$133,576	$5,343
Town of Burkittsville	0	0	$0	$0
Town of Emmitsburg	21	0.84	$0	$0
Town of Middletown	3	0.12	$0	$0
Town of Mount Airy	0	0	$0	$0
Town of Myersville	1	0.04	$0	$0
Town of New Market	0	0	$0	$0
Town of Thurmont	9	0.36	$0	$0
Town of Walkersville	8	0.32	$0	$0
Town of Woodsboro	3	0.12	$0	$0
Village of Rosemont	1	0.04	$5,251	$210
Unincorporated Areas	159	6.36	$36,544,136	$1,461,765
Frederick County (Total)	**230**	**9.2**	**$36,886,520**	**$1,475,461**

Climate change models predict shifts in precipitation patterns for the Mid-Atlantic region. As warming progresses, precipitation events are expected to increase in intensity with seasonal variations. Changes in precipitation patterns in Maryland are likely to intensify both floods and droughts. This means fewer spring and summer rainstorms, but when they do occur, they are likely to bring more short duration high-intensity rain events than historically experienced. In addition, precipitation is expected to increase during the winter months. However, due to warming air temperatures, this is expected to fall more frequently as rain or freezing rain versus snow. All of this will likely result in increases in both fluvial (riverine) and pluvial flooding without adequate mitigation.

Loss Estimation

Riverine flooding loss estimates for each jurisdiction were derived using the FEMA Hazus-MH Flood Module for riverine hazards. Flood hazard is defined by a relationship between depth of flooding and the annual chance of inundation to that depth. Annualization is the mathematical method of converting individual losses to a weighted average that may be experienced in any given year. Annualized loss is the preferred measure with which to express potential risk for hazard mitigation planning as it is useful for creating a common denominator by which different types of hazards may be compared. Annualized losses compared across a region, may indicate targeted areas for prioritization of hazard mitigation actions. Areas with signification annualized losses may be subject to not only local flooding (nuisance flooding) but also frequent storm event flooding as well. The analysis was completed using the multi-frequency riverine depth grids published in January 2021.

The annualized results for Frederick County are summarized in Table 5.11. Due to population growth and increased development, all estimates of the numbers of vulnerable structures and losses may under-estimate risk at the present time. Annualized flood damage due to flash flooding (stormwater or pluvial flooding) is not accurately reflected in the results and is explored more in the Pluvial Flood Analysis section.

Table 5.11. Total Annualized Flood Loss (in $1,000s)

Jurisdiction	Buildings	Contents	Inventory	Relocation	Income	Rental	Wages	Total Loss
Communities								
City of Brunswick	$45.98	$25.98	$0.00	$13.98	$0.00	$3.99	$2.00	$91.93
City of Frederick	$5,570.06	$6,040.69	$89.20	$1,657.36	$2,526.97	$793.40	$4,530.07	$21,207.75
Unincorporated Areas	$9,038.37	$8,169.82	$224.82	$1,997.85	$2,342.26	$815.38	$4,678.53	$27,267.02
Town of Burkittsville	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Town of Emmitsburg	$106.19	$76.43	$0.00	$23.57	$24.46	$7.84	$23.46	$261.96
Town of Middletown	$135.08	$94.35	$0.00	$42.14	$38.01	$9.69	$34.74	$354.00
Town of Mount Airy	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Town of Myersville	$56.16	$66.66	$0.00	$20.36	$23.94	$4.05	$524.31	$695.49
Town of New Market	$0.01	$0.00	$0.00	$0.00	$0.91	$0.00	$2.72	$3.64
Town of Thurmont	$305.70	$331.30	$1.00	$198.42	$314.35	$79.03	$483.65	$1,713.45
Town of Walkersville	$309.94	$300.27	$7.10	$131.25	$79.69	$38.62	$141.69	$1,008.57
Town of Woodsboro	$82.06	$142.74	$8.81	$35.16	$98.70	$13.67	$99.62	$480.76
Village of Rosemont	$7.04	$4.02	$0.00	$0.03	$0.00	$0.01	$0.00	$11.10
Frederick County (Total)	**$15,656.58**	**$15,252.27**	**$330.93**	**$4,120.13**	**$5,449.28**	**$1,765.68**	**$10,520.79**	**$53,095.67**
Colleges								
Frederick Community College	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Hood College	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Mount St. Mary’s University	$1.79	$1.04	$0.00	$0.00	$0.00	$0.00	$0.00	$2.82

Points of note on impacts and areas of vulnerability:

- Out of the total number of critical facilities (fire stations, police stations, schools, and hospitals) located, a small number of these facilities can be expected to endure moderate damage, and in most cases, few facilities are projected to obtain substantial damage. No loss of use was projected in any county.
- Building occupancy most affected by a 100-year flood event would be residential followed by commercial. In addition, the building material type in all counties that would obtain the most damage was calculated to be wood. Since damage to residential structures was modeled to be most prevalent in all county scenarios, it is apparent that safety concerns and homeowner education on proper clean up after flood waters recede would be very important during the post-disaster management phase.
- All communities may expect some level of emergency shelter needs post-disaster.

Complete Hazus scenario generated reports for flooding can be found in Appendix H.

As evidenced in the loss figures (Table 5.12) obtained from NCEI and Hazus, floods have the potential to be destructive and, although analyses vary, the overall trends are consistent. Total damages, on an annualized basis, for incorporated communities range from about $210.04 in the Village of Rosemont to more than $8,000 in the City of Brunswick, using NCEI data. There are nine communities that either had no NCEI-reported flooding or did not have any damages associated with flooding. Total annualized damages are compared to the annualized damages as determined by Hazus. While Hazus reports much higher loss values than NCEI, it also shows that the differences in the magnitude of the loss values may be a result of inconsistent storm event reporting in the NCEI Storm Events Database.

Table 5.12. Comparison of NCEI Annualized Events to Hazus Annualized Losses

County	NCEI Annualized Events	NCEI Total Annualized Damages	Hazus Total Annualized Losses
City of Brunswick	0.28	$8,142.26	$91,928.28
City of Frederick	0.72	$5,343.05	$21,207,748.40
Unincorporated Areas	6.36	$1,461,765.44	$27,267,023.24
Town of Burkittsville	0	$0.00	$4.62
Town of Emmitsburg	0.84	$0.00	$261,962.27
Town of Middletown	0.12	$0.00	$353,998.28
Town of Mount Airy	0	$0.00	$0.00
Town of Myersville	0.04	$0.00	$695,486.55
Town of New Market	0	$0.00	$3,641.90
Town of Thurmont	0.36	$0.00	$1,713,451.74
Town of Walkersville	0.32	$0.00	$1,008,568.35
Town of Woodsboro	0.12	$0.00	$480,755.92
Village of Rosemont	0.04	$210.04	$11,099.03
Frederick County (Total)	**9.2**	**$1,475,460.79**	**$53,095,668.60**

National Flood Insurance Program (NFIP)

The National Flood Insurance Program (NFIP) is a federal program that enables property owners in participating communities to purchase insurance for flood losses since homeowner insurance policies do not cover damage from flood. Flood insurance is designed to provide an alternative to post-disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. Frederick County and the localities participating in the HMCAP pay special attention to properties that have faced repeated flood damage and NFIP claims, as they offer excellent opportunities for high-impact flood mitigation. These “repetitive loss properties” are further described below.

Additional information on the NFIP and HMCAP-participating communities capabilities within it can be found in Chapter 6 under the National Flood Insurance Program section.

Repetitive Loss Areas

Frederick County pays special attention to repetitive loss properties due to their unique potential for high-return mitigation projects. Both the NFIP and FMA have definitions for Repetitive Loss and Severe Repetitive Loss structures or properties as described below. However, the HMCAP primarily focuses on the NFIP definition.

Repetitive Loss refers to a structure or property meeting either (1) or (2) from the following definitions:

1. A structure that meets one of the two following qualifiers:
    a. Two or more claims of more than $1,000 paid by the NFIP within any rolling 10-year period, since 1978; or
    b. Two or more claims (building payments only) that, on average, equal or exceed 25 percent of the market value of the property.[56]
2. A structure covered by a contract for flood insurance made available under the NFIP that meets both of the two following qualifiers:
    a. Has incurred flood-related damage on two occasions, in which the cost of the repair, on average, equaled or exceeded 25 percent of the market value of the structure at the time of each such flood event; and
    b. At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.[57]

Severe Repetitive Loss refers to a structure or property meeting either (1) or (2) from the following definitions:

1. A structure that meets one of the two following qualifiers:
    a. Received four or more separate claim payments of more than $5,000 each (including building and contents payments); or
    b. Received two or more separate claim payments (building payments only) where the total of the payments exceeds the current value of the property.[58]
2. A structure covered by a contract for flood insurance made available under the NFIP that has incurred flood related damage and meets one of the two following qualifiers:
    a. Four or more separate claims payments (includes building and contents) have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or

[56] This definition is based on the definitions for RL used by the NFIP program. See 44 C.F.R. § 209.2 and pt. 61, Appendices A(1)-A(3); see FEMA, National Flood Insurance Program, Flood Insurance Manual, Appendix A, pg. 11-12, and Appendix E, pg. 5 (Apr. 2021); and see FEMA, National Flood Insurance Program, Community Rating System Coordinator’s Manual, pg. 120-7 (2017).
[57] This definition is based on the definitions for RL used by the Flood Mitigation Assistance (FMA) program. See 42 U.S.C. § 4121(a)(7); and see 44 C.F.R. § 77.2(i).
[58] This definition is based on the definitions for SRL used by the NFIP program. See 42 U.S.C. § 4014(h); see FEMA, National Flood Insurance Program, Flood Insurance Manual, Appendix I, pg. 1, and Appendix L, pg. 8 (Apr. 2021); and see FEMA, National Flood Insurance Program, Community Rating System Coordinator’s Manual, pg. 120-8 (2017).

b. At least two separate claims payments (includes only building) have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.[59]

Repetitive loss properties are important to the NFIP because they cost $200 million per year in flood insurance claim payments nationwide. Repetitive loss properties represent only 1% of all flood insurance policies; yet, historically, they account for nearly one-third of the claim payments (over $4.5 billion to date). Mitigation of the flood risk to these repetitive loss properties will reduce overall costs to the NFIP as well as to individual homeowners.

There are 31 repetitive loss properties with a combined 82 claims in all of Frederick County. The City of Brunswick, Town of Thurmont, Town of Middletown, and City of Frederick all have at least one repetitive loss property. Overall, there are 23 repetitive loss properties in Flood Zone A (SFHA), 3 repetitive loss properties in Flood Zone C, and 5 repetitive loss properties in Flood Zone X. Table 5.13 provides the type and number of repetitive loss properties in Frederick County and its communities, with targeted structures for mitigation highlighted in red. Some of the properties in the table may no longer be considered repetitive loss properties because they have been mitigated, as shown in the table. Before the next plan update, Frederick County will work with the State and FEMA Region III to review and reconcile all sources of repetitive loss data.

Table 5.13. Repetitive Loss/Severe Repetitive Loss Overview

Locality Name	Occupancy Type	Mitigated	NFIP Insured	# Losses	Flood Zone	NFIP RL/SRL	FMA RL/SRL
Brunswick	Single-Family	No	No	6	A	RL	--
Frederick County	Other - Nonresidential	No	No	3	A	RL	--
Frederick County	Other - Nonresidential	No	No	5	A	SRL	SRL
Frederick County	Single-Family	No	No	3	A	RL	--
Frederick County	Single-Family	Yes	No	3	C	RL	--
Frederick County	Single-Family	Yes	No	3	A	RL	--
Frederick County	Single-Family	Yes	No	3	A	RL	--
Frederick County	Single-Family	No	No	3	A	RL	--
Frederick County	Single-Family	No	No	3	C	RL	--
Frederick County	Single-Family	Yes	No	3	A	RL	--
Frederick County	Single-Family	No	No	2	A	RL	--
Frederick County	Single-Family	No	No	3	C	SRL	SRL
Frederick County	Single-Family	No	No	2	A	RL	--
Frederick County	Single-Family	No	No	3	A	RL	--
Frederick County	Other - Nonresidential	No	No	2	A	RL	--

[59] This definition is based on the definitions for SRL used by the FMA program. See 42 U.S.C. § 4104c(h)(3); and see 44 CFR § 77.2(j).

Locality Name	Occupancy Type	Mitigated	NFIP Insured	# Losses	Flood Zone	NFIP RL/SRL	FMA RL/SRL
Frederick County	Single-Family	No	No	2	A	SRL	SRL
Frederick County	Single-Family	No	Yes	3	A	SRL	SRL
Frederick County	Single-Family	No	No	2	X	SRL	SRL
Frederick County	Other - Nonresidential	No	No	3	A	SRL	SRL
Thurmont	Unknown	No	No	3	A	RL	--
Thurmont	Single-Family	No	No	2	A	RL	--
Frederick County	Single-Family	No	Yes	2	A	RL	--
Frederick County	Single-Family	No	Yes	2	A	RL	--
Frederick County	Single-Family	No	No	2	A	--	--
Frederick County	Single-Family	No	No	3	A	RL	--
Middletown	Business	No	No	2	A	RL	--
City of Frederick	Single-Family	No	Yes	2	X	RL	--
City of Frederick	Other - Nonresidential	No	No	2	X	RL	--
City of Frederick	Single-Family	No	No	2	X	--	--
City of Frederick	Single-Family	No	No	3	X	SRL	SRL

Impact Summary

Primary Impacts

Flood damage to property and populations can be devastating, both emotionally and financially. Flood damage to businesses could result in loss of income, wages, and tax revenues. Buildings, including homes and critical facilities, are susceptible to damage and sometimes collapse as a result of a severe flood.

The primary effects of both riverine and pluvial floods are those due to direct contact with the flood waters. As water velocities tend to be high with floods, discharge increases as velocity does. With higher water velocities, streams are able to transport and carry larger items as suspended loads, such as trees, rocks, or even cars and houses. Flooding can also concentrate garbage, debris, and toxic pollutants. Erosion is also a big issue with flooding. This mass erosion can undermine bridges, levees, and even building, leading to their collapse. Additionally, there is also the possibility that homes can be inundated with water, potentially leading to structure and personal property damage that can range from minor to catastrophic.

Damage can extend outside of structures as well. Flooding of a vehicle usually results in damage that cannot be repaired cost effectively. Crop loss, especially in the early stages of planting where soil and seeds can be washed away, can be an issue. Livestock, pets, and other animals can be carried away with the flood waters, and often drown, as can humans.

Secondary Impacts

Secondary effects result from primary effects. For example, the concentration of garbage, debris, and toxic pollutants can cause health hazards. Drinking water can become contaminated, especially if treatment plants are flooded. This can result in disease and other health problems, especially in underdeveloped areas.

Utilities can also be impacted. Gas and electrical services may be interrupted, either because the lines got damaged by the flood itself, the lines were damaged by suspended items like rocks or trees, or the gas and electrical facilities themselves were flooded. Various transportation systems may also be disrupted due to debris in the way, road damage, or bridge collapse. This can include either roadways or railways. Flooded roadways can cause congestion on alternative routes and lengthen travel times for emergency vehicles and school buses. Having transportation systems down can result in food shortages and problems with clean-up, including removing debris from roads. Public works and public safety expenditures during floods to keep conditions safe and to clean up after an event often exceed the cost of primary impacts.

Risk Assessment

Assets Exposed

Exposure analysis shows the total value of buildings in a mapped floodplain. It is not an estimation of loss from a particular event. Using Frederick County-provided parcel data, an exposure analysis was performed to see the value at risk if flooding were to occur. This parcel data was used in conjunction with the FEMA flood hazard areas to assign parcel points to a specific flood zone. Parcel points that were within 50 feet of a flood zone were included, due to the possibility of the parcel point not being directly on the structure. Full results are shown in Table 5.17..

Unincorporated areas have the most exposure, followed by the City of Frederick, the Town of Thurmont, and the City of Brunswick. The Towns of Burkittsville and Mount Airy, while having values associated with their parcels, had no parcel points in any of the floodplains. Based on percentage of structures in the floodplain, the Town of Thurmont is the most exposed to flooding, followed by the Town of Emmitsburg and the City of Frederick.

Table 5.14. Jurisdictional Exposure to FEMA Floodplains

Jurisdiction	Total Value	Value Exposure in Floodplain					Percent Value Exposed
		AE	AE - Floodway	X - 0.2 PCT	X - 0.2 PCT - 50ft	Grand Total	
City of Brunswick	$596,543,300	$6,505,300	$0	$0	$2,536,600	$9,041,900	1.52%
City of Frederick	$7,357,519,300	$41,597,400	$13,934,600	$150,727,000	$156,539,200	$362,798,200	4.93%
Town of Burkittsville	$11,657,200	$0	$0	$0	$0	$0	0.00%
Town of Emmitsburg	$174,886,900	$782,200	$1,876,200	$1,471,700	$4,613,500	$8,743,600	5.00%
Town of Middletown	$510,489,100	$0	$0	$312,000	$484,600	$796,600	0.16%
Town of Mount Airy	$334,903,300	$0	$0	$0	$0	$0	0.00%
Town of Myersville	$146,925,000	$57,600	$0	$0	$344,100	$401,700	0.27%
Town of New Market	$162,849,100	$0	$0	$0	$473,200	$473,200	0.29%
Town of Thurmont	$465,555,110	$8,724,200	$3,211,700	$14,674,600	$7,583,300	$34,193,800	7.34%
Town of Walkersville	$578,212,000	$729,600	$0	$725,300	$6,727,700	$8,182,600	1.42%
Town of Woodsboro	$94,704,300	$10,900	$0	$0	$1,601,600	$1,612,500	1.70%
Village of Rosemont	$18,603,000	$67,000	$0	$0	$0	$67,000	0.36%
Unincorporated Areas	$15,673,470,610	$137,054,200	$2,326,600	$155,952,100	$143,913,700	$439,246,600	2.80%
Frederick County (All)	**$26,126,318,220**	**$195,528,400**	**$21,349,100**	**$323,862,700**	**$324,817,500**	**$865,557,700**	**3.31%**

Critical Facilities Exposed

Critical Facilities are necessary to preserve the welfare and quality of life in the County, or to fulfill important public safety, emergency response, and/or disaster recovery functions. Many public and commercial facilities serve vital functions for communities, which, if interrupted due to flooding, would severely impact citizens. Some facilities also house large numbers of people who would experience difficulty if required to evacuate before or during a severe flood (i.e., a hospital).

Since flooding can prevent access to a critical facility even if the facility is elevated or floodproofed above the flood level, knowing what facilities are located in existing flood hazard areas and avoiding building any new critical facilities in flood hazard areas is critically important to ensuring public safety. Twelve critical facilities in Frederick County are located in either the 0.2%- or 1%-annual-chance floodplain. Of those, only two are located in the floodway. Facilities located in flood zones are shown in Table 5.18. by jurisdiction.

Table 5.15. Critical Facilities Located in Flood Zones by Jurisdiction

Facility Type	AE	X-shaded	X-unshaded	All Facilities
Brunswick	2	0	12	14
Burkittsville	0	0	3	3
Emmitsburg	1	1	7	9
City of Frederick	3	5	117	125
Middletown	0	0	11	11
Mount Airy	0	0	5	5
Myersville	0	0	6	6
New Market	0	0	7	7
Rosemont	0	0	1	1
Thurmont	0	5	13	18
Walkersville	0	0	13	13
Woodsboro	0	0	5	5
Unincorporated Areas	10	4	147	161
Frederick County (All)	**16**	**15**	**347**	**378**

For a detailed list of the critical facilities that are located in flood zones, see Appendix D. It is worthwhile to note that water and wastewater treatment plants, by their nature, must be near a body of water and thus are typically located in the floodplain.

Cultural and Historic Resources Exposed

Figure 5.2 shows flood hazard areas and their proximity to the cultural and historic resources in Frederick County.

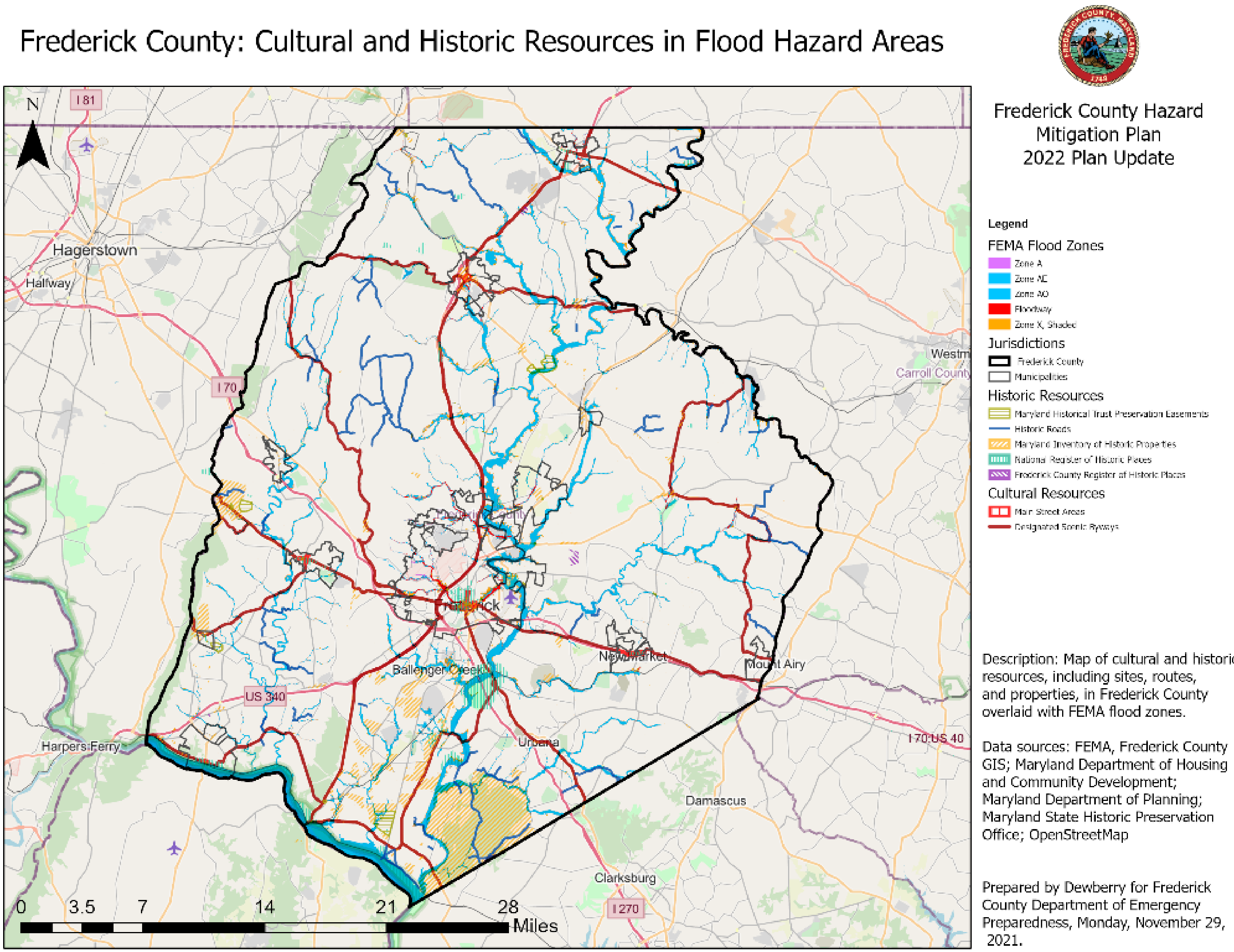

Figure 5.2. Cultural and Historic Resources and Their Proximity to Flood Hazard Areas

Population Exposed

People that live within or near floodplains are more likely to experience flooding compared to those that do not. Using population data from the 2018 American Community Survey, census tracts in Frederick County were overlaid with the effective FEMA Special Flood Hazard Areas to identify areas where residents may be exposed to flooding. Census tracts illustrate overall population, but do not indicate whether within these boundaries that residents live. Some populous tracts may contain concentrated pockets of development, while others may be more evenly distributed. This analysis considers only overall tract population as an indicator of exposure.

Figure 5.3 shows the County's 2018 population by census tract, segmented by quintiles and Figure 5.4 shows social vulnerability by census tract. Frederick County's southernmost border is formed by the Potomac River. Along these waters, Special Flood Hazard Areas affect less populous tracts to the southeast, and more populous ones closer to Brunswick and Rosemont to the southwest. Other rivers, streams, and tributaries run through the County, especially in less populous and incorporated areas to the northern part of the region. Frederick County's most populous tracts are clustered to the southeast around the City of Frederick, New Market, and Mount Airy. In recent years, Frederick County has witnessed both population and development growth. Floodplain ordinances will be essential to ensure that future development and residents within Special Flood Hazard Areas are able to withstand future flood events.

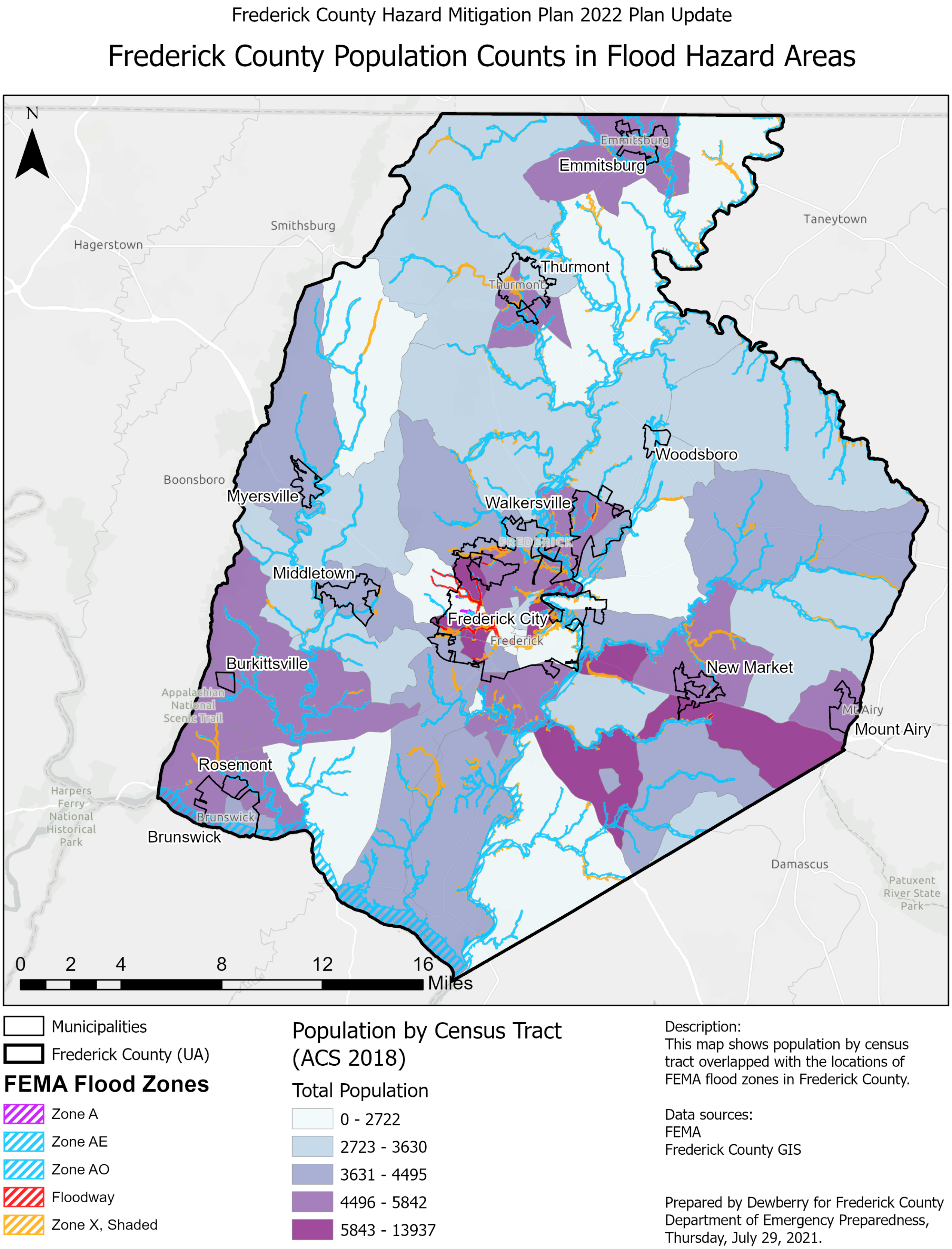

Figure 5.3 Population in FEMA Special Flood Hazard Areas

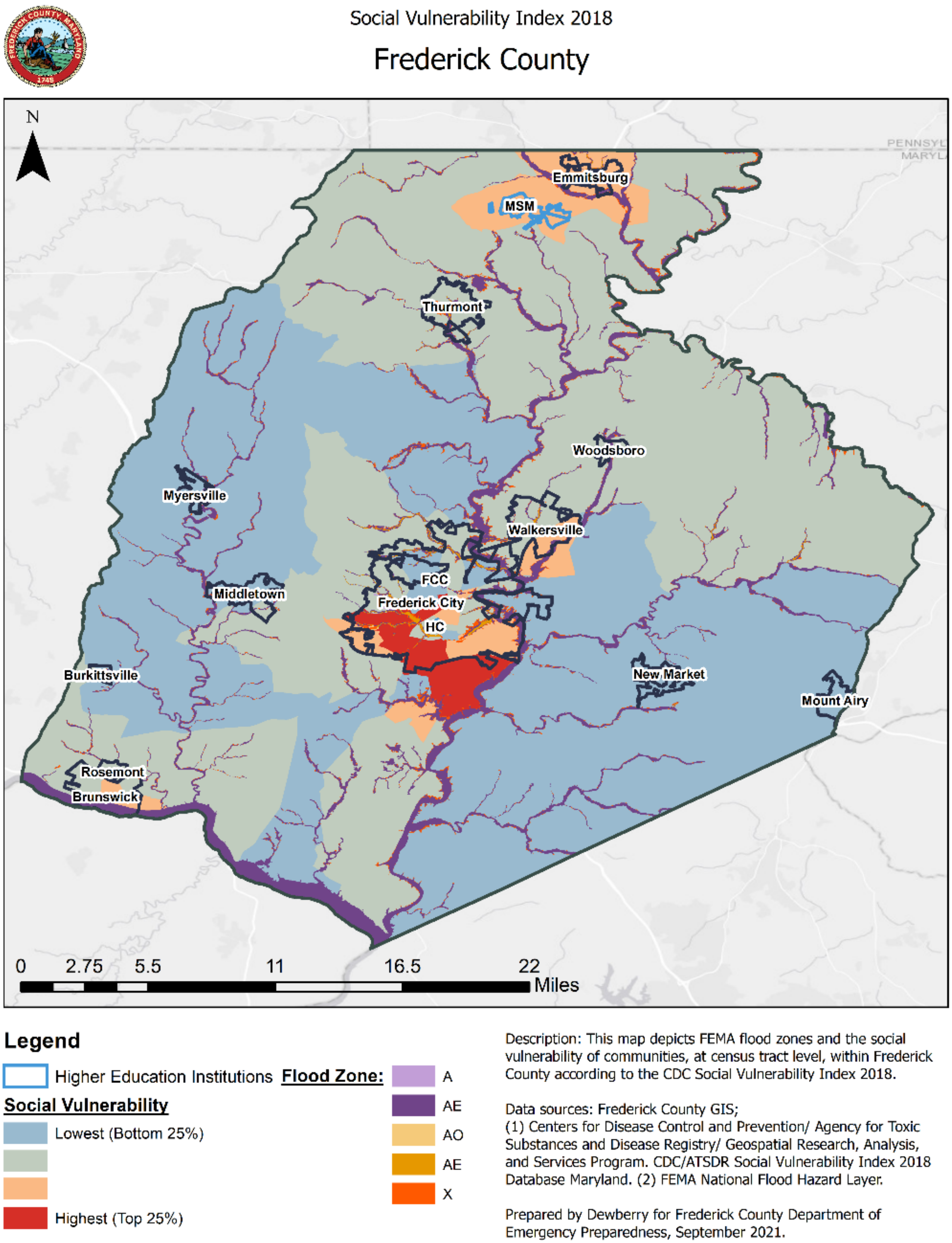

Figure 5.4. Social Vulnerability and FEMA Flood Zones

Pluvial Flood Analysis

This section provides an overview of the pluvial (stormwater) flood. For a more detailed write up, see Appendix A.

Motivation

As described at the beginning of the chapter, there are two major types of flood hazard: fluvial and pluvial. Previous Frederick County hazard mitigation plan updates, as with most mitigation plans, have included a flood exposure analysis and loss estimation based entirely on FEMA flood maps, which only consider fluvial (riverine) flood risk. It is important to also understand the pluvial (stormwater) flood hazard because it is large and increasing, due to climate and urbanization trends. Fortunately, recent advances in computing power and topographic data make it faster and easier than before to consider pluvial flood risk in hazard mitigation plans.

Recognizing the opportunity to better understand flooding more holistically, the County commissioned a new pluvial flood hazard analysis as part of the Plan update. This study provides a new baseline understanding of pluvial flood risk for planning. The analysis employed a large number of assumptions to simplify the development and running of the model across a very large area on a fixed budget. Despite its limitations, the model results provide the most complete picture to date of pluvial flooding hot spots and exposure over a range of potential storm events.

Study Scope

The goal of the pluvial flooding analysis was to develop high level stormwater flood risk products for a limited range of precipitation events for all of Frederick County. The risk products were derived from a two dimensional (2D) hydraulic model using readily available data and simplifying assumptions based on engineering judgement. The model results were not calibrated or validated to any observed flood data, which is sparse and difficult to obtain. The model results were however compared to the FEMA Special Hazard Flood Area (SFHA) and previous flood modeling at Clover Hill to ensure generally consistency in areas where the flood map products overlap.

Modeling Approach

The pluvial flood analysis was conducted using a U.S. Army Corps of Engineer HEC-RAS Version 6 2-dimensional (2D) unsteady flow model. The open-source model and documentation were downloaded from https://www.hec.usace.army.mil/software/hec-ras/download.aspx.

Topographic Processing

Existing Digital Elevation Model (DEM) and LiDAR datasets were downloaded for the Frederick County area using the United States Geological Survey (USGS) National Map API. The best-available DEMs were stitched together into a single elevation data layer. The DEM used across most of Frederick County was collected in 2012 with a resolution of 1/9 arc-second (3.4 m).

Development of Major Watersheds

The USGS Watershed Boundary Dataset was used to help delineate Frederick County into two major watersheds: Catoctin watershed and Monocacy watershed. A separate pluvial flood model was developed for each major watershed, which was necessary to reduce model run times.

Development of Rainfall Inputs

The pluvial flood model simulates stormwater flooding with a “rain-on-grid” modeling approach. The rain-on-grid approach adds or “rains” the appropriate amount of rainfall onto the surface of each grid cell at each model time step. During the model simulation, rainfall ponds and/or moves from model grid cell to grid cell based on the governing hydraulic equations which account for topography, differences in water surface elevation, and surface roughness. The rainfall timestep was set to six minutes, which was sufficiently short to capture the rise and fall of rainfall during the storm. Note the rain-on-grid approach used here is substantially different than the approach used in traditional FEMA models, which use increases in river flows instead of increases in rainfall to simulate flood events.

The rain-on-grid approach was applied with five different storm events: the 100-year 24-hour event, 100-year 12-hour event, 100-year 6-hour event, 25-year 24-hour event, and 10-year 24-hour event. These scenarios were chosen to represent a range of potential extreme storm events. The NOAA Atlas-14 dataset was used to get the cumulate rainfall totals for each major watershed (Table 5.16).

Table 5.16. Average Cumulative Total Rainfall for Each Scenario

Rainfall Scenario	Average Cumulative Rainfall at Catoctin Watershed (in)	Average Cumulative Rainfall at Monocacy Watershed (in)
100-year 24-hour	6.92	7.24
100-year 12-hour	5.89	6.03
100-year 6-hour	4.67	4.73
25-year 24-hour	5.11	5.28
10-year 24-hour	4.14	4.22

Rainfall Infiltration

Rainfall infiltration was modeled within HEC-RAS using the Soil Conservation Service curve number approach. The method is described in detail in the HEC-RAS Version 6 Hydraulic Reference Manual. [60]

Manning's n

Manning's n values were assigned to each grid cell in the model mesh based on its land use class from the 2019 National Land Classification Dataset.

Bridges and other Hydraulic Structures

The model geometry was manually adjusted to ensure that flows could pass through large bridges and major culverts. While this method prevents unrealistic ponding upstream of structures, it may not realistically simulate local hydraulic conditions that affect flooding such as flow constriction, expansion, and backwater.

Stormwater Infrastructure

The pluvial model did not explicitly simulate the effect of stormwater management infrastructure including stormwater catch basins, subsurface storm pipes, and outfalls. Instead, the influence of stormwater infrastructure was indirectly captured by the infiltration model, which assumes a "typical" amount of stormwater runoff from areas based on the density of development.

[60] Brunner, W. B. (2021). *HEC-RAS, River Analysis System Hydraulic Reference Manual.*

Flood Map Post-Processing

The HEC-RAS model simulation produced maps of the maximum flooding extent and the maximum flood depth across Frederick County for the five rainfall scenarios. The flood maps were post-processed to remove minor "nuisance" flooding from the maps. The final flood map for the 100-year 24-hour event is shown in Figure 5.5.

Model Evaluation

The model results were compared with existing FEMA and local flood model results and found to be generally consistent.

Exposure Analysis

An exposure analysis was conducted to understand the potential pluvial flood hazard for buildings, critical infrastructure, and major educational institutions. The results from the three types of exposure analysis are summarized in the sections that follow.

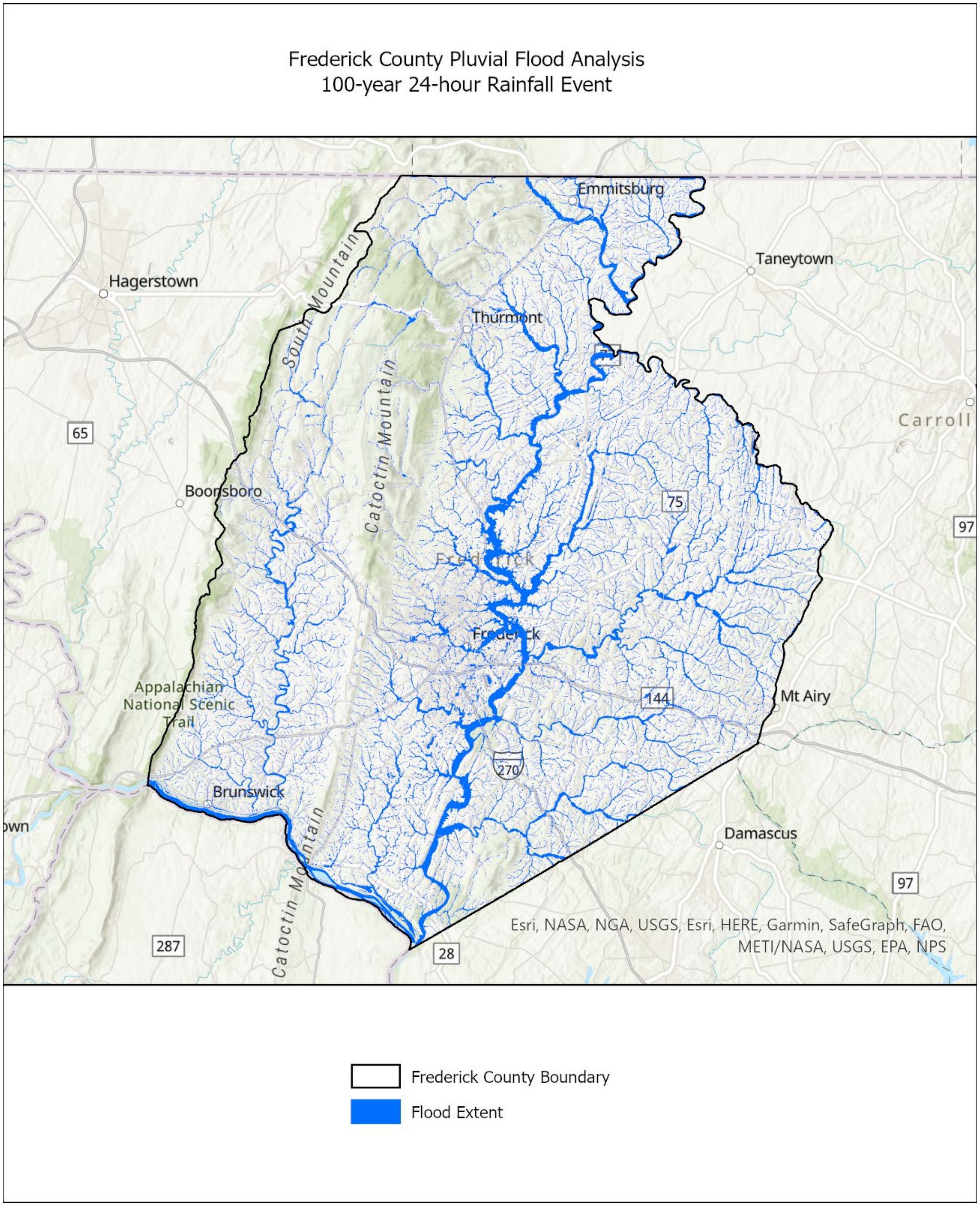

Figure 5.5. Modeled Flood Extent for the 100-Year 24-Hour Rainfall Event Across Frederick County

Building Exposure

The estimated exposure of buildings to pluvial flooding is presented for the 100-year 24-hour event (Table 5.20.). Tables for the other four scenarios are presented in the technical appendix (Appendix A). The total number of buildings exposed across Frederick County ranges from 7,566 (4.2% of total) for the 10-year 24-hour event to 12,560 (6.9% of total) for the 100-year 24-hour event. The highest number as percent of total buildings affected are in The City of Frederick and Burkittsville. The number of buildings exposed based on our pluvial modeling is generally higher than the number of buildings exposed to the FEMA floodplain, which only considers fluvial (riverine) flooding.

Table 5.17. Building Exposure to Pluvial Flooding for 100-Year 24-Hour Event

Jurisdiction	Number of Buildings	Number of Buildings Flooded	Percent of Buildings Flooded (%)	Value of Buildings ($M)	Value of Buildings Flooded ($M)	Percent of Value Flooded (%)
Unincorporated Areas	128,662	6,822	5.3	15,665.9	915.7	5.8
Walkersville	3,790	397	10.5	578.2	36.3	6.3
New Market	914	47	5.1	163.7	3.5	2.1
Myersville	1,043	18	1.7	148.3	3.4	2.3
City of Frederick	31,252	4,126	13.2	7,547.7	840.9	11.1
Mount Airy	2,151	82	3.8	334.9	6.2	1.9
Rosemont	326	8	2.5	18.6	1.0	5.4
Brunswick	4,414	265	6.0	596.5	22.8	3.8
Emmitsburg	1,451	123	8.5	175.6	6.6	3.8
Woodsboro	883	97	11.0	94.7	4.0	4.3
Burkittsville	207	28	13.5	11.7	1.9	16.6
Middletown	2,502	149	6.0	510.7	13.9	2.7
Thurmont	4,514	398	8.8	465.6	26.9	5.8
Frederick County (Total)	**182,109**	**12,560**	**6.9**	**26,312**	**1,883**	**7.2**

Critical Infrastructure Exposure

The estimated exposure of critical facilities infrastructure to pluvial flooding for different rainfall events is presented in Table 9 in Appendix A. The modeling suggest that 53 critical sites will flood during at least one of the simulated events.

Educational Institution Exposure

The exposure of buildings at select institutions of higher education is shows in Table 9 and Figure 9 in Appendix A. The pluvial analysis suggests that several buildings are at risk of pluvial flooding. As previously stated, these modeling results do not consider the flood reduction benefit of specific stormwater infrastructure and best management practices at these sites.

Limitations and Future Work

The pluvial flood analysis was performed using a state-of-practice pluvial model with readily available topography other data. Although the modeling results should constitute the best-available estimates of pluvial flooding across the region, it was necessary to make several assumptions that contribute to the overall uncertainty of the results including:

- The best-available DEM used in the model was too expansive to ground-truth and was assumed to represent actual ground conditions;
- Bridges, culverts, and other structures were modeled as generic flow passages that don't necessarily capture actual local hydraulic features such as flow contraction and backwater; and
- Stormwater infrastructure was implicitly modeled in the HEC-RAS infiltration model, which assumes that the infrastructure performance is "typical" or average, which may be different than actual site conditions.

To reduce model uncertainty and produce a better picture of the overall pluvial flood hazard, future work should consider making the following improvements:

- Improve the model mesh resolution from 100 m to 30 m or less, which may require breaking up the major watersheds into smaller watersheds to maintain reasonable model run times;
- Add additional detail to bridges and other hydraulic structures including invert elevations and structure dimensions;
- Simulate the effect of stormwater management infrastructure, which can reduce accumulation of water in some areas while delivering it more rapidly to others; and
- Add additional rainfall scenarios to simulate the effect of different antecedent moisture conditions, which controls soil infiltration, as well as potential future changes in climate and land use.

Vulnerability Summary

Flooding has the greatest effect on the people living in the area impacted, but it can also impact a community's overall ability to function by disrupting community services, overloading response capacity, and interrupting utility service. Flash floods have been and will continue to be a significant threat to the economic and social well-being of the more developed areas of Frederick County, such as the City of Frederick and Mount Airy. In particular, the towns that have concentrated structures, assets, and populations are vulnerable to flood damages.

Based on the risk assessment above, besides unincorporated areas, the City of Frederick has the highest number of buildings and the highest value of structures exposed to flooding. Jurisdictions that lie along water bodies, like the Monocacy River, Toms Creek, and Potomac River, also show a higher number and share of structures exposed to flooding, such as Walkersville, Brunswick, and Emmitsburg. In the future, as precipitation patterns change, flood risks will intensify in areas adjacent to water bodies and, more specifically, flash flooding risks will elevate in more developed areas, where there are more impervious and paved surfaces. If development and population growth encroach into flood-prone areas, Frederick County's vulnerability to flooding will increase. Ensuring that new and existing structures are up to code or have mitigation measures in place will be essential to protecting Frederick County residents and their property.

Reducing Vulnerability

Frederick County and the City of Frederick have completed flood mitigation projects in recent years. These projects are discussed below.

- **Point of Rocks Mitigation Project**: Using federal, state, and local funding, Frederick County made purchase offers to the owners of properties in Point of Rocks that had sustained complete first floor and partial second floor flooding 3 times in 6 years. The offers were based on the average of 2 appraisals. The Point of Rocks Flood Mitigation Project benefited the community by removing 14 repetitive loss properties from harm's way and protecting 75 people. The project permanently eliminated the risk of loss of life, injury, and property damage associated with flooding of these residences. In addition, the project saves approximately $350,000 in physical damages and $100,000 in response services for each future flood event. Additional project benefits include creation of public recreation space and additional parking areas.

- **Carroll Creek Mitigation Project**: After Carroll Creek flooded much of the historic downtown business district in 1976, the City of Frederick invested in a $60 million, 10-year flood control project. Carroll Creek was channelized, and 4 underground concrete conduits, each wider than a city bus, were built to accommodate the 1% annual chance flood. As a result, FEMA no longer considers hundreds of valuable downtown properties to be in a mapped floodplain, saving businesses and residents millions in flood insurance.
- **Park Improvements**: The second phase of park improvements includes new and widened multi-use paths, landscape planters, lighting, water features, and crosswalk improvements. The occurred primarily between Bentz and South Market Street and between the Delaplaine Arts Center and East Patrick Street; as of October 2015, the work is complete between Bentz Street and South Market Street and between East Street and East Patrick Street. More than $100 million in new and renovated private construction is planned along the new park/path sections, which will eventually result in hundreds of new jobs and increased state and local tax revenues.

Karst and Land Subsidence

Hazard Identification

Hazard Description

Land subsidence occurs when large amounts of groundwater have been withdrawn from certain types of rocks, such as limestone, dolomite, and gypsum. The rock compacts because the water is partly responsible for holding the ground up. When water is withdrawn, the rock falls in on itself.

Common causes of land subsidence from human activity are pumping water, oil, and gas from underground reservoirs; dissolution of limestone aquifers (sinkholes); collapse of underground mines; drainage of organic soils; and initial wetting of dry soils (hydrocompaction).

The zone of dewatering influence, established by the State, identifies areas around quarries in which quarry owners can be held liable should the quarry adversely affect adjacent properties' well water supplies and/or sinkhole formation. Based on information from the Maryland Department of the Environment, Mining Program,

> "There are certain regions of the state where dewatering of surface mines may interfere with water supply wells and may contribute in some instances to sudden subsidence of land known as sinkholes. It is the intent of the surface mine law (Environment Article 15-801--15-834) to provide an added measure of protection to those property owners that may be impacted by the surface mine operations by establishing a zone of influence around the quarry."[61]

Land subsidence is usually not observable because it occurs over a large area. When land subsidence is isolated in a small area, it appears as a sinkhole. Karst refers to a specific type of terrain, characterized by sinkholes, caves, underground streams, and other cavernous features, that is highly susceptible to land subsidence.[62]

Location

Land subsidence occurs in nearly every state, but karst areas tend to be more vulnerable due to its erodibility. The Engineering Aspects of Karst map in Appendix E, shows karst areas containing distinctive surficial and subterranean features developed by solution of carbonate and other rocks and characterized by closed depressions, sinking streams, and cavern openings. This dataset is a digital version of USGS Open File Report 2014-1156 (scale: 1:7,500,000). USGS karst mapping shows northwestern and southern karst regions in Frederick County. The southern region is located east of Maryland Route 351, west of Interstate 270, and extending north into The City of Frederick. The karst topography is classified as fissures, tubes, and caves generally less than 1,000 feet (300 meters) long, 50 feet (15 meters) or less in vertical extents, and in gently dipping to flat-lying beds of carbonate rock.[63]

A map of generalized rock types in Frederick County can be found in Appendix E. The karst region in the map is shown as a limestone rock formation that extends farther to the northeast into Woodsboro. The limestone, dolomite, and marble bedrock in Frederick County are considered to be areas at risk for karst features because they are formed by the slow dissolution of calcium and magnesium oxides in the rock types.

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[61] Maryland Department of the Environment, Mining Program.
[62] Western Maryland Resource Conservation & Development Council, Inc. "A User's Guide to Karst and Sinkholes in Western Maryland." January 2004. http://www.mgs.md.gov/reports/Karst_in_Maryland.pdf
[63] United States Geological Survey. *Land Subsidence in the United States.* USGS Fact Sheet 165-00. December 2000. http://water.usgs.gov/ogw/pubs/fs00165/SubsidenceFS.v7.PDF

Frederick County has been known to have a number of sinkholes. In 2002, a study titled Stratigraphy-Karst Relationships in the Frederick Valley of Maryland was conducted by David K. Brezinski and James P. Reger of the Maryland Geological Survey. The following information has been adapted from this study:[64]

> "Karst features are present in strata of Triassic, Ordovician, and Cambrian age in the Frederick Valley of Maryland. […] The Frederick Valley of Maryland's western Piedmont represents the State's second largest karst terrain. Although the largest is located in eastern Washington County and is known as the Hagerstown Valley or Great Valley, the Frederick Valley has had more incidences of catastrophic collapse and active subsidence than its larger neighbor. The Frederick Valley is a lowland, flat region that stretches from the Potomac River northward to Woodsboro in northern Frederick County, an area of approximately 400 square kilometers. […]
>
> This study recognized and recorded three types of karst features: closed depressions, active sinkholes, and karst springs. By far the most common feature recognized were closed depressions, otherwise known as dolines. These features are recognizable topographic lows towards which the surrounding area is inclined and can be from a few meters to 100 meters across. The second category of karst features recorded is active sinkholes. These features are differentiated from depressions by the recognition of recent activity, or an open throat. The third category of karst features recognized is springs."

In cooperation with the Maryland State Highway Administration, the Maryland geological Survey conducted a report titled Stratigraphy of the Frederick Valley and its Relationship to Karst Development in 2004. This report included detailed geologic mapping along with karst feature identification. This effort mapped and identified 116 karst features in the Frederick Valley of Frederick County.[65] Of these, the most common identified features included depressions (64%) and active sinkholes (34%). Springs made up less than 2% of features, the least common of any identified.

Extent

Sinkholes can range from a few feet across and less than a foot deep to hundreds of acres in width and a hundred feet deep. The severity of a sinkhole will depend on its size, how quickly it forms, and its proximity to existing development. A sinkhole that occurs gradually over time may be able to be addressed before damage occurs, whereas one that forms quickly may lead to property damage or service disruptions, if roads or utilities are affected. Sinkholes that occur in more developed areas will likely experience more significant damage due to the concentration of buildings, infrastructure, and people. However, even sinkholes that form gradually can incur significant damage if no interventions occur, such as the collapse of a roadway or building foundations.

Previous Occurrences

There is limited data on the historical occurrence of sinkholes. Previously, the Maryland State Highway Administration conducted a study of the extent of sinkholes that occurred between 2000 and 2004 near major transportation routes in Frederick County.[66] The study identified between 250 and 300 sinkholes in Frederick County, 154 of which can be identified as distinct locations and have been mapped. Fifteen sinkholes more than 6 feet deep were located throughout the County. Of these, 6 were near/in the City of Frederick, 2 were near U.S. Route 15, and 3 were near Maryland Route 194. Two sinkholes more than 10 feet deep were found south of the City of Frederick, one near Interstate 70 and the other near Interstate 270. Several sites in particular have

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[64] David K. Brezinski and James P. Reger. *Stratigraphy-Karst Relationships in the Frederick Valley of Maryland.* Maryland Geologic Survey. https://doi.org/10.3133/wri024174

[65] Maryland Geological Survey. *Stratigraphy of the Frederick Valley and Its Relationship to Karst Development*. 2004. http://www.mgs.md.gov/reports/RI_75.pdf

[66] https://roads.maryland.gov/OPR_Research/MD-04-SP208B4N-Sinkhole-Hazard-Mapping_Phase%20II_Summary.pdf

experienced numerous and sometimes large sinkholes. As mapped by the Fredrick County Division of Public Works, these include:

- Devilbiss Bridge Road/Railroad
- Spectrum Drive
- New Horizons Way
- Westview Drive
- Crestwood Boulevard
- English Muffin Way
- New Design Road
- Technology Way

Given the geology of the area, it is likely that the data used to create the sinkhole activity is missing activity north of the City of Frederick in Walkersville and Woodsboro.[67]

Frederick County has witnessed an increased frequency of these events in recent years. Between 2010 and 2016, Frederick County Division of Public Works spent $210,086 on the repair of utilities and roads related to sinkholes. Frederick County Division of Public Works frequently identifies and repairs sinkholes along county roads. Events before 2016 are included in Appendix C. Events after 2016 have not been similarly documented, and the most reliable, cumulative data remains from 2010 to 2016. Since the last plan update, two significant sinkholes incidents have affected Frederick County, described below:

- Around May 15, 2018, four sinkholes opened up on The City of Frederick property following multiple days of heavy rains and flash flooding. One of the holes resulted in multiple lane closings on Monocacy Boulevard near Gas House Pike. The others were at Sagner Park and the County's Wastewater Treatment Plant. Frederick County issued a Local State of Emergency to respond to the weather-related events. Estimated costs from the sinkholes were over $35,000.
- On July 8, 2019, a sinkhole opened up at the Darcars Kia dealership on Urbana Pike after the County received roughly 6 inches of rain within a few hours' time. A customer narrowly avoided injury as the sinkhole opened up mere moments after they had driven over the spot.

Probability and Severity of Future Occurrences

There is limited historical data on sinkholes, which prevents a clear picture of the probability of future events. Based on data collected between 2004 and 2016, more than 300 karst or land subsidence events occurred in Frederick County. In that time frame, the expected annual number of events is roughly 20. Between 2010 and 2016 (the period with the most complete data), Frederick County Division of Public Works spent $210,086 on repairs due to sinkhole damage. Based on those records, Frederick County may experience $17,507 annually in sinkhole related costs including road clearing and damages. However, this data is outdated, and the County has witnessed increasingly frequent sinkholes. The actual expected event occurrence and associated damages is likely higher.

Most research points to sinkhole development being heavily dependent on groundwater drawdown, but the role of climate change should also be considered. A case study was done in Florida that showed a correlation between climate change and an increase in sinkholes.[68] Sinkhole collapse phases were linked and followed shortly after periods of drought. As drought likelihood and intensity is expected to increase in Frederick County, especially during the summer and fall, future occurrences may be higher than historical projections suggest.

[67] The Towns of Walkersville and Woodsboro considered incorporating a mitigation action to develop more current and comprehensive land subsidence and sinkhole data during the 2021 Plan update process. It was determined that, based off of local observations and incidences of sinkholes, developing this data was not a priority at this time. However, the mitigation action will be reconsidered during future annual update meetings and during the 5-year update process.

[68] https://nhess.copernicus.org/preprints/nhess-2018-18/nhess-2018-18-SC1-supplement.pdf

Impact Summary

Primary Impacts

The direct effects from sinkholes can include structure damage to buildings and infrastructure, risks to health and safety depending on human and animal proximity to sinkholes, and personal property damage.

Secondary Impacts

Secondary impacts may include transportation delays when sinkholes appear in or around roadways. Businesses can be disrupted when impacted by sinkholes as well, having limited impacts to direct employees of that business and more widespread, but likely minor, impacts to customers.

Larger scale land subsidence can potentially lead to increased risk of flooding over time in the form of pooling and related drainage issues. This is due to certain areas sinking below the surrounding areas, encouraging water to seek new lowest points in the land.

Where land subsidence or sinkholes exist, runoff, spills, or pesticides and fertilizers from lawns and farms can leak through the many spaces in the rock, unfiltered by the soil, enter the groundwater system, and leak into water resources. Since thousands of residents in this region get their water from private home wells, these areas would be especially susceptible to immediate pollution. The Frederick Quarry is another major cause of sinkholes in the area; quarry owners are required to repair sinkholes within the established Zone of Influence.

Risk Assessment

Assets Exposed

Building footprints were intersected with the USGS engineering aspects of karst spatial extent. Table 5.21. summarizes the number of structures and the associated market value vulnerability for areas in karst topography. The City of Frederick and the unincorporated areas of the County are vulnerable to sinkholes due to karst topography. Nearly half (48.4%) of the structures located in the City of Frederick are in karst geology and have an associated vulnerability of $5.7 billion (52.8% of the city's total exposure).

Table 5.18. Building Footprints Within Karst Areas

Municipality	Total # Building Footprints	Building Footprints on Karst Geology	Total # Parcels	Parcels on Karst Geology	Total Parcel Value Exposure	Average Value Exposure per Building
Brunswick	4,414	0	3,159	0	$0	$0
Burkittsville	207	0	76	0	$0	$0
Emmitsburg	1,451	0	1,014	0	$0	$0
City of Frederick	31,252	22,125	24,510	16,400	$5,456,664,400	$246,629
Middletown	2,502	0	1,737	0	$0	$0
Mount Airy	2,151	0	1,301	0	$0	$0

Municipality	Total # Building Footprints	Building Footprints on Karst Geology	Total # Parcels	Parcels on Karst Geology	Total Parcel Value Exposure	Average Value Exposure per Building
Myersville	1,043	0	621	0	$0	$0
New Market	914	0	582	0	$0	$0
Rosemont	326	0	134	0	$0	$0
Thurmont	4,514	1,979	2,559	1,013	$180,368,210	$91,141
Walkersville	3,790	3,790	2,202	2,202	$578,212,000	$152,563
Woodsboro	883	879	468	462	$94,021,000	$106,964
Unincorporated Areas	128,674	19,515	61,743	11,404	$3,767,079,200	$193,035
Frederick County (All)	**182,121**	**48,288**	**100,106**	**31,481**	**$10,076,344,810**	**$208,672**

Loss Estimation

Exposure analysis reflects all properties potentially at risk. It is not an estimation of potential losses, However, if even a small fraction of the exposed property received losses one can see the losses would be quite significant in terms of property damage.

Critical Facilities Exposed

Based on critical facilities data and the USGS engineering aspects of karst spatial extent (Table 5.22.), 155 out of the 378 facilities are located in karst areas. Of these facilities, 90 facilities are located in the City of Frederick, 13 in the Town of Walkersville, 5 in Thurmont, 5 in Woodsboro, and 42 in the Unincorporated areas of Frederick County. The facility type most affected are shopping centers (44), which are a part of the supply network. The next most affected are schools (23). Appendix D includes the specific facilities and associated hazard vulnerabilities.

Table 5.19. Critical Facilities in Karst Areas by Municipality

Municipality	Facilities in Karst Area	Facilities Outside Karst Areas	Total Facilities	Percent in Karst Areas
Brunswick	0	14	14	0%
Burkittsville	0	3	3	0%
Emmitsburg	0	9	9	0%
City of Frederick	90	35	125	72%
Middletown	0	11	11	0%

Municipality	Facilities in Karst Area	Facilities Outside Karst Areas	Total Facilities	Percent in Karst Areas
Mount Airy	0	5	5	0%
Myersville	0	6	6	0%
New Market	0	7	7	0%
Rosemont	0	1	1	0%
Thurmont	5	13	18	28%
Walkersville	13	0	13	100%
Woodsboro	5	0	5	100%
Unincorporated Areas	42	119	161	26%
Frederick County (All)	**155**	**223**	**378**	**41%**

Cultural and Historic Resources Exposed

Figure 5.6 shows cultural and historic resources in Frederick County and their proximity to karst areas. As most of the City of Frederick resides in karst areas, a high amount of cultural and historic resources are at risk. Most notable, there are large tracts of Maryland Historical tryst Preservation Easements.

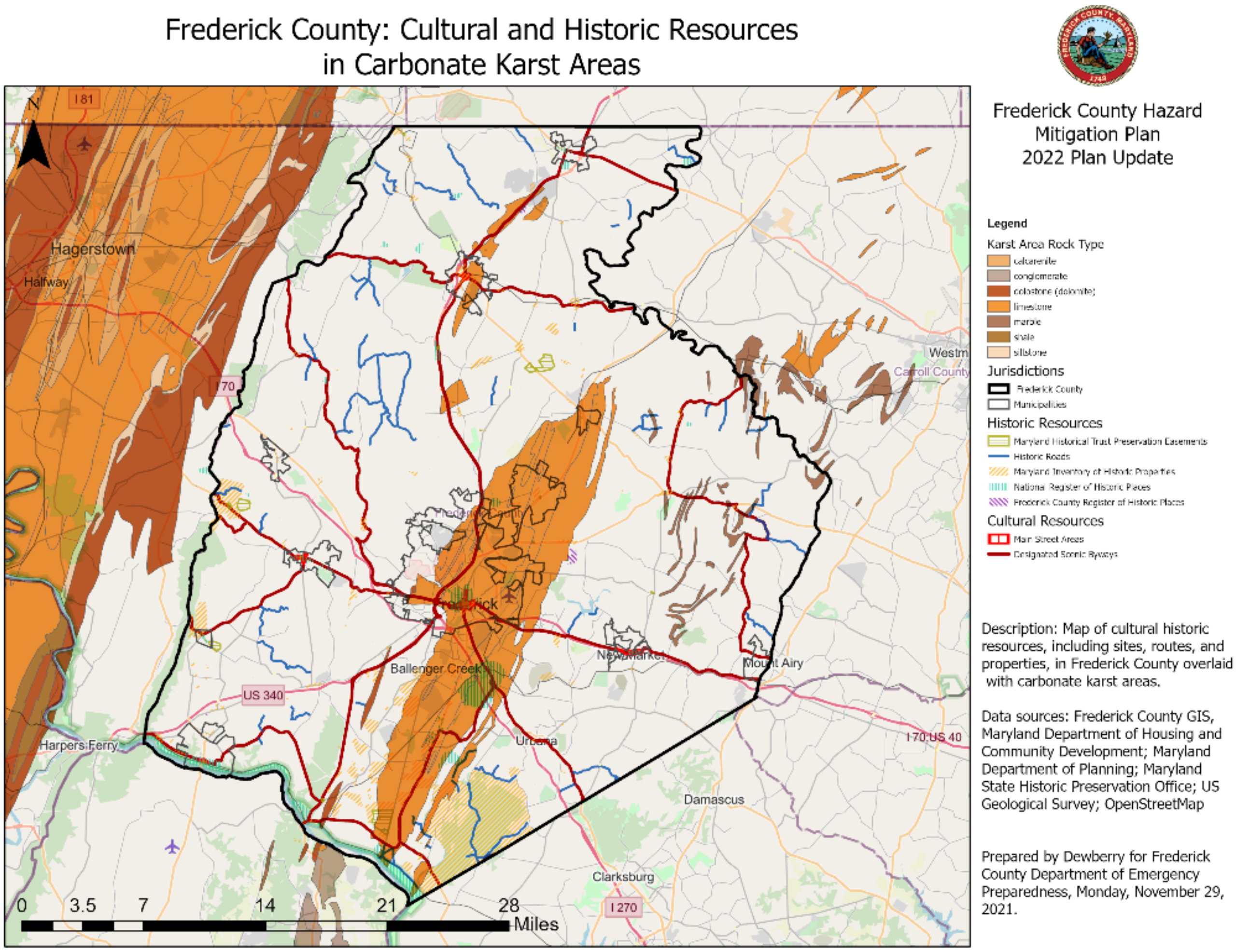

Figure 5.6. Cultural and Historic Resources and Their Proximity to Karst Areas

Population Exposed

People that live in areas with underlying karst areas are more likely to be affected by land subsidence and sinkholes than those do not. Using population data from the 2018 American Community Survey, census tracts in Frederick County were overlaid with karst areas. Census tracts illustrate overall population, but do not indicate whether within these boundaries that residents live. Some populous tracts may contain concentrated pockets of development, while others may be more evenly distributed. This analysis considers only overall tract population as an indicator of exposure.

Figure 5.7 illustrates the County's population by census tract, segmented by quintiles. The region's karst areas are located within some of Frederick County's most populous tracts, including The City of Frederick and the surrounding unincorporated areas. Smaller stretches of karst lie under parts of Thurmont and Emmitsburg. Residents in these areas may be more likely to witness sinkholes and land subsidence.

Frederick County: Population Counts in Karst Areas

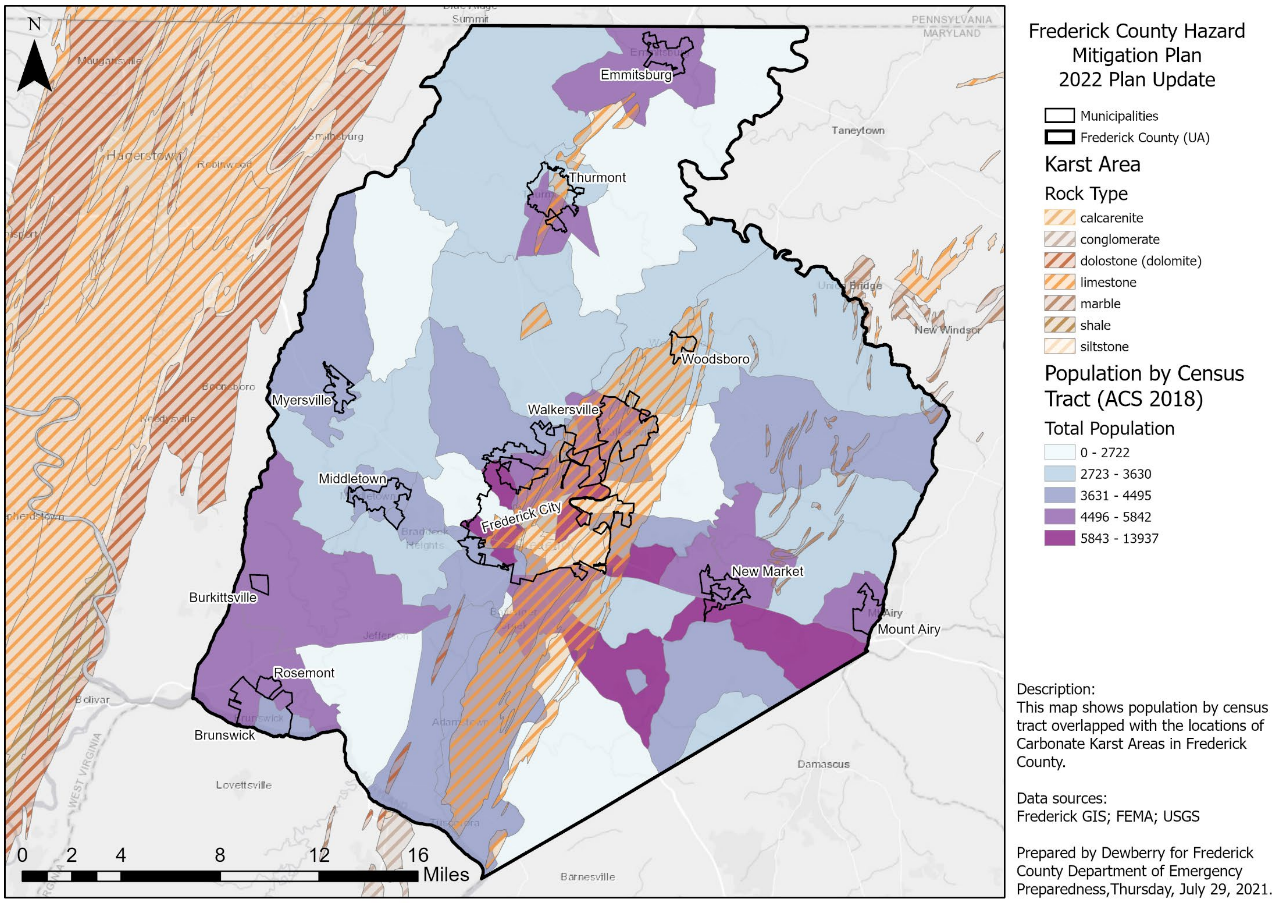

Figure 5.7 Population in Karst Areas

Vulnerability Summary

Population within the Frederick County region continues to grow at a rapid pace, ranking third within the State for population increase percentage from 2010-2018. In the past 10 years, Frederick County has gained about 38,332 residents according to the U.S. Census Bureau.[69] This growth will continue to increase demands on groundwater supplies, elevating the risk for more land subsidence in areas already experiencing sinkholes, urban areas, as well as new subsidence in other areas. In the past, major subsidence areas have been in agricultural settings where groundwater has been pumped for irrigation.

With current and future population in mind, the City of Frederick is especially vulnerable to the karst and land subsidence hazard, especially sinkholes. It is an urban area that can see heightened groundwater demands from population growth, and it already has high exposure. There are 31,252 buildings, including 90 critical facilities, in karst areas. Due to close proximity of buildings, sinkholes can have secondary impacts that effect more people as well.

[69] Census Bureau. "Quick Facts: Frederick County, Maryland." 2021. https://www.census.gov/quickfacts/frederickcountymaryland

Reducing Vulnerability

Several county and local governments in other states have legislated special water-management practices for industrial or commercial sites located in karst areas that require:

- Refraining from dumping anything onto a parking lot, storm drain, or down a sinkhole
- Diverting water runoff away from sinkholes
- Remediating sinkholes that receive runoff as soon as possible
- Maintaining vegetation on steep slopes to keep soil in place
- Identifying the best practices for dispersed storm water management in karst areas
- Working with the local health department to select the best septic system for each site and contacting local health officials if there is a reason to believe the system is malfunctioning

Under a 1991 Amendment to Maryland's Surface Mining Law, the MDE is required to establish and define Zones of Influence around limestone and marble quarries in Baltimore, Carroll, Frederick, and Washington Counties. A quarry's Zone of Influence is based on local topography, watersheds, and geologic and hydrologic factors. When establishing Zones of Influence, MDE conducts field investigations and evaluates any available information (e.g., groundwater studies and well monitoring data).

Drought

Hazard Identification

Hazard Description

Drought occurs when water systems cannot provide the minimum necessary water to sustain plant, animal, or economic systems due to shortfalls in precipitation, soil moisture, or runoff. Drought is the result of complex interactions between physical and human processes and can have widespread effects. Differing built and natural landscapes throughout the State often make this hazard a regional issue, rather than statewide. Despite all the problems that droughts have caused, it has proven to be difficult to define, and there is no universally accepted definition. Unlike a flood, a drought is not a distinct event and typically has no well-defined start or end. Further, the impacts of drought vary by affected sector.

The most commonly used drought definitions are based on meteorological, agricultural, hydrological, and socioeconomic effects:

- **Meteorological drought** refers to a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought. It can also affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as streamflow, snowpack, lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.
- **Socioeconomic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts result from prolonged periods of dry weather accompanied by extreme heat and usually occur during the summer months (July and August). The warmest time of the year in Frederick County is July when maximum temperatures average 89 degrees. Extreme temperatures of 100 degrees occur occasionally. Drought forecasting is difficult and often unreliable due to the climate complexities involved since drought is not the result of a single cause. Sometimes about a month of notice is possible, however.

Location

Agricultural droughts are the most common form of drought in Frederick County and poses the greatest threat to region's agricultural operations. High summer temperatures can exacerbate the severity of a drought. When soils are wet, a significant portion of the sun's energy goes toward evaporation of the ground moisture. However, when drought conditions eliminate soil moisture, the sun's energy heats the ground surface and temperatures can soar, further drying the soil.

The U.S. Drought Monitor is a tool produced in partnership between the National Drought Mitigation Center, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. It illustrated the geographic extent of drought conditions. For example, on September 28, 2021, no parts of Maryland were considered abnormally dry or in a drought condition by the US Drought Monitor, as shown in Figure 5.8.

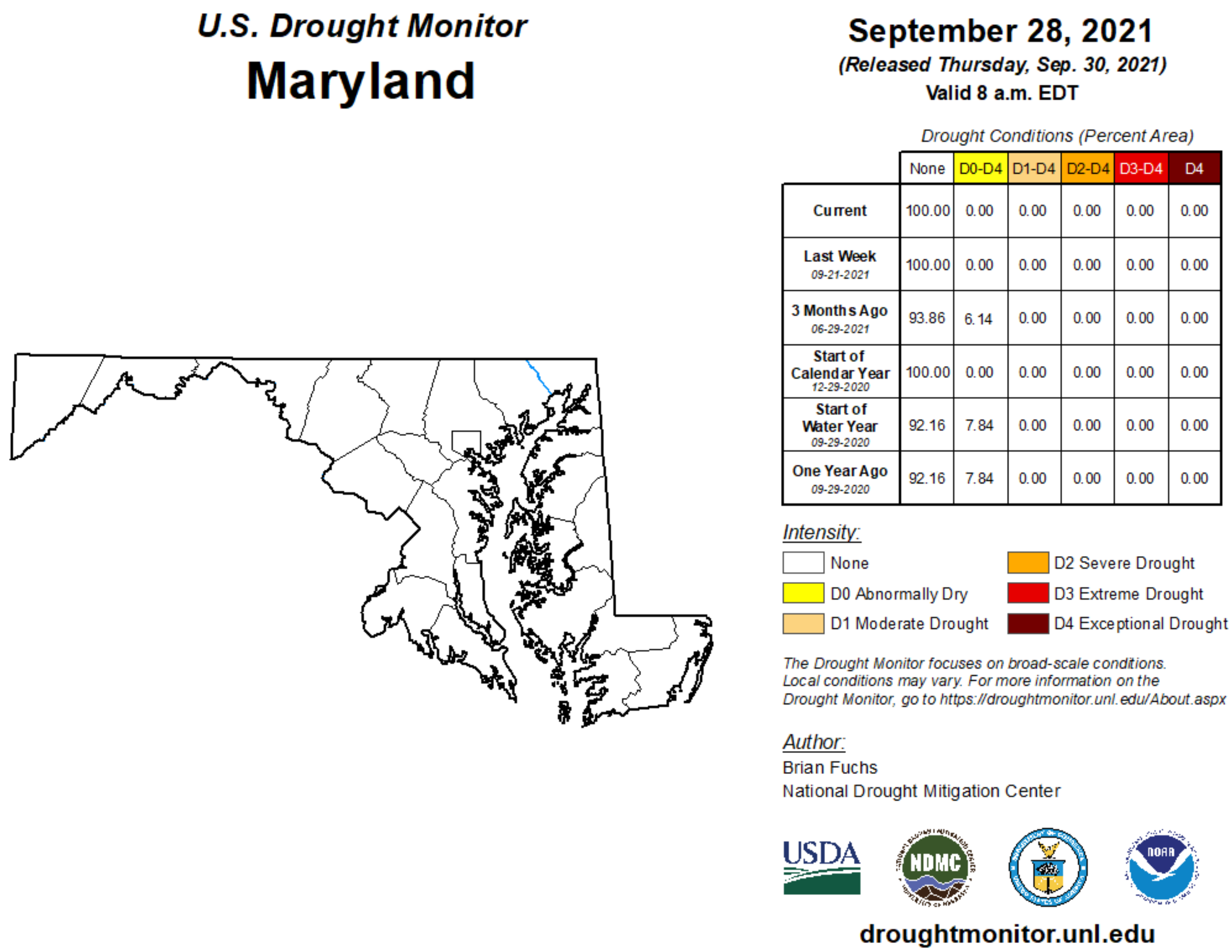

Figure 5.8. An Example of the U.S. Drought Monitor for Maryland

Extent

The extent (i.e., magnitude or severity) of drought can depend on the duration, intensity, geographic extent, and the regional water supply demands made by human activities and vegetation. The intensity of the impact from drought could be minor to total damage in a localized area or regional damage affecting human health and the economy. Generally, impacts of drought evolve gradually, and regions of maximum intensity change with time. The severity of a drought is determined by areal extent as well as intensity and duration. The frequency of a drought is determined by analyzing the intensity for a given duration, which allows determination of the probability or percent chance of a more severe event occurring in a given mean return period. Table 5.23. summarizes the levels of drought severity and their possible impacts on a community or region.[70]

Table 5.20. Drought Severity Classification and Possible Impacts

Category	Description	Possible Impacts
D0	Abnormally dry	Going into a drought: short-term dryness slows planting, growth of crops or pastures; fire risk above average. Coming out of a drought: some lingering water deficits; pastures or crops not fully recovered.

[70] U.S. Drought Monitor.

Category	Description	Possible Impacts
D1	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low; some water shortages develop or are imminent; voluntary water use restrictions requested.
D2	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.
D3	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions.

Previous Occurrences

According to the National Centers for Environmental Information (NCEI), Frederick County experienced 12 drought periods from 1950 to 2021, often spanning months. Between 1997 and 1999, three regional droughts incurred more than $40.2 million in crop damages (adjusted for inflation).

No significant droughts have been recorded since 2007; these events are summarized in Appendix C.

Probability and Severity of Future Occurrences

Droughts are often unpredictable and may be localized, which makes it difficult to assess the probability. Historical records of drought show that when droughts occur, they have a costly impact on agricultural production of Frederick County. Most droughts in this area are shorter, multi-month droughts, while widespread multiyear droughts are much less common. Based on historical occurrences as reported by NCEI, since 1993, 12 droughts occurred in Frederick County, resulting in an expected annual number of events of 0.43, or drought conditions likely every few years. It is predicted an increase in drought conditions will occur due to climate changes.

Maryland is projected to experience both higher average temperatures and precipitation rates during the winter and spring seasons by the mid-21st century. Despite increased precipitation, the region may experience more severe droughts in the summer and fall as higher air temperatures accelerate soil moisture loss.[71, 72] Both summer and winter temperatures are likely to increase. Precipitation is likely to increase as well, leading to a generally wetter future. Typical climate forecasts tend to suggest that increased temperatures coupled with increased annual precipitation generally correspond to higher intensity storms (greater flood risk) and longer dry periods in the summer months (more frequent and/or intense droughts). It should be noted that small reservoir systems could be very sensitive to such changes.

As Frederick County's economy and population continues to grow, the potential effects of prolonged droughts may grow with it. If development encroaches on rural or undeveloped areas, the County could lose agricultural and forest land, open spaces, and rural character, while facing increased water needs. Unmanaged residential and commercial growth could strain existing water supplies, intensifying future drought events.

Those who rely on surface water (reservoirs and lakes) and subsurface water (groundwater) are usually not adversely affected by a drought. A short-term drought that persists for three to six months may have little impact on these areas, depending on the characteristics of the hydrologic system and water use requirements. Droughts of longer duration affect areas that are dependent on stored surface or subsurface supplies while the

[71] NOAA National Centers for Environmental Information. 2018. "State Climate Summaries: Maryland and District of Columbia." Retrieved from https://statesummaries.ncics.org/chapter/md/.
[72] Environmental Protection Agency. 2016. "What Climate Change Means for Maryland." Retrieved from https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-md.pdf.

impacts of a drought may be less in agricultural areas as rain quickly replenishes soil moisture. Groundwater users who are often the last to be affected by drought during its onset may also be the last to experience a return to normal water levels. The length of a recovery period is a function of the intensity of the drought, its length, and the quantity of precipitation as the drought ends.

Loss Estimation

Drought events poses a significant risk to agriculture, which depend on water supplies. According to the 2017 Census of Agriculture, Frederick County's farmland constitutes 45% of the jurisdiction's total area and 10% of all Maryland's farm areas. The County also produces 5% of total agriculture sales in Maryland.

Cumulatively, drought events (12) since 1993 caused roughly $40.2 million in crop damages. On average, Frederick County may experience $1,438,488 annually in drought-related crop damages. In addition to crop damages, other less easily quantifiable damages (e.g. wells drying up) likely increase overall losses annually. More of these potential losses are discussed in the impact summary below.

Impact Summary

Primary Impacts

According to the American Planning Association, since 1980, drought has been the fourth most common type of disaster in the United States but is the second most costly overall and per incident.

While a drought does not pose immediate threats to life and property, it can have severe economic, environmental, and social consequences. A lack of precipitation can affect not only agricultural production but also tourism, water utilities, residential wells, businesses, and more. Droughts may also lead to losses or destruction of fish and wildlife habitat, loss of wetlands, and lower water levels in reservoirs, lakes, and ponds. The reduction in water levels can also cause private wells to go dry or pumps to fail and can cause dry hydrants to be unusable for fire protection purposes.

When drought begins, agriculture is usually first to be affected because of heavy dependence on stored soil moisture. Soil moisture can be rapidly depleted during extended dry periods. Dryland farming and ranching are the most at risk from drought. Water uses that depend on in-stream flows are at high risk but less exposed; these include irrigated farms; aquatic, wetland, and riparian environmental communities; and recreational activities. Urban and agricultural water users who rely on reservoirs and wells that are not dependent on high rates of aquifer recharge are the last to experience drought.

Secondary Impacts

Droughts can increase the severity of flooding as land that has been dry for extended periods of time does not allow water to infiltrate as quickly, which may lead to flash flooding. Droughts also exacerbate the possibility of wildfires due to the very dry conditions. Risk to life and property is greatest in areas where forested areas adjoin urbanized areas (high-density residential, commercial, and industrial), known as the wildland-urban interface (WUI). Buildings are not anticipated to be directly affected by a drought, and all are expected to be operational during a drought event. However, buildings, critical facilities, and infrastructure within the WUI zone are considered vulnerable to wildfire.

The impacts on public health from drought can be severe which includes increase in heat-related illnesses, waterborne illnesses, recreational risks, limited food availability, and reduced living conditions. Those individuals who rely on water, such as farmers, may experience financial-related stress. Additionally, industries that rely on water for business may be impacted the hardest (e.g., landscaping businesses). Even though most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant to the recreation and tourism industry.

Risk Assessment

Assets Exposed

Drought events generally do not impact buildings; however, they have the potential to impact agriculture-related facilities and critical facilities that are associated with potable water supplies. Drought has a major impact on livestock and crops. Approximately 45% of Frederick County is dedicated to agriculture, making up almost 10% of the State's total farm area. Frederick County has the largest amount of farmland, 188,576 acres, pastureland (26,969 acres), and total number of farms (1,373) in the State. Based on the number of operations with sales, the main agricultural products are cattle, grain, corn, and soybeans (Table 5.24. Number and Types of Crop Farms). The amount of livestock on these farms, according to the U.S. Department of Agriculture's 2017 Census, is shown in Table 5.25..

Table 5.21. Number and Types of Crop Farms[73]

Crop Type	Number of Farms Reporting	Inventory (acres)
Corn for grain	231	29,672
Corn for silage	85	9,541
Forage (Hay and haylage)	730	36,024
Soybeans	244	41,503
Wheat	163	14,399

Table 5.22. Number and Types of Livestock Farms[74, 75]

Livestock Type	Number of Farms Reporting	Inventory (animals)
Cattle and calves	613	39,637
Chickens (Broilers and layers)	274	112,706
Equine (Horses and ponies, and mules, burros and donkeys)	55	3,306
Hogs and pigs	91	1,699
Sheep and lambs	144	4,684
Turkeys	N/A	N/A

[73] U.S. Department of Agriculture; 2017 Census of Agriculture. 2017. "Chapter 2, Table 1 - County Summary Highlights: Frederick County, MD." Retrieved from https://www.nass.usda.gov/Quick_Stats/CDQT/chapter/2/table/1/state/MD/county/021/year/2017.
[74] U.S. Department of Agriculture; 2017 Census of Agriculture. 2017. "Chapter 2, Table 1 - County Summary Highlights: Frederick County, MD." Retrieved from https://www.nass.usda.gov/Quick_Stats/CDQT/chapter/2/table/1/state/MD/county/021/year/2017.
[75] U.S. Department of Agriculture; 2017 Census of Agriculture. 2017. "Chapter 2, Table 2 - Market Value of Agricultural Products Sold." Retrieved from https://www.nass.usda.gov/Quick_Stats/CDQT/chapter/2/table/2/state/MD/county/021/year/2017.

Population Exposed

All of Frederick County is vulnerable to droughts. Which communities will be affected by droughts, and to what degree, depends on the type of drought, its severity, tenure, and residents' water needs. The City of Frederick is the second most populous in Maryland (78,842 in 2020). In the last several years, Frederick County as whole has witnessed growth in both population and development. As the region grows, more residents will be affected by future droughts, and unmanaged growth may exacerbate droughts that do occur.

Vulnerability Summary

Due to the drought impacts that can be expected as discussed above, the agricultural sector is especially vulnerable to drought. Droughts severely impact farm income due to crop damage and undernourished livestock, and they can increase the cost of potable water if water supplies have to be augmented. Areas with a high amount of agricultural land are, therefore, at an increased vulnerability, such as the unincorporated areas of Frederick County.

However, urban areas remain vulnerable as well. They may face increased strain on their water supply due to a higher population density. This may cause concern for municipalities such as the City of Frederick. Additionally, since droughts are often accompanied by excessive heat, the urban heat-island effect is a concern. It prevents inner-city buildings from releasing heat built up during the daylight hours, further increasing already high temperatures. Secondary impacts of excessive heat are severe strain on the electrical power system and potential brownouts or blackouts.

Finally, areas with stormwater drainage issues face increased vulnerability to drought conditions if periods of extreme precipitation follow after severe drought conditions. This scenario is projected to be more likely in the future. A detailed discussion of these areas can be found in the technical appendix (Appendix A).

Reducing Vulnerability

Identifying the first stages of drought and conserving water will help mitigate drought to an extent. In the future, there is also the potential for managing population growth and development based on available groundwater, water supplies, and water infrastructure. Mitigation management for drought is a proactive process, but most of the process is initiated at the state level. In Maryland, the Governor's Water Conservation Advisory Committee delivered a final report in 2000 that offered the recommended actions in Table 5.23 for the four drought stages.[76]

Table 5.23. Maryland Water Conservation Advisory Committee's Recommended Actions by Drought Stage

Stage 1: Normal Conditions (Green)
Stage 2: Watch (Yellow) – 5% to 10% reduction goal
• Drought conditions evaluated biweekly • MDE media office works with local TV and radio stations to issue frequent drought updates to public • MDE increases monitoring of any problems incurred by water systems • Utilities or local governments may impose restrictions more stringent than the State guidelines

[76] Maryland Statewide Water Conservation Advisory Committee. 2000. "Maryland Statewide Water Conservation Advisory Committee: Final Report." Retrieved from https://mde.maryland.gov/programs/Water/droughtinformation/Documents/www.mde.state.md.us/assets/document/drought/droughtreport.pdf.

- Water systems activate Water Conservation Plans
- Water systems aggressively pursue leak detection surveys and repair programs
- Reduce water usage for main flushing, street flushing, and park irrigation
- Business and industries activate water emergency plans
- Homeowners, government facilities, businesses, and industry should reduce water use for irrigation purposes

Stage 3: Warning (Orange) – 10% to 15% reduction goal

- Drought conditions evaluated on a weekly basis
- Residences, businesses, and industry voluntarily comply with nonessential water use restrictions
- MDE media office works with local TV and radio stations to issue periodic notification of drought measures, and to increase public awareness of water conservation
- MDE continues to monitor problems incurred by water systems
- Utilities or local governments may impose restrictions more stringent than the State guidelines
- Water systems actively implement water conservation measures
- Water systems individually contact industrial users to reduce water usage
- Water systems discontinue flushing water lines, fire hydrants, and distribution equipment
- Facility managers for government buildings identify leaks and accelerate maintenance and/or repairs
- Encourage business and industry to irrigate with treated wastewater in accordance with health guidelines

Stage 4: Emergency (Red) – 15% to 20% reduction goal

- Drought conditions evaluated at least weekly
- Implement mandatory restrictions on nonessential water uses
- MDE media office works with local TV and radio stations to issue daily drought updates to public
- Establish Drought Hotline
- Utilities or local governments may impose restrictions more stringent than the State guidelines
- MDE and water systems notify consumers of severity of water shortage
- Water systems conduct field surveillance of abuses, leaks, etc.
- Local police and/or water systems execute enforcement of water conservation restrictions
- Water systems verify availability of alternate water source or interconnection
- Residences comply with mandatory nonessential water use restrictions
- Business and industry comply with water conservation plans to reduce water use by at least 10%
- Business and industry evaluate need for reduced hours of operation

Wildfire

Hazard Identification

Hazard Description

A wildfire is an uncontrolled fire that spreads through vegetative fuels, such as brush, marshes, grasslands, forests, or fields. Nearby structures may be exposed and possibly consumed by the spreading fire. Wildfires often begin unnoticed and spread quickly, usually signified by dense area-wide smoke. Wildfires are sometimes called "forest fires," but this analysis will use the term "wildfire."

The Wildland-Urban Interface (WUI) refers to places where structures and other human development meet or intermingle with wildland or vegetative fuels. WUI fires are wildfires that occur in these geographic areas. The WUI consists of both interface and intermix communities. In interface communities, housing exists near large areas of dense wildland vegetation, whereas in intermix communities, housing and wildland vegetation are intermingled.[77]

Location

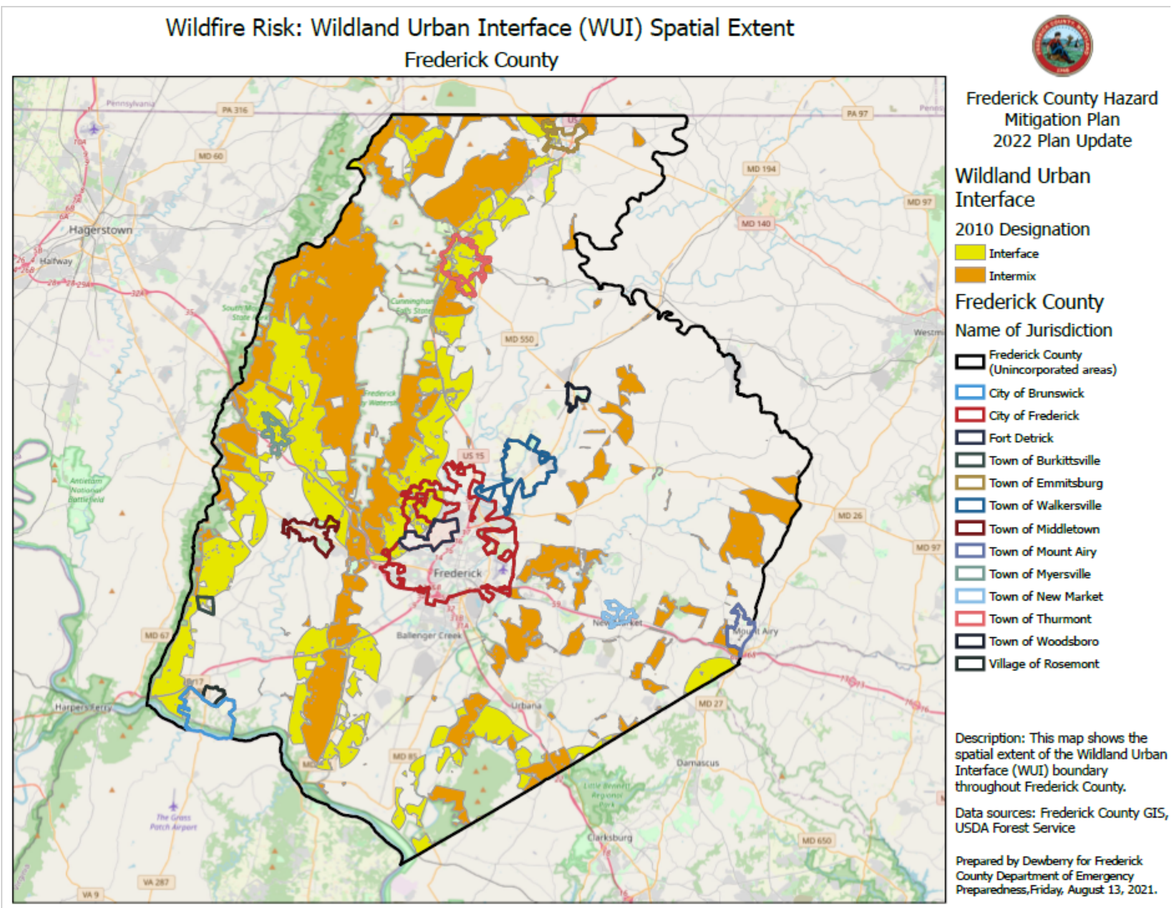

Figure 5.9. Wildland Urban-Interface Map

Areas within the WUI, as seen in Figure 5.9, face a higher risk of potential damage from wildfires. As summarized in Table 5.27, Nearly 29% (193 square miles) of Frederick County's land area falls in either the WUI

[77] U.S. Forest Service. 2015. "The 2010 Wildland-Urban Interface of the Conterminous United States." Retrieved from https://www.fs.fed.us/nrs/pubs/rmap/rmap_nrs8.pdf.

interface or intermix areas. Nearly 97% of all land area in the WUI is in the unincorporated areas of Frederick County.

Table 5.24. Wildfire Exposure by Land Area in the WUI

Municipality	Total Area (Square Miles)	Interface	Intermix
Brunswick	3.69	0	0.08
Burkittsville	0.45	0	0.23
Emmitsburg	1.48	0	0.43
City of Frederick	21.03	0.05	2.00
Middletown	1.84	0	0.22
Mount Airy	1.40	0.01	0
Myersville	1.01	0	0.83
New Market	0.76	0	0
Rosemont	0.56	0.02	0
Thurmont	3.09	0.22	2.24
Unincorporated Areas	625.34	112.34	74.54
Walkersville	4.73	0	0
Woodsboro	0.70	0	0
Total	**666.08**	**112.64**	**80.57**

Not all areas in the WUI face the same level of wildfire risk. Based on 2018 data, Frederick County holds 135,804 forested acres, making up 32% of its total land area.[78] The Fire Zones map (Appendix E) prepared by the Maryland Department of Natural Resources divides the County into distinct zones that identify the fire risk for that area. Based on the 2021 Draft Maryland State Hazard Mitigation Plan, approximately 2.6% of Frederick County's land area falls in high and medium-high risk zones identified by the Maryland Department of Forestry.[79] The risk is based on factors such as fuel type, slope, potential for ignition (human), and land value. Zone 6 is considered the area with the highest risk and Zone 1, the lowest risk. There are no Zone 1 designations in the County.

Portions of the City of Frederick, Walkersville, and southwest portions of the unincorporated areas of the County, lie in Zone 2. Zone 3 includes Brunswick, Burkittsville, Emmitsburg, Middletown, Mount Airy, New Market, Rosemont, Thurmont, Woodsboro, and unincorporated areas in the southeast part of the County; Zone 4

[78] Maryland Department of Natural Resources. 2020. "2020 Forest Action Plan – Part I: Forest Resource Assessment." Retrieved from https://dnr.maryland.gov/forests/Documents/Maryland-State-Assessment-2020FINALpages.pdf#page=75
[79] State of Maryland. 2021. "2021 Draft Maryland State Hazard Mitigation Plan." Retrieved from https://aecomviz.com/MEMA-Maryland-360/Doc/MEMA%20HazMitPlan%20JULY%2009_FINAL%20with%20Appendices.pdf#page-1030

includes the Myersville area, and portions of the northwestern part of Frederick County make up Zone 5. The Zone 6 area carries the highest fire risk posing concern for future development and is located primarily in the northwest part of the County.

Extent

Wildfires can occur at any time of day and during any month of the year, but in Maryland, wildfire season peaks in the spring due to the combination of low humidity, high winds, and dried forest fuels. Wildfire season length and peak months may vary from year to year.

The most common cause of wildfire ignition is human activity, which accounts of 96% of all wildfires in Maryland.[80] The leading cause of wildfires in the State is improper debris or outdoor burning (35% of fires annually), followed by arson (30%). Lightning is the only natural cause of wildfires and accounts for just 4% of all wildfires ignited in Maryland.

The primary factors that influence how many fires occur and how many acres they burn include land use, vegetation, the amount of combustible materials present, and weather conditions, such as wind, low humidity, and lack of precipitation. Generally, fires are more likely when vegetation is dry from a winter with little precipitation and/or a spring and summer with sparse rainfall.

The National Fire Danger Rating System assesses existing and expected conditions of identified factors that contribute to how dangerous a fire may become, as well as how prepared an organization is to address potential fires. The National Fire Danger Rating System rates fire potential using five color-coded levels, which are outlined in Table 5.28.

Table 5.25 National Fire Danger Rating System

Rating	Description
Low	• Fuels will not ignite easily from small embers or firebrands, but a sudden and intense heat source, like lightning, could start fires in decayed wood or duff, which refers to decomposing organics above the soil but below freshly fallen leaves. • Fires that start in open, dry grasslands may burn freely for a few hours after rain, but wood fires may spread slowly by creeping or smoldering and may burn in irregular fingers. • There is little danger of spreading, and control of these fires is generally easy.
Moderate	• Fires can start from most accidental causes, but except for lightning, the number of fire starts is generally low. • Fires that start in open, dry grasslands can burn and spread fast on windy days. • Timber fires spread slowly to moderately fast. • The average fire intensity if moderate, although heavy concentrations of fuel may burn hot. • Short-distance spotting, which refers to sparks carried by wind that start new fires beyond the main fire, may occur but is not persistent. • Fires are not likely to become serious and control is relatively easy.
High	• All fine dead fuels can ignite readily, and fires can start easily from most causes. • Unattended brush and campfires are likely to escape and become uncontrolled.

[80] Maryland Department of Natural Resources. N.d. "Wildland Fire in Maryland." Retrieved from https://dnr.maryland.gov/forests/Pages/wfm.aspx.

Rating	Description
	• Fires spread easily, and short-distance spotting is common. • High intensity burning may develop on slopes or in concentrations of fuels. • Fires may become serious and difficult to control unless they are suppressed aggressively and while small.
Very High	• Fires start easily from all causes, spread rapidly and increase quickly in intensity immediately after ignition. • Spot fires are a constant danger. • Fires burning in light fuels may quickly become high intensity, potentially exhibiting characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels. • Direct attack is rarely possible after these fires have burned longer than a few minutes.
Extreme	• All types of fires can start quickly, burn intensely, and spread rapidly. • All fires are potentially serious. • Compared to Very High conditions, fires can transition to high intensity burning much faster and small fires can grow into big fires much more quickly as well. • Except for immediately after ignition, direct attack may be dangerous and rarely possible. • Spot fires are possible, and long-distance spotting is likely. • Fires that develop in conifer stands or heavy slash, which refers to debris left after logging or pruning, may be unmanageable while Extreme conditions persist. • Under Extreme conditions, the only effective and safe control actions are on the flanks of the fire until the weather changes or fuel supply diminishes.

Previous Occurrences

The NCEI database does not collect wildfire events. Historical wildfire data and associated damage are captured through two sources: Frederick County Fire AMS and the Maryland Department of Natural Resources. These two sources cannot be combined due to overlap and possible duplication of events. Additionally, there are no presidentially declared disasters for wildfires recorded for Frederick County.

Frederick County Fire AMS data from 2010 through 2015 indicates there were 119 calls related to wildfires or vegetation fires. Ninety-four of the calls were confirmed to be vegetation fires and were responded to accordingly. Maryland Department of Natural Resources data recorded 382 wildfires from 1988 through 2010. These events incurred a combined $18,882 in crop damages and one injury. No property damages or fatalities were recorded. No updates to these data are available as of August 2021.

Since 2016, one significant wildfire event has affected Frederick County: On March 8, 2016, a five-acre wildfire ignited in Gambrill State Park in Frederick County. The cause of the ignition is unknown, but heavy winds and dead, dry vegetation from the winter months allowed the wildfire to quickly spread. Around 60 fire and rescue crew members from Frederick County responded to the event and were able to extinguish the flames after about two hours.[81, 82]

Probability and Severity of Future Occurrences

As summarized in Table 5.29, Frederick County can expect to experience 20 wildfire events in a given year. This analysis is based off of more recent County AMS data. Based on the Department of Natural Resources data, the County can expect to experience roughly 29 wildfire events that incur $1,452 in damages in a given year.

Table 5.26. Annualized Wildfire Events and Damage

	Total Events	Cumulative Damage	Total Years of Record[83]
County AMS (Annualized)	119	N/A	6
	20	N/A	
State DNR (Annualized)	382	$18,882	13
	29	$1,452	

Anticipating the future frequency and severity of wildfires requires an understanding of how wildfires are affected by climate factors. Many wildfires are started by human activity, but the potential severity and extent of these events is affected by atmospheric temperatures and precipitation patterns. In general, hot and drier seasons will reduce the amount of moisture in soils and vegetation, ultimately creating more fuel for fires to consume to grow and spread.

External factors, like development patterns, can also affect the potential magnitude of future wildfires. Wildfires typically start in natural areas and pose the most immediate risk to the ignition site. In recent years, Frederick County's population increased in both urban and rural areas. As more recreational and full-time residences are developed in wooded land or the WUI, the potential for property damage from fires increases.

Majority of wildfires in Maryland are caused by human activity, but the severity and extent of wildfires depends on climate conditions, including atmospheric temperatures and precipitation patterns. Wildfires are more likely during hotter months because higher temperatures accelerate evaporation, drying out soil and vegetation. Similarly, changes to season precipitation patterns during the winter and spring can also affect soil and vegetative moisture during peak wildfire months. Combined, temperatures and precipitation can influence the likelihood that wildfires ignite and their potential magnitude and geographic extent.

As global temperatures rise, Frederick County is projected to experience more extremely hot days: by 2050, the region is expected to experience upwards of nearly 29 days over 95 degrees and 9 days over 100 degrees (both in Fahrenheit).[84] At the same time, Maryland is projected to witness more frequent and intense rainfall events. During dry spells, hotter temperatures will increase the evaporation rate, drying out soils and vegetation.

With climate change, increasing temperatures and more frequent or severe droughts may lengthen the fire season and potential intensity of fires. Future vulnerability of wildfires will also depend on seasonal precipitation

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[81] Maryland Department of Natural Resources. 2016. "Dry and Windy Conditions Elevate Wildfire Risk." Retrieved from https://news.maryland.gov/dnr/2016/03/09/spring-conditions-elevate-wildfire-risk/.

[82] Arias, Jeremy. 2016. *The Frederick News-Post.* "Gambrill State Park brush fire that produced 'ring of fire' under investigation." Retrieved from https://www.fredericknewspost.com/news/disasters_and_accidents/gambrill-state-park-brush-fire-that-produced-ring-of-fire-under-investigation/article_7f03a567-4fc0-59a0-b849-755418a6cf62.html.

[83] County AMS data records are for the years 2010 to 2015. Maryland Department of Natural Resources data records are for the years 1998 to 2010.

[84] National Oceanic and Atmospheric Administration. (n.d.) *Climate Explorer*. Retrieved from https://crt-climate-explorer.nemac.org/.

patterns. Combined with more development in forested areas, the number of people, properties and communities at risk to wildfires could increase. Future wildfires and urban interface fires could cause substantial loss of property along with direct and indirect economic effects for residents and community businesses.

Impact Summary

Primary Impacts

Wildfires can spread quickly, reaching homes, businesses, utilities, transportation corridors, and other physical structures with little notice. Trees or wood utility poles may catch fire and collapse, blocking roadways or causing additional damage to nearby properties. Some transportation routes may be detoured or closed to stop travelers from approaching the flames. Natural spaces and wildlife in the fire's path will likely be burned or destroyed by flames.

Uncontained wildfires can destroy or significantly damage property, public infrastructure, and natural resources in or around the WUI. In additional to physical damage, affected areas may experience smoke and ash. Large, severe wildfires can create significant smoke and ash that can be suspended in the air for days. Depending on wind patterns, these materials can spread, carrying pollution and reducing air quality in the surrounding area.

Most wildfire-related deaths occur as a result of fire suppression activities; however, if roads are damaged or there is insufficient warning, other injuries and deaths could occur. Since death or injury statistics curves for wildfire are not available, they are estimated based on past wildfire events.

Secondary Impacts

Wildfires can extensively hinder the economy of an affected area, especially recreation and tourism industries, upon which Frederick County depends. Affected businesses may need to close to execute repairs, or if workers cannot travel to job sites. Property repairs for damaged homes and commercial facilities can be costly for residents and business owners alike.

These events can also be costly if many first responders are needed to evacuate residents or tend to the injured. After a wildfire, local and county governments may need to assess damage and pay for property and infrastructure repairs. Major direct costs associated with wildfires include fire suppression, subsequent salvage and removal of downed timber and debris, and restoration of the burned area.

If burned woodlands and grasslands are not replanted quickly, widespread soil erosion may occur. Accelerated erosion can elevate the potential for landslides, mudflows, and floods to occur, intensifying existing damage.

Public Health Impacts

Wildfires can create significant smoke, ash, and haze. Depending on wind patterns, these materials can be transported into surrounding areas, reducing air quality and visibility. People who live in affected areas face a higher risk of burn-related injuries and smoke inhalation. For individuals with underlying or pre-existing health conditions, added smoke and ash in the air raises the potential for health complications. First responders who work near the flames may face much higher risks of injuries, particularly burns, and smoke inhalation, while performing their job duties. Finally, buildup of ash, soil, and fire debris can cause changes in water quality that effect taste, color, and smell. Depending on fire severity and characteristics, water quality can be compromised for months or, in extreme cases, years after the fire has been extinguished.

Risk Assessment

Assets Exposed

Building footprints were intersected with the WUI interface and intermix zones with results shown in Table 5.30. Nearly 17% of structures in Frederick County lie within the interface zone, while 13% reside in the intermix zone. Since the 2016 plan, the number of structures in Frederick County has grown, but the share of those in the WUI interface and intermix zones has fallen one percentage point each.

Table 5.27. Building Footprints in WUI Areas in Frederick County

Municipality	Total Number Building Footprints	Interface	Intermix
Brunswick	4,412	70	0
Burkittsville	215	20	0
Emmitsburg	1,452	675	1
City of Frederick	30,328	3,621	0
Middletown	2,504	375	0
Mount Airy	2,166	0	27
Myersville	1,037	988	0
New Market	869	0	0
Rosemont	329	0	7
Thurmont	4,546	3,862	115
Unincorporated Areas	129,502	21,140	24,041
Walkersville	3,808	0	0
Woodsboro	886	0	0
Total	**182,054**	**30,751**	**24,191**

The fundamental factor necessary to assess physical vulnerability is the extent to which structures sustain damage when exposed to fire and heat. Current standard loss estimation tables do not exist for wildfires. The local fire department and structural engineers should help estimate structure and content damage from wildfires. The following loss estimation identifies critical facilities, building footprints, and market values of parcels in WUI interface and intermix areas.

Within Frederick County, the total market value of all structures exceeds $8.2 billion. Of those structures, more than $5.3 billion of the total market value, or 64%, falls within the WUI interface or intermix zones, representing the total market value vulnerable to wildfires. Table 5.31 summarizes the number of structures within interface and intermix and the associated vulnerability.

Table 5.28. Land Improvement Market Values Within the WUI

Municipality	Total Market Value Vulnerability	Total Market Value Exposure
Brunswick	$596,543,300	$9,277,900
Burkittsville	$11,657,200	$10,386,000
Emmitsburg	$174,886,900	$99,328,700
City of Frederick	$858,736,500	$769,047,000
Middletown	$510,489,100	$81,741,100
Mount Airy	$334,903,300	$4,949,900
Myersville	$146,925,000	$134,439,700
New Market	$162,849,100	$0
Rosemont	$18,603,000	$287,800
Thurmont	$465,555,110	$385,086,310
Unincorporated Areas	$4,300,216,300	$3,829,570,600
Walkersville	$578,212,000	$0
Woodsboro	$94,704,300	$0
Total	**$8,254,281,110**	**$5,333,392,910**

Critical Facilities Exposed

Of the 378 critical facilities in Frederick County, 54 facilities (14.3%) are in the WUI spatial extent (Table 5.32.). Of these exposed facilities, 16 are fire and EMS stations (Table 5.33). The unincorporated areas of Frederick County contain the most critical facilities. Of these, 11 facilities fall in the WUI. The locality with the highest number of exposed facilities is Thurmont, which contains five critical facilities in the WUI. Appendix D includes the specific facilities and associated hazard vulnerabilities.

Table 5.29. Critical Facilities in the WUI by Municipality

Municipality	Interface	Intermix	Total in the WUI	Percent in WUI
Brunswick	0	0	0	0.0%
Burkittsville	1	0	1	33.3%
Emmitsburg	3	0	3	33.3%
City of Frederick	7	0	7	5.6%
Middletown	0	0	0	0.0%
Mount Airy	0	0	0	0.0%

Municipality	Interface	Intermix	Total in the WUI	Percent in WUI
Myersville	5	0	5	83.3%
New Market	0	0	0	0.0%
Rosemont	0	0	0	0.0%
Thurmont	9	2	11	61.1%
Unincorporated Areas	16	11	27	16.8%
Walkersville	0	0	0	0.0%
Woodsboro	0	0	0	0.0%
Total	**41**	**13**	**54**	**14.3%**

Table 5.30 Critical Facilities in the WUI by Facility Type

Critical Facility Type	Total in the WUI	Total	Percent in WUI
Dry Hydrant	7	42	1.9%
Fire/EMS	16	55	4.2%
Government Facilities	2	37	0.5%
Interchange	1	29	0.3%
Landfill	1	1	0.3%
Library	2	7	0.0%
Medical Center	4	8	0.5%
Post Office	6	32	1.1%
School	10	23	1.6%
Shopping Center	4	67	2.6%
Transit Station	0	3	1.1%
Wastewater Treatment Plant	1	7	0.0%
Total	**54**	**378**	**0.3%**

Cultural and Historic Resources Exposed

Figure X shows cultural and historic resources in Frederick County and their proximity to karst areas.

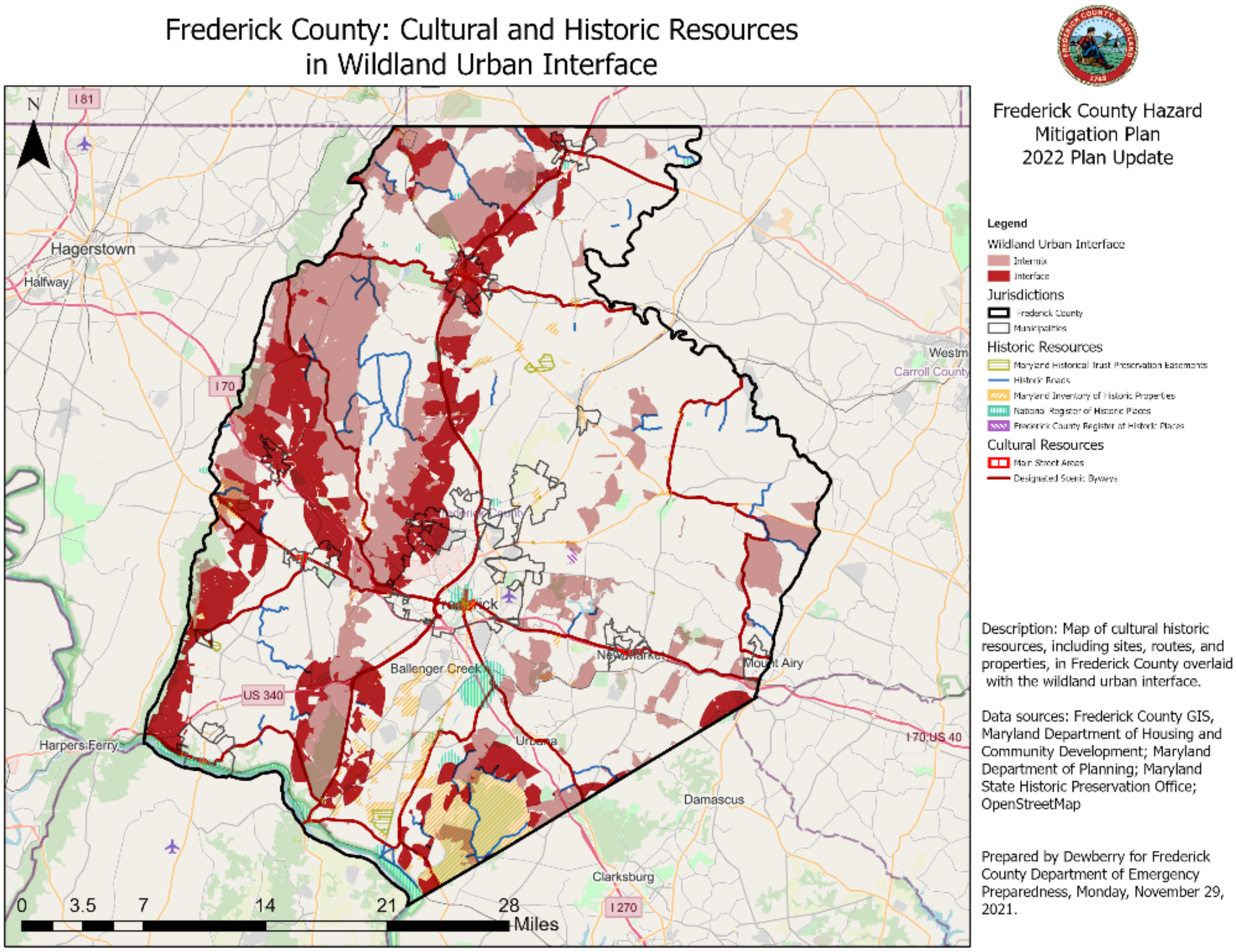

Figure 5.10. Cultural and Historic Resources and Their Proximity to the Wildland Urban Interface

Population Exposed

People that live in either the WUI interface or intermix areas are more likely to be affected by a wildfire compared to those who do not. Using population data from the 2018 American Community Survey, census tracts in Frederick County were overlaid with the WUI spatial extent. Census tracts illustrate overall population, but do not indicate whether within these boundaries that residents live. Some populous tracts may contain concentrated pockets of development, while others may be more evenly distributed. This analysis considers only overall tract population as an indicator of exposure.

Figure 5.11 illustrates the County's population by census tract, segmented by quintiles and Figure X shows social vulnerability and the WUI. The region's most populous tracts are clustered to the southeast around the City of Frederick, New Market, and Mount Airy. This part of the County has several pockets of the WUI, some of which overlap with highly populous census tracts in unincorporated areas. Western Frederick County contains larger and continuous stretches of the WUI. Populous tracts that intersect with these portions of the WUI are concentrated around Emmitsburg and Burkittsville. In recent years, Frederick County has witnessed both population and development growth. If development encroaches into WUI areas, the number of people exposed to future wildfires will grow as well.

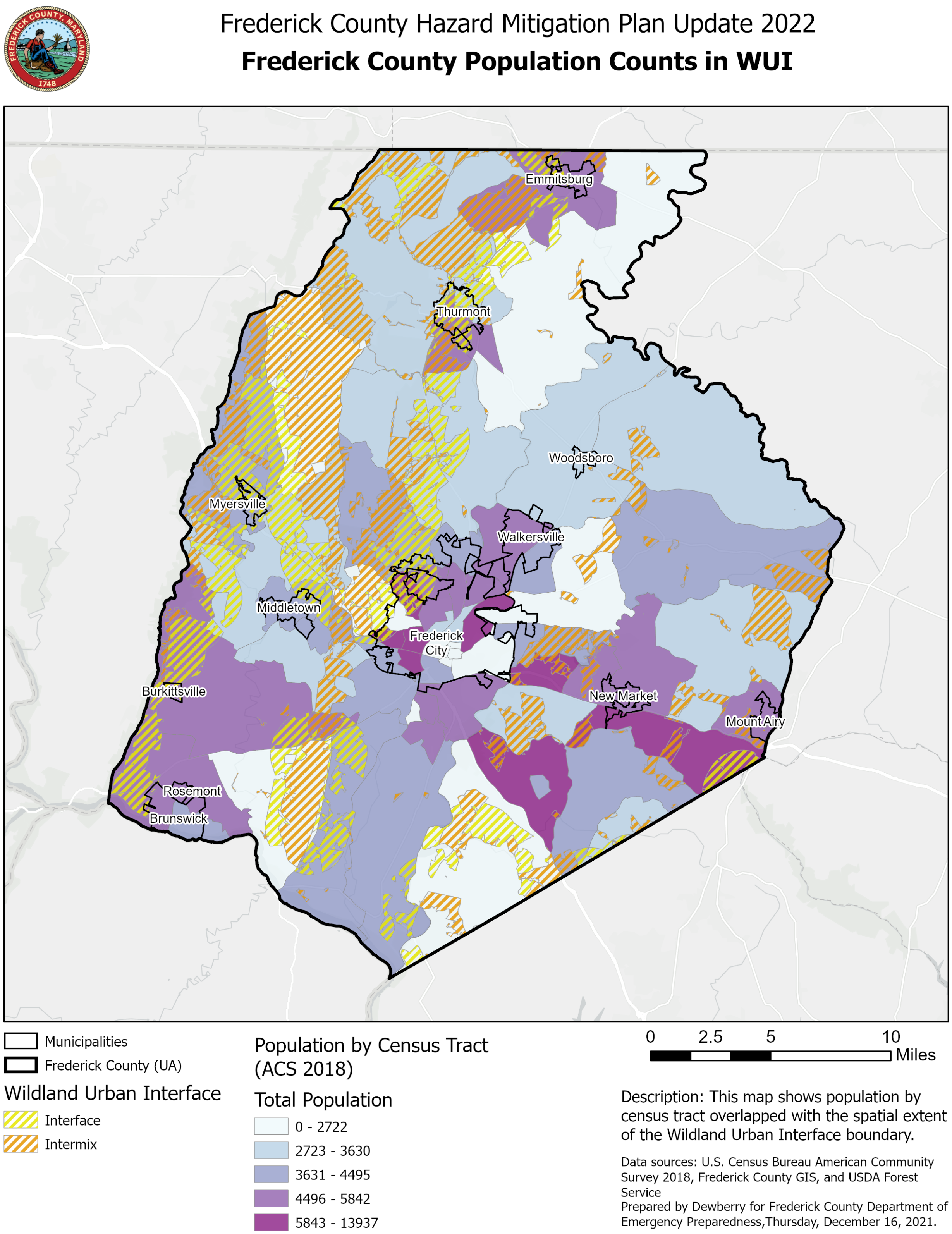

Figure 5.11. Population in WUI Areas in Frederick County

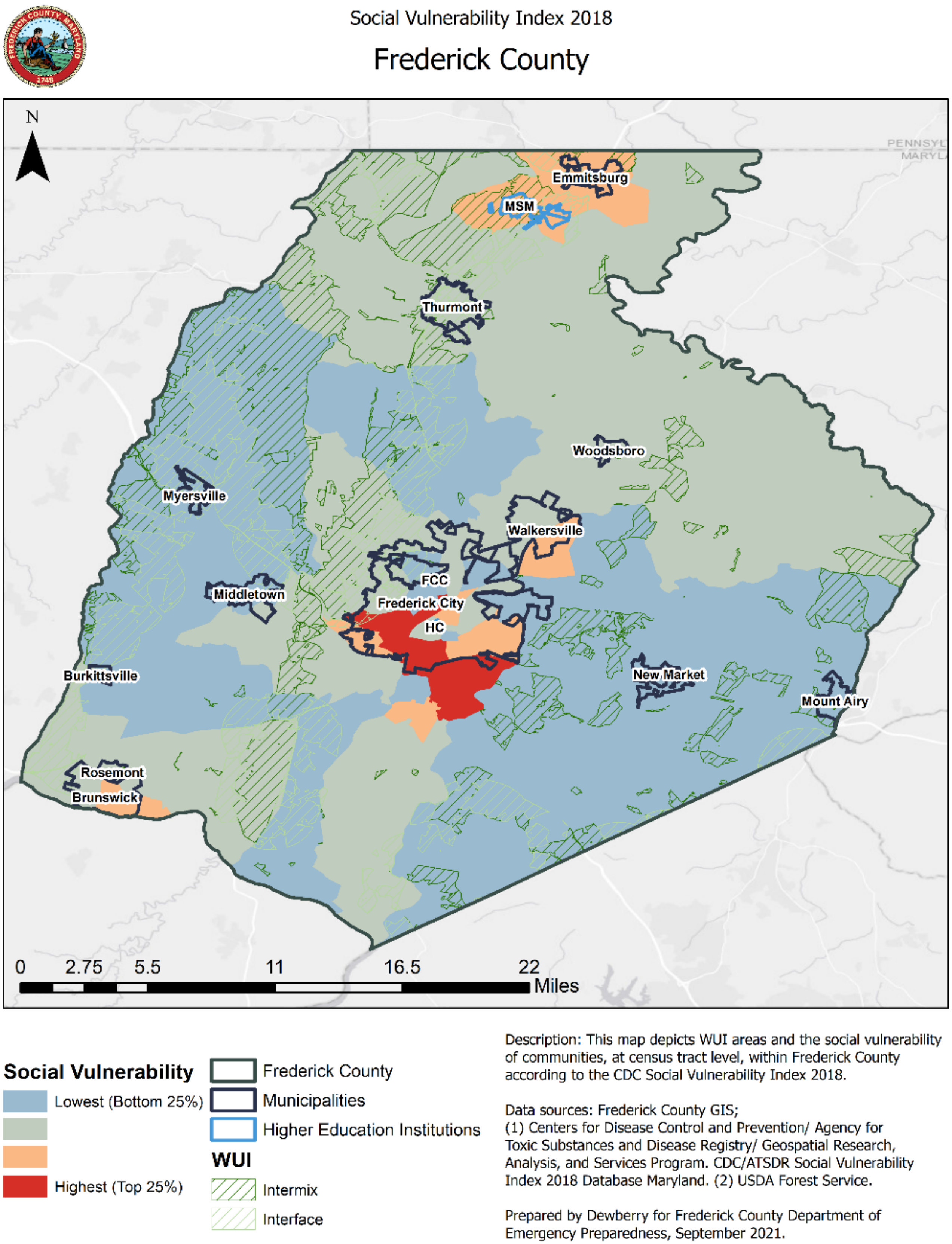

Figure 5.12. Social Vulnerability and the Wildland Urban Interface

Vulnerability Summary

More information about specific properties in or near wooded areas as well as total damage values would support determination of the relative vulnerability, as would an assessment of the vegetation types in determining specific risk factors. If more development occurs in forested areas, the occurrence of human-caused fires may likely increase, as will the number of people and property potentially at risk to wildfire and WUI fire exposure. Particular attention should be paid while planning for development in Zones 4 and 5.

Reducing Vulnerability

As development encroaches into rural and forested areas, the potential danger for people and property will increase. Mitigating the risk of WUI fires must address fuel management in addition to growth management to address the potentially expanding population in wildfire-vulnerable areas. These measures may define the necessary interface between private property needs and natural resource needs, public education, fire breaks, and maintenance of fire roads. Other mitigation options include hazardous fuels reduction, defensible space, and ignition-resistant construction materials and techniques.

Landslide

Hazard Identification

Hazard Description

Landslides include a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors, such as:

- Erosion by rivers, glaciers, or ocean waves creates over-steepened slopes.
- Rock and soil slopes are weakened through saturation by snowmelt or heavy rains.
- Earthquakes create stresses that make weak slopes fail; earthquakes of magnitude 4.0 and greater have been known to trigger landslides.
- Volcanic eruptions produce loose ash deposits, heavy rain, and debris flows.
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore from waste piles or from man-made structures may stress weak slopes to failure.

Slope material that becomes saturated with water may develop a debris flow or mud flow. The resulting slurry of rock and mud may pick up trees, houses, and cars, blocking bridges and tributaries and causing flooding along its path. Landslides occur in every state and United States territory. Any area composed of very weak or fractured materials resting on a steep slope can and will likely experience landslides.

Landslides are often prompted by the occurrence of other disasters. Floods or long duration precipitation events create saturated, unstable soils that are more susceptible to failure. The forces of earthquakes can also cause landslides.

Location

Landslides can occur anywhere land on a slope becomes unstable. It is more likely on slopes that are overly steep, have loose debris such as rocks, or contain excess weight from rain or snow accumulation. Due to the topography in the County, naturally occurring landslides are more likely to be seen in the northwest region near Thurmont or, more generally, on the western side of the County in and around South Mountain and Gathland State Parks.

Extent

Landslides constitute a major geologic hazard because they are widespread, occurring in all 50 states, and causing $1 to 2 billion in damages and more than 25 fatalities annually. Landslides pose serious threats to highways and structures that support fisheries, tourism, timber harvesting, mining, and energy production as well as general transportation. Landslides commonly occur with other major natural disasters such as earthquakes and floods that exacerbate relief and reconstruction efforts. Expanded development and other land uses have increased the incidence of landslide disasters.

Localized landslide data and information is limited, and the understanding of landslide hazards is better understood at a regional and national level. A previous USGS dataset, last updated in 2001, indicated the western half of Frederick County has high susceptibility and incidence, while the eastern portion exhibited a low susceptibility and incidence. This dataset, however, has not been updated, and is intended for analysis at national or large regional areas.

More recently, in 2019, the USGS developed a Landslide Inventory Map that documents historical landslides throughout the nation and identifies a confidence index (from high confidence in extent or nature of landslide to possible landslide), for areas that potentially affected by landslides.[85] This database does not include any historical landslides or areas of high or possible landslide susceptibility within Frederick County. Additionally, according to the 2021 State of Maryland Hazard Mitigation Plan, Frederick County has a moderate risk for soil movement, which includes landslides, sinkholes, coastal erosion.

There are currently no landslide monitoring stations in the State of Maryland. The closest landslide monitoring station is in North Carolina. However, landslide activity in the State of Maryland is commonly induced by prolonged rainfall associated with strong storms.

Previous Occurrences

NCEI contains no data for landslide events in Frederick County. However, landslide and mudslide activity has occurred in the area and are described below.

- According to the United States Department of Agriculture Farm Service Agency, Frederick County was one of several counties to be declared a contiguous disaster county due heavy rain and flooding that caused landslides and mudslides between May 15 and May 28, 2018.[86] A landslide occurred on Alternate route 40 on Braddock Mountain that undermined the highway and required repairs by the State Highway Administration.
- On June 27, 2006, thunderstorms brought 4 to 7 inches of rain to the County in a short amount of time. Numerous roads were closed across the county due to high water or mud slides.

Probability and Severity of Future Occurrences

Due to the localized variability of the hazard, probabilistic landslide data are limited and not available without a local study of specific hazard areas and conditions. However, generalized risk can be used to extrapolate general likelihood of future occurrences.

As previously discussed, USGS data on landslide susceptibility indicated the western portion of the County having a high landslide susceptibility and incidence, with the western most edge having a high susceptibility and moderate incidence (Appendix E). This dataset, however, has not been updated since 2001, and more recently updated datasets, like the USGS's Landslide Inventory, does not include any previous events or show any susceptible areas in Frederick County. According to the Global Facility for Disaster Reduction and Recovery, Frederick County has low landslide probability and risk.[87] The Global Facility for Disaster Reduction and Recovery utilizes a global dataset that considers the risk from annual rainfall-triggered landslides and earthquake-triggered landslides.

Due to Frederick County's terrain, rainfall patterns, geology, soil, and land cover, localized landslides are known to be an uncommon hazard according to emergency management professionals on the Hazard Mitigation Planning Committee. While this has been the case in the past, it might not hold as steady in the future. Climate change can alter bedrock and slope stability as a result of changes in temperature and increased precipitation, so there is a potential for landslide risk to increase as briefer, higher precipitation events are expected.

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[85] USGS. "U.S. Landslide Inventory." https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=ae120962f459434b8c904b456c82669d
[86] USDA. "Disaster Designation Information: State and County Records of Disaster Designation Information Made By the US Secretary of Agriculture." 2018. https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index
[87] Global Facility for Disaster Reduction and Recovery. "Frederick County, Maryland: Landslides." https://thinkhazard.org/en/report/3234-united-states-of-america-maryland/LS

Impact Summary

Primary Impacts

Rainfall-triggered landslides are a significant, yet underreported phenomena which may impact or threaten lives, property, and development. Impacts to roadways are common as they are often the closest development to a sloped area. The true impact of landslides is often disguised by more broad data relating to the precipitation events that prompt them. Rain-triggered landslide events are often concurrent with wind damage and floods, so the impacts and costs of landslide damages are often being reported and attributed to larger storm activity.

Secondary Impacts

When damage occurs to roadways, traffic delays can delay everyday travel for commuters which can impact leisure and business activities. The slope where the hazard occurred would need to be examined to determine the risk of a repeat event, so delays can potentially extend past the immediate cleanup time.

Risk Assessment

Assets Exposed

As discussed previously, there is limited data on the localized risk to landslides. The USGS Landslide Inventory does not assign any confidence index scores – which indicates areas where there is high confidence of landslides occurring to landslides being possible in the area – anywhere in Frederick County. However, structures located in areas of dramatic slope changes, where the risk to landslides is higher, are more likely to be vulnerable to damage. Additionally, buildings that are not constructed to code or that have a foundation inappropriate for its underlying soil type may be more likely to affected by landsides, if they occur.

Population Exposed

The accumulation of landslide risk is a result of increased development activity and a reduction in slope stability. Though underreported, landslide risk is present in many highly populated and developed areas. The City of Frederick has the second largest population (78,842 in 2020) in the State of Maryland, and Frederick County as a whole has shown growth trends in population and development in the last few years. In order to address landslide-related losses or future risk, the interaction of development and slope stability should be considered in order to mitigate risk.

Vulnerability Summary

Frederick County has experienced few landslide incidences over the past decade, few of which are captured in databases like NCEI and the USGS Landslide Inventory. However, areas of dramatic elevation changes face a higher vulnerability to potential damage or harm, such as western and northwester Frederick County. Between 2010 and 2020, Frederick County gained 38,332 residents and recorded the third highest percentage increase in population in Maryland. If development encroaches into areas with significant slope variations, the County's vulnerability to landslides could grow.

Heavy precipitation events can trigger landslides. Both the frequency and intensity of severe rainfall events are projected to increase in Maryland due to climate change. These changes may elevate the chance for landslides to occur in Frederick County, particularly the western and northwestern parts of the region.

Reducing Vulnerability

Key areas of focus to reduce vulnerability to landslides in the County include:

- Identify areas where riparian landslides may occur and map landslide hazard areas.
- Develop and maintain a database to track historical occurrences of landslides.
- Apply soil stabilization measures, such as planting certain types of vegetation on steep, publicly-owned slopes.

Dam and Levee Failure

Hazard Identification

Hazard Description

Dam Failure

Dams are artificial barriers that store, slow, or divert water, wastewater, or liquid-borne materials. They serve to regulate water supply, control floods, provide hydroelectric power, or create recreational opportunities. Most dams in Maryland consist of an earthen embankment to retain water and a combination of spillways designed to convey water safely around or through the facility. Maryland has no natural lakes or ponds, meaning that nearly all water bodies are formed by dams.[88]

Dams are sources of concentrated vulnerability and can be serious disaster agents if they fail. FEMA defines dam failure as the "catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water."[89] There is often little to no advance warning prior to a dam failure, which intensifies the potential risk for downstream property damage, and loss of life or injury. While minor dam failures can lead to catastrophic failures, in most cases these minor failures can be corrected.

Dams can fail for several reasons, including the following:

- Overtopping caused by floods that exceed the capacity of the dam,
- Deliberate acts of sabotage,
- Structural failure of materials used in dam construction,
- Movement and/or failure of the foundation supporting the dam,
- Settlement and cracking of concrete or embankment dams,
- Piping and internal erosion of soil in embankment dams,
- Inadequate maintenance and upkeep.[90]

Levee Failure

FEMA defines a levee as "a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to reduce risk from temporary flooding." These embankments run in a long strip, sometimes for many miles, along a river, lake or ocean. Grass or other mat-like vegetation is planted on the levee's bank to prevent erosion.

A levee failure occurs when the levee fails or is otherwise breached, causing the previously contained water to flood the land protected by the levee. There are several main types of failures that occur in man-made levees. The foundation could breach suddenly or gradually due to either surface erosion or by any sort of subsurface failure. Sand boils, which results when the rising pressure of the water flowing through the pores in the soil is stronger than the downward pressure of the soil, can also occur during a breach. If there is no surface cover, like grass, are more prone to surface erosion.

[88] State of Maryland. 2021. "2021 Draft Maryland State Hazard Mitigation Plan." Retrieved from https://aecomviz.com/MEMA-Maryland-360/Doc/MEMA%20HazMitPlan%20JULY%2009_FINAL%20with%20Appendices.pdf#page-89
[89] Federal Emergency Management Agency. 2004. "Federal Guidelines for Dam Safety: Glossary of Terms." Retrieved from https://www.fema.gov/sites/default/files/2020-08/fema_dam-safety_glossary_P-148.pdf.
[90] Federal Emergency Management Agency. 2016. "Be Aware of Potential Risk of Dam Failure in Your Community." Retrieved from https://www.fema.gov/sites/default/files/2020-08/fema_dam-safety_aware-community_fact-sheet_2016.pdf.

Location

Frederick County has 27 dams within its jurisdiction. The dams are mostly low hazard, with some significant and high hazard dams as well. Of these 27 dams, 19 were included in a list provided by Frederick County;[91] the other 8 were exclusively found on the National Inventory of Dams (NID). The eight additional dams found in the NID data include three low hazard dams and five significant hazard dams. Included in the list of 27 dams provided by Frederick County are three low-hazard dams that were not included in the NID. Table 5.34 lists all the dams and their associated information. Figure 5.13 shows the dams by hazard potential.

Dam inundation extents exist for four of the high hazard dams and one significant-hazard dam in Frederick County: Lake Merle Dam, Fishing Creek Dam, Rainbow Dam, Lake Linganore, and Hunting Creek Dam. Maps of all five inundation zones can be found in Appendix E.

[91] The original list from Frederick County GIS listed 21 dams, but upon consultation with the Maryland Department of the Environment, it was determined that three of the dams (Higgins Lake, Lake Whittier, and Shay Lake) were very likely categorized as "small ponds." Therefore, they are not included in the list of dams in the HMCAP.

Table 5.31. Dams Located in Frederick County

Dam	River	Owner Type	Owner Name	Primary Dam Type	Height	Year Built	Hazard Potential	Condition Assessment	Emergency Action Plan
Bentz Community Pond	Hunting Creek	State	MD Department of Natural Resources, Public Lands, Engineering & Constr-Western	Masonry	12 feet	1908	Low Hazard	--	Not Required
Bond Farm Pond	Spruce Run-Tr	Private	William M Bond	Earth	17 feet	1973	Low Hazard	Not Rated	Not Required
Cohen Pond	Ballenger Creek-Tr	Private	David Chaput	Earth	33 feet	1952	Significant Hazard	Poor	Yes
Damazo Pond	Little Catoctin Creek-Tr	Private	H Damazo	Earth	22 feet	1975	Low Hazard	Satisfactory	Not Required
Fishing Creek Dam*	Fishing Creek	Local Govt.	City of Frederick	Earth	58 feet	1925	High Hazard	Unsatisfactory	Yes
Frederick Research Park Lot 4 Stormwater Management Pond	Monocacy River-Tr	Private	Corporate Office Properties Trust	Earth	20 feet	--	Significant Hazard	Poor	No
Holly Hills Section 4 Stormwater Management Pond 1	Long Branch	Private	Holly Hills Homeowners Association	Earth	26 feet	2001	Significant Hazard	Satisfactory	Yes
Hunting Creek Dam (Cunningham Falls State Park Dam)*	Hunting Creek	State	MD Department of Natural Resources	Earth	79 feet	1969	High Hazard	Fair	Yes
Kump's Dam	Middle Creek	Private	VFW Post 6658	Masonry	14 feet	1900	Low Hazard	--	Not Required
Lake Anita Louise (Pinehurst Dam (Upper))	Linganore Creek-Tr	Private	Lake Linganore Association	Earth	40 feet	1973	Low Hazard	Not Rated	Not Required
Lake Jennifer	South Fork-Tr	Private	Lake Jennifer Common	Earth	15 feet	1963	Low Hazard	Poor	Not Required
Lake Linganore (Brosius Dam)*	Linganore Creek	Private	Lake Linganore Association	Earth	63 feet	1972	High Hazard	Unsatisfactory	Yes

Dam	River	Owner Type	Owner Name	Primary Dam Type	Height	Year Built	Hazard Potential	Condition Assessment	Emergency Action Plan
Lake Marian (Woodridge Road) (Lake Marian (Woodridge Road))	Linganore Creek-Tr	Private	Lake Linganore Association	Earth	50 feet	1973	Low Hazard	Not Rated	Not Required
Lake Merle Dam (Meadowlake Dam)*	Linganore Creek-Tr	Private	Lake Linganore Association	Earth	43.65 feet	1971	Significant Hazard	Poor	Yes
Lilypons Dam	Monocacy River	Private	Lilypons Water Gardens	--	--	--	Low Hazard	--	Not Required
Mason-Dixon Farms Irrigation Pond	Cattail Branch-Os	Private	Mason Dixon Farms INC	Earth	14.5 feet	1984	Low Hazard	Not Rated	Not Required
Monocacy Boulevard Dam (I-70 Dam)	Carroll Creek-Tr	State	MD Department of Transportation, State Highway Admin Bridge Hydraulics	Earth	20 feet	2011	Significant Hazard	Fair	Yes
Mt Airy Park-N-Ride Stormwater Management Pond (Sha Bmp No. 100171)	Bush Creek-Tr	State	MD Department of Transportation, State Highway Administration	Earth	15 feet	1972	Significant Hazard	Fair	Yes
PB Dye Golf Course Irrigation Pond Dam	Little Bennett Creek	Private	The Club at PB Dye	Earth	22 feet	1990	Low Hazard	--	Not Required
Point of Rocks Dam (Potomac Station Stormwater Management Dam)	Potomac River-TR	Local Govt.	Frederick County Parks and Recreation	Earth	13.8 feet	1990	Significant	Poor	No
Emmitsburg Dam (Rainbow Dam)*	Turkey Creek	Local Govt.	Town of Emmitsburg	Earth	30 feet	1964	High Hazard	Satisfactory	Yes
Reichs Ford Landfill Stormwater Management Dam	East Boyer Run	Local Govt.	Frederick County Dept. Of Solid Waste Mgmt.	Roller-Compacted Concrete	39 feet	1995	Low Hazard	Satisfactory	Not Required

Dam	River	Owner Type	Owner Name	Primary Dam Type	Height	Year Built	Hazard Potential	Condition Assessment	Emergency Action Plan
Spring Ridge Stormwater Management Pond No. 4a	Lower Monocacy-Tr-Linganore Cr	Private	Spring Ridge Conservancy	Earth	16 feet	1994	Low Hazard	Not Rated	Not Required
St Clair Farm Pond	Church Branch, Tr-Bush Creek	Private	Thomas K. St. Clair	Earth	18 feet	1968	Significant Hazard	Satisfactory	Yes
Starners Dam	Monocacy River	Private	Starners Dam Association	--	--	--	Low Hazard	--	Not Required
Summit Lake Church Camp Dam	Offstream-Little Owens Creek	Private	Summit Lake Bible Conf INC	Earth	15 feet	1930	Low Hazard	Not Rated	Not Required
Urbana Lake/Urbana	Bennett Creek-Tr	State	MD Department of Natural Resources - Fisheries Administration	Earth	25 feet	1963	Low Hazard	Satisfactory	Not Required

*These dams have inundation zones associated with them that are used for the analyses in this section.

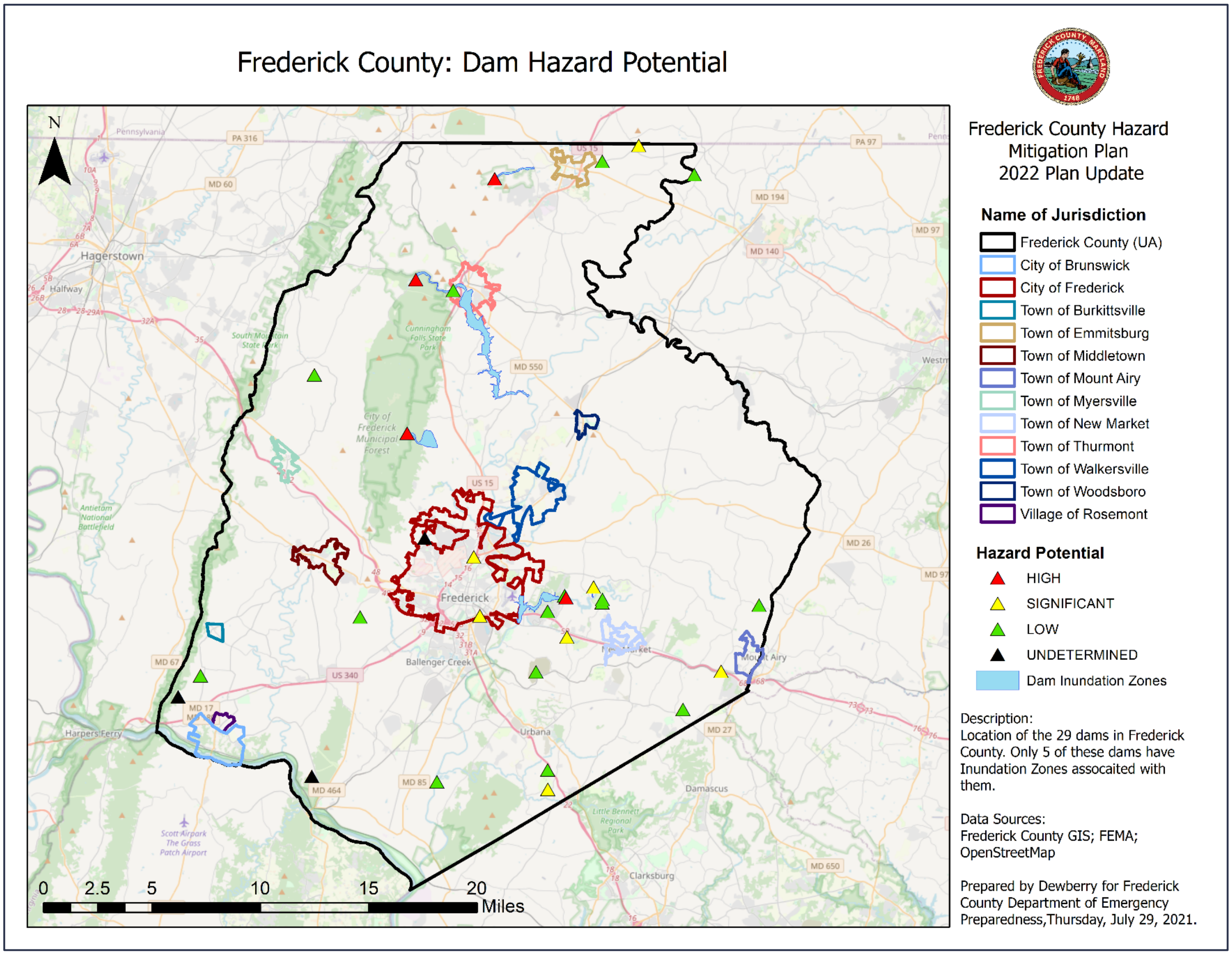


Figure 5.13. Frederick County Dam Hazard Potential

There is only one levee in Frederick County: The Carroll Parkway Levee. It is located west of the City of Frederick's downtown along Carroll Parkway between College Avenue and North Bentz Street, south of Baker Park. This system is 0.1 miles in length and is controlled and operated by the City of Frederick. The Carroll Parkway Levee is part of the flood control project that came together in response to the 1976 flood that caused between $5 million and $25 million in damages to the City of Frederick's downtown.[92] According to the United States Army Corps of Engineers (USACE) National Levee Database, 251 people and $3.52 Million in property value is protected by the Carroll Parkway Levee. However, it is classified by FEMA as a Non-Accredited Levee System—meaning that it does not meet NFIP levee requirements—and is therefore not shown on any FIRM as reducing the base flood hazard risk.

[92] The Frederick News-Post. 2018. "Carroll Creed flood control project did its job during recent floods." Retrieved from https://www.fredericknewspost.com/news/politics_and_government/levels_of_government/municipal/carroll-creek-flood-control-project-did-its-job-during-recent-floods/article_06903b48-2716-5de3-8272-73d58060ffa0.html.

Extent

Risk Types

There are three major flood risks that can be applied to any dam or levee. These risks include **incremental risk**, **non-breach risk**, and **residual risk**. Each of these risk measures focus on a different aspect of risk.[93]

Incremental risk is the risk to the pool area and downstream floodplain residents that can be directly attributed to a dam breach both before and after overtopping, or if a component malfunctions or fails to operate properly when the consequences of that malfunction are over and above those that would occur without dam breach. The consequences typically are due to downstream inundation, but loss of the pool can result in significant consequences in the pool area upstream of the dam.

Non-breach risk is the risk to the pool area and the downstream affected floodplains even if the dam functions as intended. This is due to 'normal' dam operation of the dam or 'overtopping of dams without breach' scenarios. It's the same thing for levees, the landside area may remain in a state of high risk even if the levee functions as intended. The USACE dam and levee safety programs will carefully and systematically assess, communicate, and consider in safety decisions the "non-breach" risks associated with the dams and levees in its portfolio.

Residual risk is the risk in the pool area and downstream of the dam and the landside area behind a levee at any point in time (i.e., prior to, during, or after implementation of risk reduction measures). The residual risk (i.e., the risk that remains) associated with a dam consists of both incremental and non-breach risk. The value of residual risk is the same as the incremental risk for scenarios where there are no non-breach risks.

Dam Hazard Classification

Dam failures can threaten significant damage and disruption to nearby communities. They are classified based on the scale of downstream damage that could occur if the structure were to fail. Maryland classifies dams into three hazard categories, as described in Table 5.35., that align with both the NID and the U.S. Natural Resources Conservation Service (NRCS) framework.

Table 5.32. Maryland Dam Hazard Classification

Hazard Classification	Description	Code of Maryland Classification	NRCS Classification
High Hazard	Likely loss of human life, extensive property damage, and cause flooding of major highways, such as State roads or interstates.	Category I	Class C
Significant Hazard	Possible loss of life or increased flood risks to roads and structures, and no more than two houses affected and less than six lives in jeopardy.	Category II	Class B
Low Hazard	Unlikely loss of life, and minor increases to existing flood levels at roads and structures.	Category III	Class A
Undetermined	Dams for which a hazard potential has not been designated or is not provided.	Not Applicable	Not Applicable

[93] US Bureau of Reclamation. 2019. "Best Practices and Risk Methodology. Chapter A-9 Risk Guidelines Presentation." Retrieved from https://www.usbr.gov/ssle/damsafety/risk/methodology.html

Hazard Classification	Description	Code of Maryland Classification	NRCS Classification

Source: Maryland Department of the Environment

Dam Condition Assessment

The hazard classification of a dam does not account for the structural integrity, condition, or operation status; therefore, dams are also given a condition assessment by the National Inventory of Dams (NID). The condition ratings are not absolute, as they are based on subjective field inspections which may change depending on the inspector. Table 5.36. gives a description of each of the condition assessments.

Table 5.33. NID Condition Assessment Descriptions

Condition Assessment	Description
Satisfactory	No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.
Fair	No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.
Poor	A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. Poor may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.
Unsatisfactory	A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.
Not Rated	The dam has not been inspected, is not under state jurisdiction, or has been inspected but, for whatever reason, has not been rated.

Based on field inspections, three of the four dams that received a high hazard rating are in excellent condition and one is listed as being in good condition.

In January 2021, the FEMA RiskMAP Flood Risk Report for the Monocacy and Middle Potomac-Catoctin Watersheds identified four dams (Lake Merle Dam, Fishing Creek Dam, Rainbow Dam, Lake Linganore, and Hunting Creek Dam) as areas of mitigation interest (AoMI).[94] All five of these sites are located in Unincorporated Frederick County. Two of the dams are locally-owned, one is state-owned, and two are privately-owned. The report identified broad actions to reduce flood risk, including engineering assessments, dam upgrades and strengthening, emergency action plans, removal of dam structures, and easements in impoundment and downstream inundation areas.

The available condition assessments for Frederick County dams are listed in Table 5.31 above.

[94] Federal Emergency Management Agency. 2021. "Monocacy and Portion of Middle Potomac-Catoctin Watersheds Study: Flood Risk Report." Retrieved from https://map1.msc.fema.gov/data/FRP/FRR_02070009_Part02070008_20210129.pdf?LOC=a2a632632f12adba1deb8088c152c5b3.

Previous Occurrences

As of August 2021, there have been no major dam or levee failures in Frederick County. According to the Maryland Department of the Environment's Dam Safety Permits Division, there have been four known dam failures in the State since 2011. They are shown in Table 5.37.

Table 5.34. Previous Dam Failures in Maryland

Year	Dam Name	Location	Description
2018	Cascade Lake Dam	Carroll County	Heavy rains caused Cascade Lake Dam to overtop and partially fail. Downstream roads closed for two weeks while the owner worked to remove the dam.
2016	Barren Creek Dam	Wicomico County	Heavy rains caused the structure to overtop and fail, leading to flooding on Barren Creek Road.
2016	Big Millpond Dam	Worcester County	Heavy rains caused the structure to overtop and fail, leading to flooding on Sheephouse Road.
2011	Preference Estates Dam	Charles County	Heavy rains caused the structure to overtop and fail.

In 2014, the Blairs Valley Dam in Washington County had a historically high pool which led to a record two feet of flow in the emergency spillway. Clear Spring was evacuated, but the dam did not fail. Additionally, the National Performance of Dams Program's Dam Incident Database lists 33 total incidents involving dams in Maryland since 1929. 16 of the incidents resulted in a dam failure (uncontrolled release of the reservoir), while 17 did not. None of the incidents occurred in Frederick County.

Probability and Severity of Future Occurrences

Without a historical basis, quantifying the probability of future dam and levee failure is not possible at this time. However, as climate change is increasing the frequency and extent of extreme rainfall, there is an increasing risk of floodwaters overtopping dams and levees. High hazard dams, especially, are at risk of failure that causes severe damages to people and property.[95]

Impact Summary

Primary Impacts

Dam failure has the potential to cause significant and long-term social effects, resulting in changes to the quality of life in the affected community. Direct economic impacts appear immediately following a dam failure event and typically include the need to repair and rebuild structures and infrastructure and reopen businesses.

A levee system failure or overtopping can create severe flooding and high-water velocities. Trees are a special type of risk. If the levee becomes saturated with water, a tree can become unstable and fall, causing the root system to take a chunk out of the saturated levee soil. This tree can then fall into the water and cause further damage downstream. Similar damage can result from traffic signs and fencing that were damaged and throwing into water. Another type of failure occurs when water overtops the structure. Levees can also be intentionally breached. This is done to protect other areas from flooding, drain flooded areas, or return the land

[95] Stanford University National Performance of Dams Program, Dam Incident Database (http://npdp.stanford.edu/dam_incidents).

to its natural state. This is not done without discussion, however, as valuable land is given up to future flooding due to the breach.

Secondary Impacts

A dam failure can have negative environmental impacts, such as the pollution of surface or groundwater, air, and soil; the release of hazardous materials; or the destruction of environmentally sensitive areas. Indirect economic impacts that might be identified during the consequence assessment are unemployment leading to population shifts, difficulty in attracting new businesses to the area, the need for governmental assistance, and lower property tax revenues. Indirect impacts may also include the closure of an industry outside the inundation area that depends on the output of a factory within the inundation area that would be destroyed by the dam failure scenario under consideration. [96] Social impacts may include a loss in the public's confidence in public officials, difficulty delivering necessary social or medical services to the community or the loss of connections among community members that provide support and enrichment.

Risk Assessment

Assets Exposed

In total, approximately $79 Million in property value is exposed between the five dam inundation areas and the Carroll Parkway Levee inundation area. Hunting Creek Dam poses the highest exposure risk, both in terms of the number of buildings and property exposure. Almost $48 Million is exposed, of which 90% is within the Town of Thurmont. This value averages to approximately $97,000 per structure. The Carroll Parkway Levee is the second to last in terms of property exposure but has the fewest number of buildings. Table 5.38. lists the high hazard dams and the levee along with their inundation areas, the number of buildings potentially impacted, and the number of buildings per acre. Frederick County-provided parcel-based tax roll data was used to calculate the Property Exposure value. Parcel centroids that were within 50 feet of the inundation areas, to account for buildings not being in the center of the parcel, were used to calculate property exposure, which is the total improvement value of a parcel, not the land value. In the absence of historical damages, it is difficult to estimate probable future losses. The number in the table represents total possible losses and overstates what would be actually lost under various breach scenarios.

Table 5.35. High Hazard Dams and Levees in Frederick County

Dam	Inundation Jurisdiction	Inundation Area (Acres)	Buildings in Inundation Area	Buildings per Acre	Property Exposure
Fishing Creek Dam	Unincorporated Areas	321.6	375	1.17	$12,431,300
Hunting Creek Dam	Town of Thurmont	369.1	446	1.21	$43,201,800
Hunting Creek Dam	Unincorporated Areas	942.2	126	0.13	$4,529,000
Lake Linganore	City of Frederick	59.9	0	0.00	$0

[96] FEMA. 2012. "Assessing the Consequences of Dam Failure". Retrieved from https://damsafety.org/sites/default/files/files/FEMA%20TM%20AssessingtheConsequencesofDamFailure%20March2012.pdf

Dam	Inundation Jurisdiction	Inundation Area (Acres)	Buildings in Inundation Area	Buildings per Acre	Property Exposure
Lake Linganore	Unincorporated Areas	367.4	26	0.07	$7,220,400
Lake Merle Dam	Unincorporated Areas	16.5	39	2.36	$9,783,900
Rainbow Dam	Unincorporated Areas	89.1	38	0.43	$942,800
Carroll Parkway Levee	City of Frederick	1.8	7	3.89	$961,700
TOTAL	**--**	**2,167.6**	**1,057**	**0.49**	**$79,070,900**

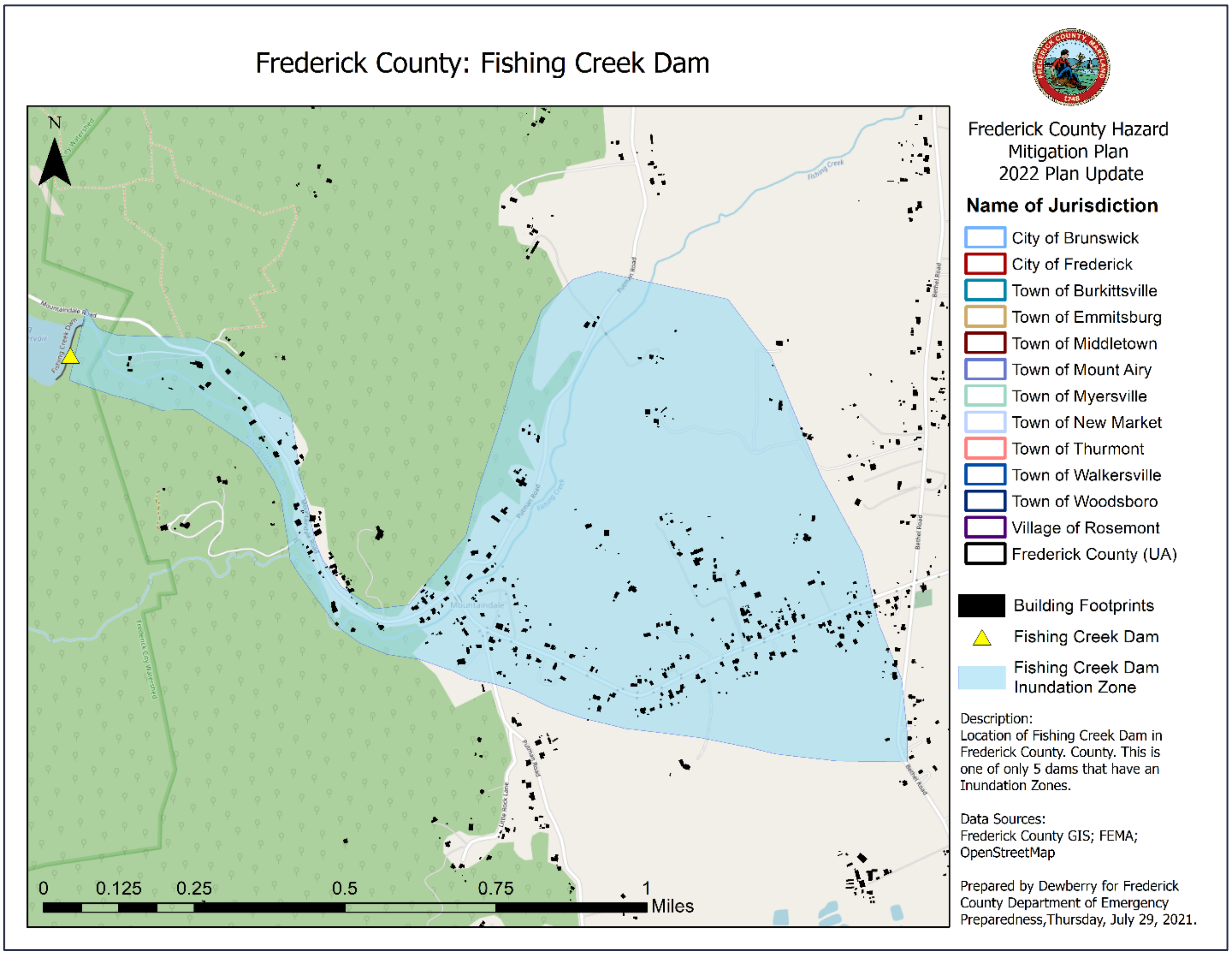


Figure 5.14. Map of Fishing Creek Dam Inundation Area and Exposure

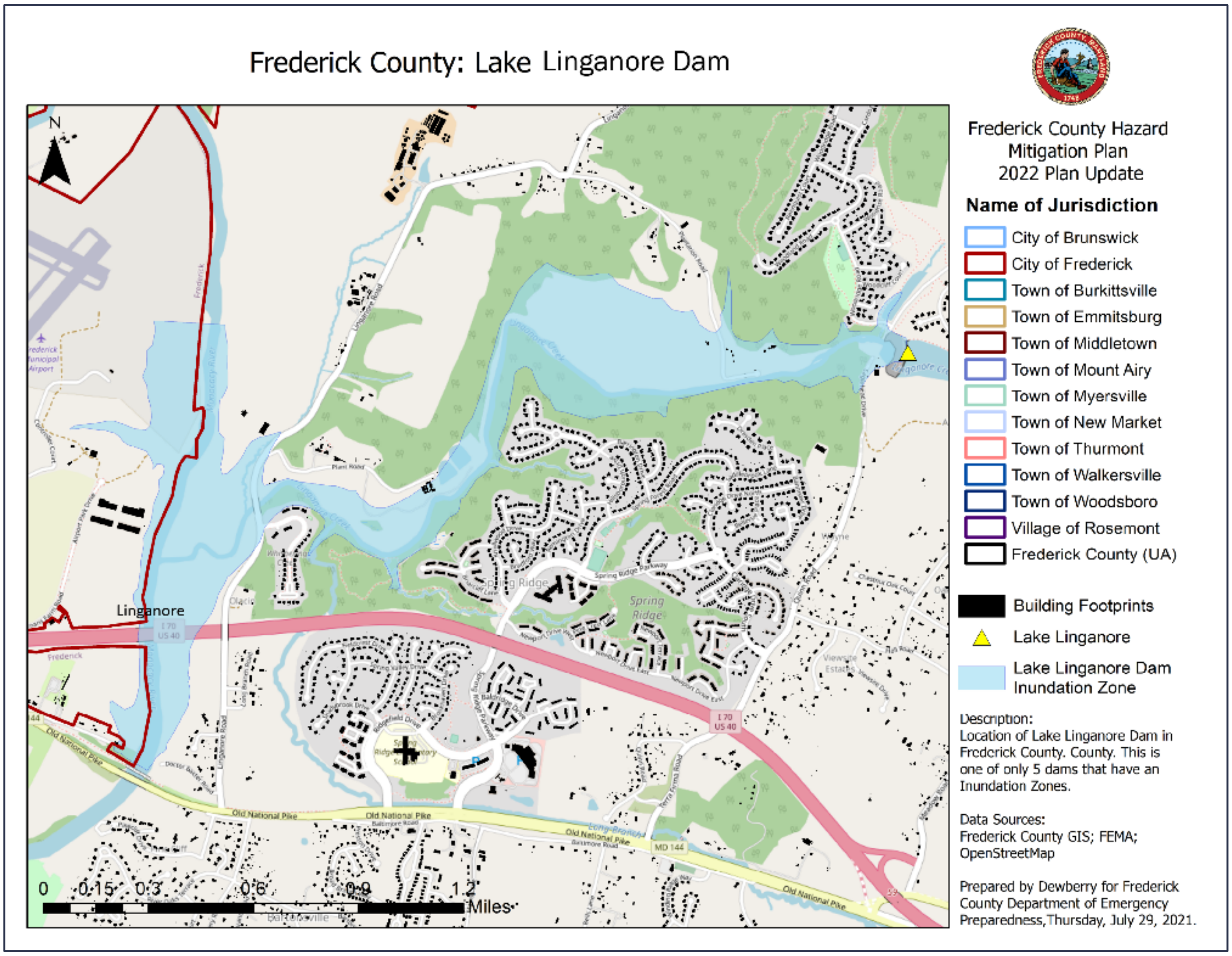


Figure 5.15. Map of Lake Linganore Dam Inundation Area and Exposure

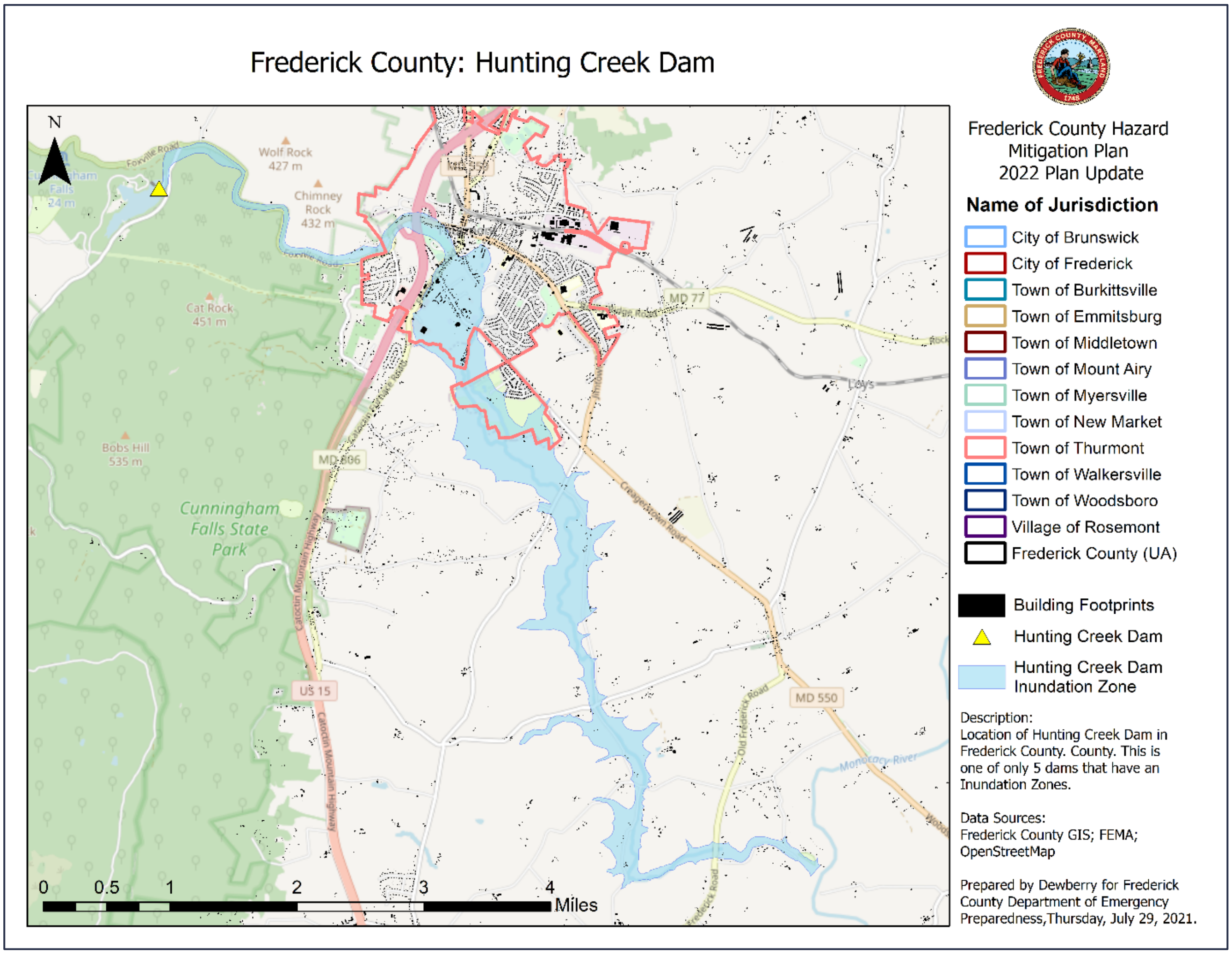


Figure 5.16. Map of Hunting Creek Dam Inundation Area and Exposure

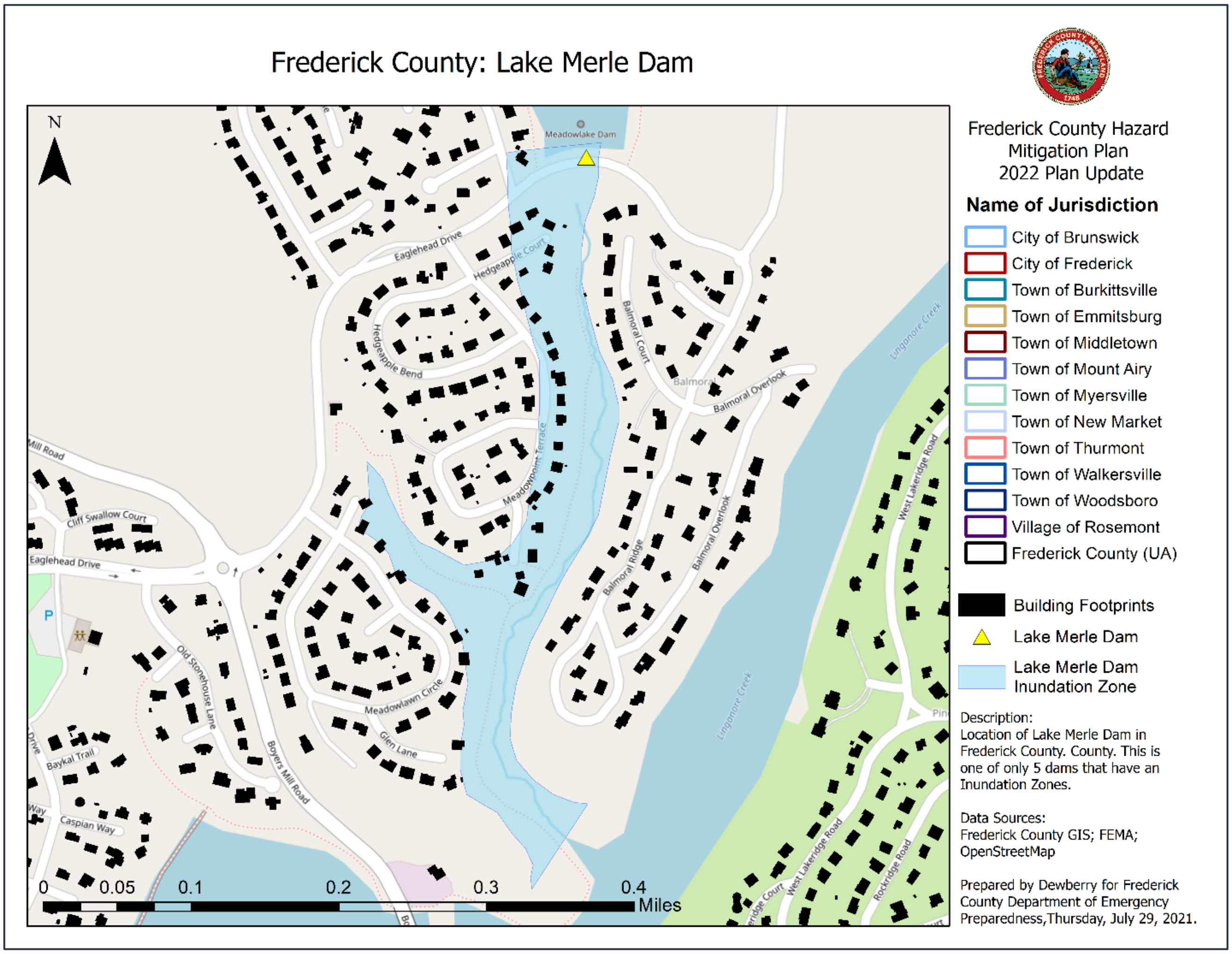


Figure 5.17. Map of Lake Merle Dam Inundation Area and Exposure

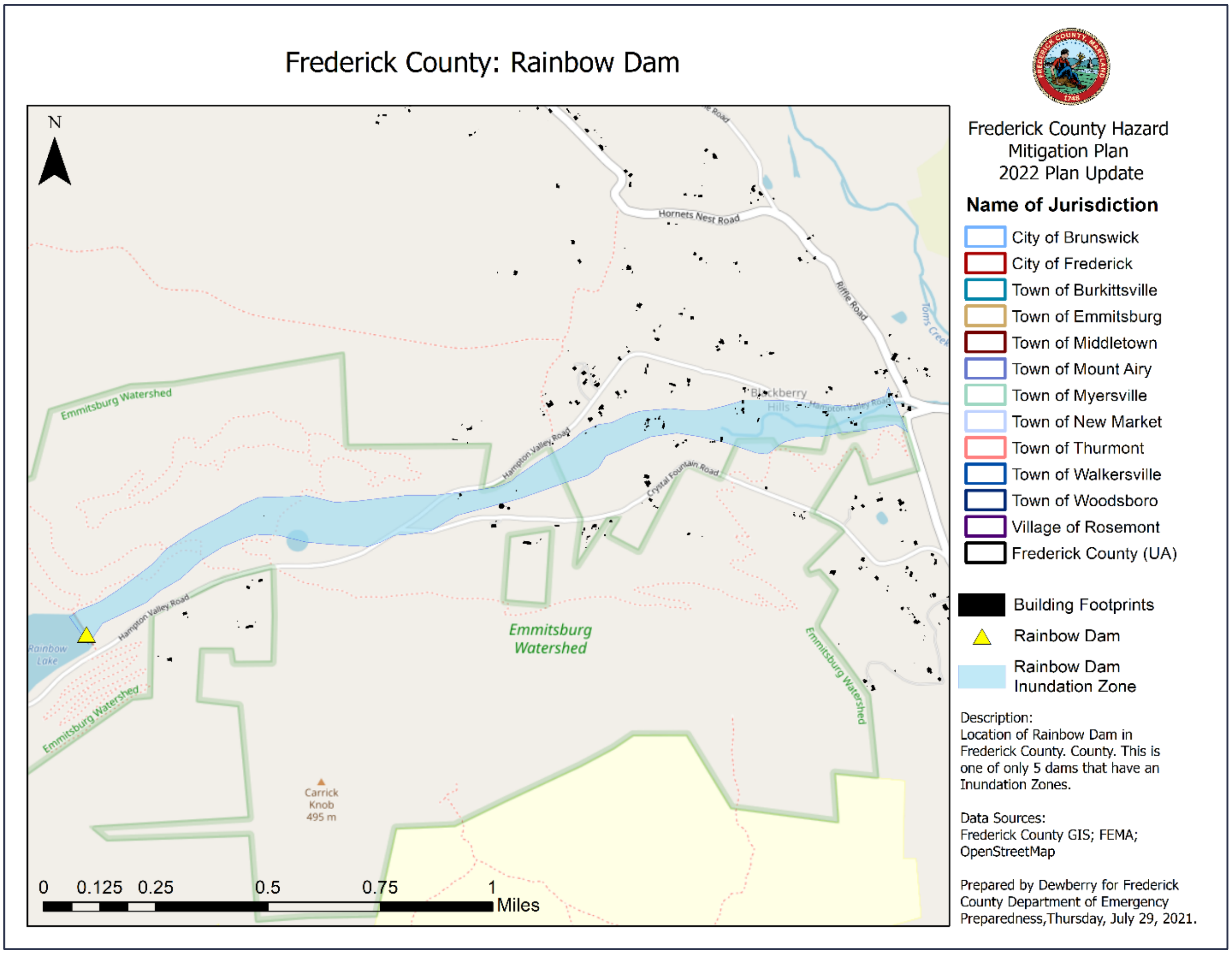


Figure 5.18. Map of Rainbow Dam Inundation Area and Exposure

Critical Facilities Exposed

Only six of the 378 critical facilities in the County fall within a dam inundation area, and none within the protected area of the Carroll Parkway Levee. All six of these facilities, five of which are in Thurmont and one in unincorporated Frederick County, fall within the Hunting Creek Dam inundation area (Table 5.39). The facilities include one dry hydrant, one interchange, one library, two shopping centers, and one wastewater treatment plant (Table 5.40). Recently, the Thurmont Wastewater Treatment Plant, located in the Hunting Creek Dam inundation zone, went through an Enhanced Nutrient Removal Upgrade that was financially supported by the State of Maryland as part of their commitment under the Chesapeake Bay 2000 Agreement.

Table 5.36. Frederick County Critical Facilities in Dam Inundation Zones by Jurisdiction

Jurisdictions	Facilities in Dam Inundation Zone	None	Grand Total
Brunswick	0	14	14
Burkittsville	0	3	3
Emmitsburg	0	9	9
City of Frederick	0	125	125

Jurisdictions	Facilities in Dam Inundation Zone	None	Grand Total
Middletown	0	11	11
Mount Airy	0	5	5
Myersville	0	6	6
New Market	0	7	7
Rosemont	0	1	1
Thurmont	5	13	18
Walkersville	0	13	13
Woodsboro	0	5	5
Unincorporated Areas	1	160	161
TOTAL	**6**	**372**	**378**

Table 5.37. Frederick County Critical Facilities Located in High and Significant Hazard Dam Inundation Zones by Facility Type

Facility Types	Facilities in Dam Inundation Zone	Facilities outside Dam Inundation Zone	Percent in Inundation Zone
Dry Hydrant	1	41	2.4%
Fire/EMS	0	55	0.0%
Government Facilities	0	37	0.0%
Interchange	1	28	3.4%
Landfill	0	1	0.0%
Law Enforcement	0	7	0.0%
Library	1	7	12.5%
Medical Center	0	32	0.0%
Post Office	0	23	0.0%
School	0	67	0.0%
Shopping Center	2	65	3.0%

Facility Types	Facilities in Dam Inundation Zone	Facilities outside Dam Inundation Zone	Percent in Inundation Zone
Transit Station	0	3	0.0%
Wastewater Treatment Plant	1	6	14.3%
TOTAL	**6**	**372**	**1.6%**

Cultural and Historic Resources Exposed

Figure 5.19 shows the dam inundation hazard areas and their proximity to the historic and cultural resources in Frederick County.

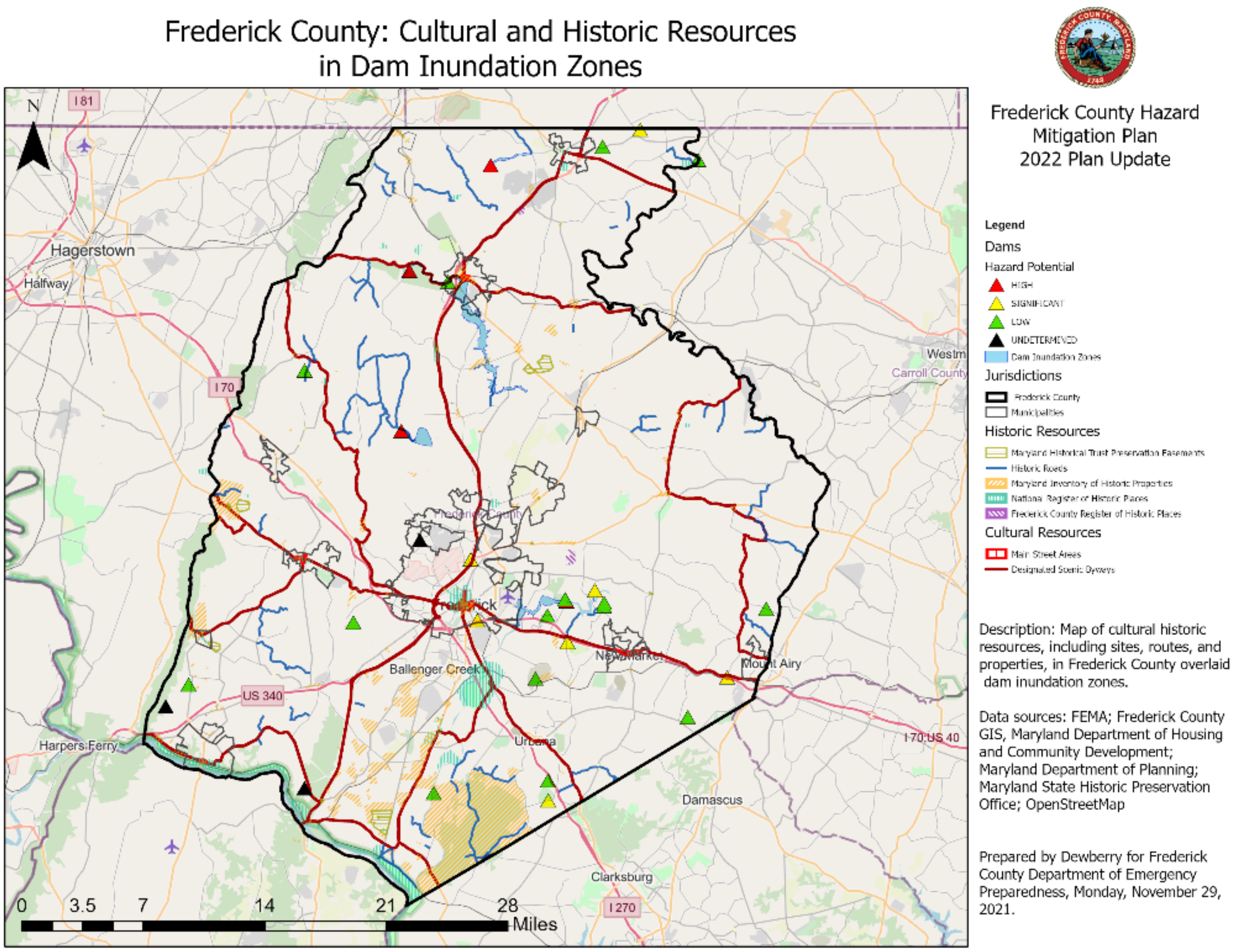


Figure 5.19. Cultural and Historic Resources and Their Proximity to Dam Inundation Zones

Population Exposed

Only three jurisdictions are affected by the five dams and one levee that have an inundation area, as illustrated in Figure 5.20. For these jurisdictions, assuming a worst-case scenario of all buildings in the inundation areas being residential, results in almost 2,800 people being exposed. Persons per household estimates were taken from the US Census Bureau's estimates between 2015 and 2019. The City of Frederick possesses the least population exposure, and the County the most (Table 7). For the dams, Hunting Creek Dam has the greatest population exposure while Lake Linganore Dam has the least (Table 8). The Carroll Parkway Levee exposes approximately 17 people. Figure 5.21 shows social vulnerability in the County and dam inundation areas.

Table 5.38. Estimated Population Exposure by Jurisdiction

Jurisdiction	Buildings in Inundation Area	Sum of Property Exposure	Average Exposure per Building	Average Persons per Household (2015-2019)	Estimated Population Exposed
City of Frederick	7	$961,700	$137,385.71	2.49	17
Unincorporated Areas	604	$34,907,400	$57,793.71	2.67	1,613
Town of Thurmont	446	$43,201,800	$96,865.02	2.61	1,164
Frederick County (All)	**1,057**	**$79,070,900**	**$74,806.91**	**--**	**2,794**

Table 5.39. Estimated Population Exposure by Dam

Dam	Buildings in Inundation Area	Property Exposure	Average Property Exposure	Estimated Population Exposed
Carroll Parkway Levee	7	$961,700	$137,386	17
Fishing Creek Dam	375	$12,431,300	$33,150	1,001
Hunting Creek Dam	572	$47,730,800	$132,809	1,500
Lake Linganore	26	$7,220,400	$277,708	69
Lake Merle Dam	39	$9,783,900	$250,869	104
Rainbow Dam	38	$942,800	$24,811	101
TOTAL	**1,057**	**$79,070,900**	**$856,733**	**2,794**

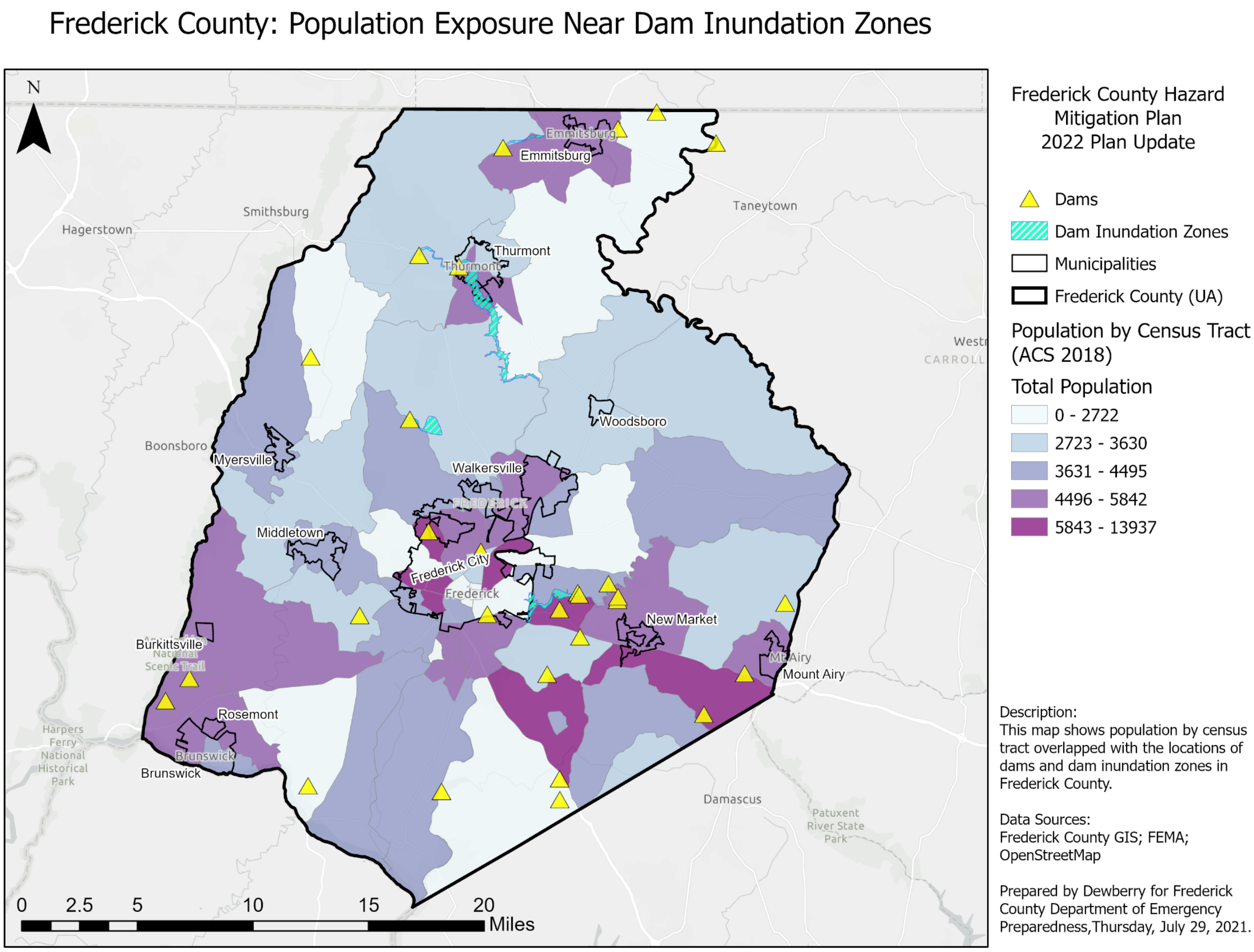
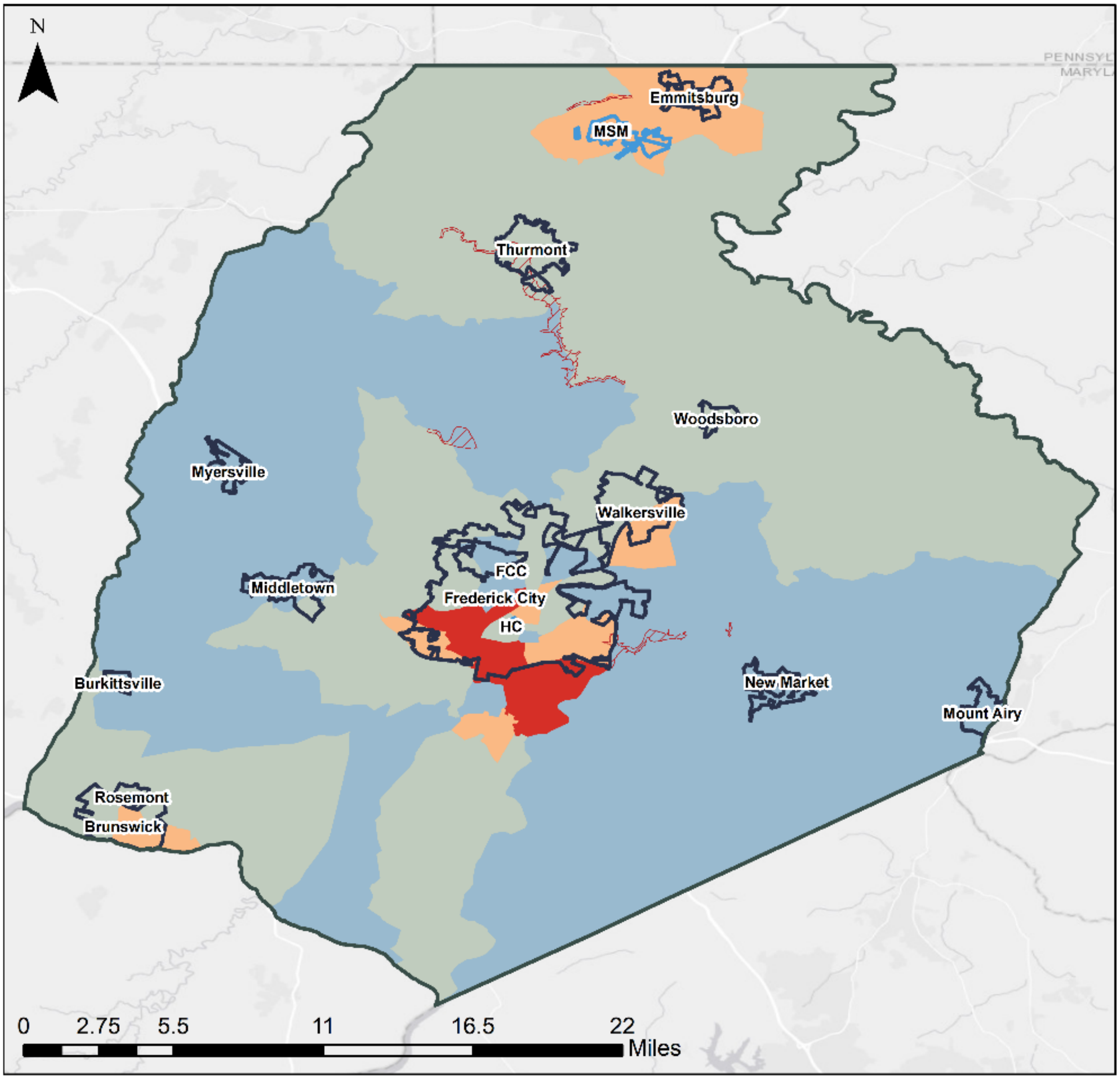


Figure 5.20 Population near Dam Inundation Zones

Social Vulnerability Index 2018

Frederick County



Social Vulnerability

- Lowest (Bottom 25%)
- Highest (Top 25%)

- Dam Inundation Zones
- Frederick County
- Municipalities
- Higher Education Institutions

Description: This map depicts dam inundation zones and the social vulnerability of communities, at census tract level, within Frederick County according to the CDC Social Vulnerability Index 2018.

Data sources: Frederick County GIS;
(1) Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC/ATSDR Social Vulnerability Index 2018 Database Maryland. (2) Frederick County GIS.

Prepared by Dewberry for Frederick County Department of Emergency Preparedness, September 2021.

Figure 5.21. Social Vulnerability and Dam Inundation Areas

Vulnerability Summary

As population increases and development patterns change, there is potential for an increased risk associated with dam failures that could result in the loss of life and property throughout Frederick County. As metropolitan areas continue to grow, stormwater control becomes increasingly important as does a reliable source of clean drinking water. Dams can provide both. While there have been no dam or levee breaches in Frederick County, a single dam or levee failure event may lead to catastrophic and expensive consequences.

As dams and levees are critical structures, they need to be properly maintained. An increased intensity of rainfall events, in combination with poorly maintained dams, can lead to breaches. Rainfall can not only cause the rivers to increase the amount of water needed to go through a channel but can also cause erosion that can undermine a dam, leading that dam to fail before water levels reach the design level of the dam. Aging and poorly maintained dams are increasingly expected to fail, making property damage, death, and environmental destruction a more likely, and perhaps a more normal, occurrence. Levees are designed to protect against a specific flood level, typically a 1%-annual-chance or 0.2%-annual-chance flood event, and can be overtopped during severe weather. Levees reduce, not eliminate, the risk to the individuals and structures behind them. It's important to remember that levees may not guard against events for which they were not designed. This is why the building of levees to mitigate flooding will continue to be an issue as communities plan and build for extreme weather events, especially as climate change progresses.

Reducing Vulnerability

Key areas of focus to reduce vulnerability to dam and levee inundation in the County include:

- Ensuring that dams and levees are properly maintained and functioning properly,
- Improving inundation mapping and mapping products to identify future mitigation projects and educate property owners about their risk, and

A Note on Coordination

Dam owners and dam safety experts were both asked to provide input into the HMCAP as well as provide general feedback. The Dam Safety Permits Division of the Stormwater, Dam Safety, and Flood Management Program within the Maryland Department of the Environment provided dam data and reviewed a draft version of this section, dam-related mitigation and adaptation actions, and the appendices for accuracy and completeness.

Dam owners were also reached out to during the planning process. Four chose to participate through providing feedback and approval of the dam-related content of the draft plan. They also expressed interest in being included in any future planning or discussions regarding their affected dams.

Primary Climate Change Interaction: Rising Temperatures

As temperatures rise, the frequency, severity, and duration of extreme heat events will likely intensify. Rising temperatures during the summer months elevate the potential for periods of extreme heat to occur. Over the next 50 to 60 years, Maryland's average summer temperatures are expected to rise over 6°F, compared to preindustrial levels.[97] Given these projections, Frederick County's susceptibility to temperature-related hazards, like extreme heat, may rise in the coming decades.

Extreme Heat

Hazard Identification

Hazard Description

There is not one standard definition for extreme heat, but temperatures that hover ten degrees or more above the average high temperature for the region sustained over several weeks are defined as extreme heat in this Plan. A heat wave is primarily a public health concern with more than 600 people in the United States killed by extreme heat every year according to the CDC. During extended periods of very high temperatures or high temperatures with high humidity, individuals can suffer a variety of ailments, including heat stroke, heat exhaustion, heat syncope, and heat cramps. Individuals with existing medical conditions such as heart disease or respiratory problems are at higher risk, as extreme heat can exacerbate such conditions. High risk groups include those under the age of 5 or over the age of 65, those with chronic illness, people taking certain medications, and individuals who work outdoors.

- **Heat stroke**, in particular, is a life-threatening condition that requires immediate medical attention. It occurs when the body's core temperature rises above 105°F as a result of environmental temperatures. Patients may be delirious, stuporous, or comatose. The death-to-cure ratio in reported cases in the United States averages about 15%. Children and individuals with chronic existing medical conditions are especially susceptible to heat stroke.
- **Heat exhaustion** is much less severe than heat stroke. The body temperature may be normal or slightly elevated. A person suffering from heat exhaustion may complain of dizziness, weakness, or fatigue. The primary cause of heat exhaustion is fluid and electrolyte imbalance. The normalization of fluids will typically alleviate the situation.
- **Heat syncope** is typically associated with exercise by people who are not acclimated to exercise. The symptom is a sudden loss of consciousness. Consciousness returns promptly when the person lies down. The cause is primarily associated with circulatory instability as a result of heat. The condition typically causes little or no harm to the individual.
- **Heat cramps** are typically a problem for individuals who exercise outdoors but are unaccustomed to heat. Similar to heat exhaustion, heat cramps are thought to result from a mild imbalance of fluids and electrolytes.

[97] Bradley, Raymond, Ambarish Karmalkar, and Kathryn Woods. CSRC. University Amherst. Maryland State Climate Report: https://www.geo.umass.edu/climate/stateClimateReports/MD_ClimateReport_CSRC.pdf

Location

Excessive heat does not have an exact spatial extent, as it effects large areas and regions when it occurs. However, it can pose particular problems for individuals in high risk groups, such as small children, the elderly, those that work or live outside, and those with certain medical conditions. Therefore, while the hazard is widespread, the risk may be localized.

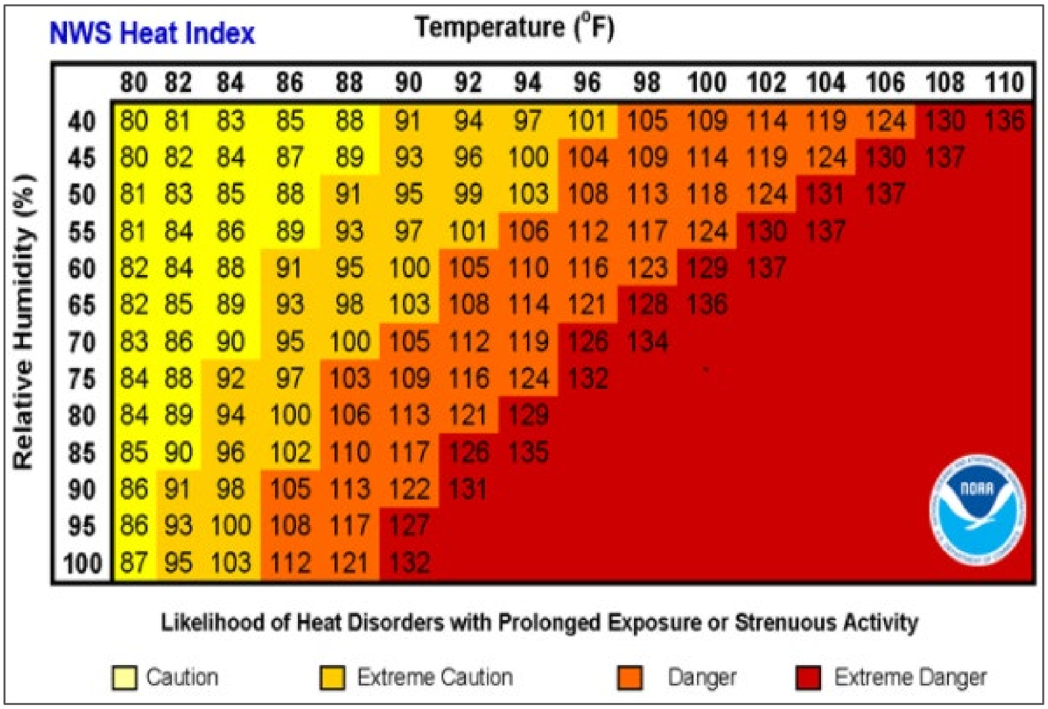
Large urban areas such as the City of Frederick can also create an island of heat that can raise the temperature by 3 to 5 degrees Fahrenheit. Therefore, urban communities with susceptible residents could face a significant medical emergency during an extended period of excessive heat. In addition to posing a public health hazard, periods of excessive heat usually result in high electrical consumption for air conditioning, which can cause power outages and brownouts. This can primarily effect areas with less resilient or inadequate infrastructure.

Extent

In 1979, meteorologist R.G. Steadman developed the heat index (Table 5.43 and Figure 5.22) to illustrate the risk associated with extreme heat. The heat index of a given location is determined by calculating the “apparent temperature” using both the relative humidity and air temperature. The apparent temperature can actually be lower than the air temperature if the relative humidity is low. In Maryland, the average annual percentage of humidity is 64%. August is the most humid month with a mean monthly relative humidity of approximately 70%.

Table 5.40. NWS Heat Danger Categories

Danger Category	Heat Disorders	Heat Index (°F)
IV. Extreme Danger	Heatstroke or sunstroke imminent.	>130
III. Danger	Sunstroke, heat cramps, or heat exhaustion likely; heat stroke possible with prolonged exposure and physical activity.	105-130
II. Extreme Caution	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and physical activities.	90-105
I. Caution	Fatigue possible with prolonged exposure and physical activity.	80-90



Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Figure 5.22. National Weather Service Heat Index Chart (2021)

The NWS issues three types of excessive heat watches, warnings and advisories depending on the heat index severity.

- An **Excessive Heat Watch** is issued when there is a potential for the heat index value to reach or exceed 110 degrees (east of the Blue Ridge) or 105 degrees (west of the Blue Ridge) within the next 24 to 48 hours.
- An **Excessive Heat Warning** is issued when the heat index value is expected to reach or exceed 110 degrees (east of the Blue Ridge) or 105 degrees (west of the Blue Ridge) within the next 12 to 24 hours. An Excessive Heat Warning may be issued for lower criteria if it is early in the season or during a multi-day heat wave.
- A **Heat Advisory** is issued when the heat index value is expected to reach 105 to 109 degrees (east of the Blue Ridge) or 100 to 104 degrees (west of the Blue Ridge) within the next 12 to 24 hours. A Heat Advisory may be issued for lower criteria if it is early in the season or during a multi-day heat wave.

Previous Occurrences

Based on data from the National Center for Environmental Information (NCEI), there have been 44 incidents of extreme heat between 1996 and 2021. Frederick County typically experiences one to two extreme heat events each year. Some of the more recent occurrences are described below. Events before 2016 are included in Appendix C.

- In the summer of 2016, NWS issued Frederick County three heat advisories, and one excessive heat warning on August 14, 2016. There were no reported injuries or deaths as a result of the extreme heat events.
- July 1-4, 2018, three heat advisories were issued in Frederick County. Another heat advisory was issued on September 4, 2018. There were no reported injuries or deaths as a result of the extreme heat events in the County in 2018.
- In July 2019, NWS issued a total of 8 excessive heat warnings, watches, and advisories in Frederick County, MD. On July 17, 2019, the Frederick County Division of Emergency Management released an

extreme heat warning to citizens. A total of six heat-related deaths were reported in the State of Maryland in July 2019, one of which occurred in Frederick County involving a citizen over 65 years old.
- Three heat advisories were issued between July 19-22, 2020 in Frederick County. No heat related injuries were reported in Frederick County.
- On July 6, 2021, the National Weather Service issued a heat advisory and air quality alert in 8 counties within Maryland, including Frederick County. Heat indices ranged from 100 to 105 degrees, indicating dangerous heat conditions.

Probability and Severity of Future Occurrences

According to the Maryland Climate and Health Profile report,[98] extreme temperatures are on the rise. Climate models show that the frequency of extreme heat events is projected to rise in Maryland across all counties and jurisdictions by 2040. Extreme heat events in the summer months more than doubled in the State of Maryland in the decades between the 1980s-2000s compared to the 60s and 70s.

An increase in extreme heat events are projected to cause higher rates of health conditions by 2040 in the State of Maryland. Potential public health vulnerabilities from extreme heat may include an increased risk of foodborne illnesses, heart attacks, and severe asthma attacks.

Impact Summary

Primary Impacts

Primary impacts from extreme heat include heat-related health effects such as heat stroke, dehydration, and dizziness. In extreme cases, these can lead to death. Primary impacts are often harder to attribute to an extreme heat event because they effect people who are already vulnerable, such as children, the elderly, and those with pre-existing medical conditions. One way to determine the overall primary impact of extreme heat is to compare hospital statistics for heat-related illnesses or deaths to standard averages. This can be done to overcome the issue of extreme heat not being recognized as the underlying cause because other ailments were also present (and exasperated by the heat).

Secondary Impacts

Secondary impacts from extreme heat are the potential delay of outside work, such as construction, during intense episodes. Even If work is not halted completely, safe working conditions would require an increase in breaks and time out of the heat. This would slow overall work. Additionally, higher temperatures increase electricity consumption due to air conditioning usage, leading to power outages. This would impact homes, businesses, and general operations throughout the County. If the power outage is extensive or occurs for a long period of time, a positive feedback loop can start. With the power out, air conditioning becomes unavailable for most. The lack of air conditioning makes people more vulnerable to the extreme heat, leading to even more heat-related health issues.

Risk Assessment

Assets Exposed

Primarily, energy infrastructure faces the highest risk from extreme heat due to the increased energy usage. If peak loads exceed what the system can handle, power outages can occur. This would mean that power

[98] University of Maryland School of Public Health's Maryland Institute for Applied Environmental Health

infrastructure throughout the County is vulnerable if it is connected to the main grid. Any homes or businesses that can run on generators or a microgrid would be less exposed to failure/power outages.

Population Exposed

All of Frederick County is vulnerable to extreme heat is some regard. Residents that live in urban and developed areas with significant heat-absorbing surfaces, such as pavement, and limited vegetative cover, like tree canopies, are more likely to be affected by extreme heat. Some populations are more vulnerable to the effects of extreme heat than others, such as people with underlying health conditions, children and infants, and the elderly.

Vulnerability Summary

Though all of Frederick County is exposed to extreme heat, more developed areas with more heat-absorbing surfaces are more vulnerable to potential adverse impacts. In particular, City of Frederick may be more vulnerable to extreme heat events due to its concentration of these types of surfaces and populations. The potential impacts of extreme heat events, however, are more likely to affect individuals than structures or property. Populations with underlying health conditions, young children, and the elderly are all more susceptible to the impacts of extreme heat. However, residents that live in structures with limited air conditions or ventilation may also be at risk of heat-related illnesses, if an event occurs and lasts for several days.

Reducing Vulnerability

Key areas of focus to reduce vulnerability to extreme heat in the County include:

- Education and awareness campaigns or programs to ensure the symptoms and warning signs of heat-related illnesses are caught early,
- Utilizing cooling centers to head of heat-related illnesses,
- Strengthening energy infrastructure to prevent power outages during peak loads,
- Increasing the usage of microgrids and generators to decrease peak loads on county-wide infrastructure and prevent widespread power outages, and
- Increasing the heat reflection capacity of urban areas by increasing greenery and decreasing the number of black surfaces that absorb heat.

Primary Climate Change Interaction: Extreme Weather

The frequency, severity, and magnitude of the hazards in the following section – winter storms, thunderstorms, tornados, and tropical cyclones – are all affected by climate change. In Frederick County, average air temperatures and annual precipitation amounts are both projected to rise in the coming decades. As temperatures rise, certain atmospheric conditions that are ideal for extreme weather events to form may become more frequent, while others, like winter storms, may become rarer.

Winter Storm

Hazard Identification

Hazard Description

Winter storms can vary in size and strength and include heavy snowstorms, blizzards, freezing rain, sleet, ice storms, and blowing and drifting snow conditions. Extremely cold temperatures accompanied by strong winds can result in wind chills that cause bodily injury, such as frostbite and death. A variety of weather phenomena and conditions can occur during winter storms. For clarification, the following are National Weather Service-approved descriptions of winter storm elements:

- **Heavy snowfall** - the accumulation of six or more inches of snow in a 12-hour period or eight or more inches in a 24-hour period.
- **Blizzard** - the occurrence of sustained windspeeds over 35 mph accompanied by heavy snowfall or large amounts of blowing or drifting snow for more than three hours.
- **Freezing drizzle/freezing rain** - precipitation that falls as liquid, but freezes on contact with roads, trees, power lines and other surface structures that are below 32 degrees F, forming a dangerous glaze of ice.
- **Ice storm** - a type of winter storm characterized by freezing rain which results in a dangerous coating of ice on trees, power lines, and road surfaces.
- **Sleet** - solid grains or pellets of ice formed by the freezing of raindrops or the refreezing of largely melted snowflakes. Sleet does not cling to surfaces.
- **Wind chill** – a calculated temperature index that describes the combined effect of wind and low air temperatures on exposed skin.

Maryland's worst winter storms are nor'easters, which usually occur when an arctic air mass is in place. While high pressure builds over New England, cold arctic air flows south from the high-pressure area. The dense cold air is unable to move west over the Appalachian Mountains, so it funnels south down valleys and along the Coastal Plain. Winds around a nor'easter's center can become intense. The strong northeast winds that rack the coast and inland areas give the storm its name. The wind builds large waves that batter the coastline and sometimes pile water inland, causing major coastal flooding and severe beach erosion. Unlike hurricanes, which usually pass within one tide cycle, a nor'easter can linger through several tides, each one piling more and more water on shore and into the bays, dragging more sand away from the beaches.

Location

Winter weather affects the entirety of Frederick County. While the probability of a winter storm occurring is roughly the same in all parts of the region, the risk of damage will vary depending on infrastructure and population density. There is a high probability for traffic accidents and traffic jams during heavy snow and light icing events. Roads may become impassable, inhibiting the ability of emergency equipment to reach trouble spots and the accessibility of medical and shelter facilities.

Extent

The severity of a winter storm is often relative to the conditions that the area of focus is accustomed to. There are some standardized tools that can be used to provide estimates on expected storm impacts, such as the National Weather Service's Winter Storm Severity Index. The Winter Storm Severity Index shows extent by communicating how disruptive a storm will be to a community based on the significance of impacts. The relative conditions of the area are considered, such as population, location, and storm characteristics. It uses the impact levels shown in Table X.

Table 5.41. Potential Winter Storm Impacts (NOAA Winter Storm Severity Index)

Impact Level	Potential Impacts
No Impacts	Impacts not expected.
Limited Impacts	Rarely a direct threat to life and property. Typically results in little inconveniences.
Minor Impacts	Rarely a direct threat to life and property. Typically results in an inconvenience to daily life.
Moderate Impacts	Often threatening to life and property, some damage unavoidable. Typically results in disruptions to daily life.
Major Impacts	Extensive property damage likely, lifesaving actions needed. Will likely result in major disruptions to daily life.
Extreme Impacts	Extensive and widespread severe property damage, lifesaving actions will be needed. Results in extreme disruptions to daily life.

Previous Occurrences

There have been seven federal disaster declarations since 1993 related to severe snowfall and winter storms in Frederick County (Table 5.45). There was a total of 265 winter related events in Frederick County between 1996 and 2021. According to the NCEI, there were 65 major winter storms, 1 major blizzard, 7 heavy snow events, and 7 ice storms. The remaining 184 events were classified as general winter weather events. These events have resulted in $406,988 of property damages and $208,282 in crop damages.

Table 5.42. Presidentially Declared Disasters for Frederick County Since 1993[99]

Disaster Number	Incident Type	Incident Date	Programs Declared			
			IH	IA	PA	HM
EM-3100	Severe Snowfall & Winter Storm	3/13/1993			✓	✓
DR-1016	Severe Winter Weather & Ice Storm	2/8/1994			✓	✓

[99] FEMA Declared Disasters (as of August 2021).

Disaster Number	Incident Type	Incident Date	Programs Declared			
			IH	IA	PA	HM
DR-1081	Severe Snowstorm (Blizzard of ’96)	1/6/1996			✓	✓
DR-1324	Severe Winter Storm	1/25/2000			✓	✓
EM-3179	Severe Snowstorm	2/14/2003			✓	✓
DR-1910	Severe winter storms and snowstorms	2/5/2010			✓	✓
DR-4261	Severe winter storms and snowstorms	1/22/2016			✓	✓
IH=Individual Housing IA=Individual Assistance			PA=Public Assistance HM=Hazard Mitigation			

Four federally declared disasters have data related to Public Assistance grants. Table 5.46 lists some of the statistics for each disaster. There was a total of 96 projects for these 4 declarations. These projects had six different project types between them: debris removal, protective measures, roads and bridges, public buildings, public utilities, and recreational or other.

Table 5.43. Declared Disaster Public Assistance Statistics for Frederick County

Disaster Number	Incident Type	Incident Date	Number of Projects	Total Project Amount	Total Federal Amount
DR-1324	Severe Winter Storm	1/25/2000	14	$449,779	$337,334
DR-1910	Severe winter storms and snowstorms	2/5/2010	38	$1,373,538	$1,030,153
EM-3179	Severe Snowstorm	2/14/2003	16	$517,226	$387,919
DR-4261	Severe winter storms and snowstorms	1/22/2016	28	$2,217,175	$1,662,723
		Totals:	**96**	**$4,557,717**	**$3,418,130**

Frederick County typically experiences 10 to 11 severe winter events each year, this is up from 6 to 7 events as reported in the 2016 Hazard Mitigation Plan. Two such events since 2015 are described below. Events before 2015 are included in Appendix C.

- On January 22 to 23, 2016, coastal low pressure in the Mid-Atlantic paired with high pressure from the North resulted in blizzard conditions throughout the County. Heavy snowfall was reported in several communities: New Market reported 35in., Myersville reported 32in., and Thurmont reported 26in. On March 4, 2016, the event received a Federal Disaster Declaration (referenced in Table 2.2)
- Higher than average amounts of ice were reported between December 16 to 17, 2019, particularly over the Catoctin Mountains. Sabillasville and Thurmont received 0.45-0.50in. of coverage; Other areas only received up to 0.1in. of coverage.

The NCEI database has recorded a total of 265 events that involve, blizzard, cold, frost/freeze, heavy snow, ice storms, winter storms, and winter weather in Frederick County. Adjusted for inflation, the number of deaths, injuries, and damages are summarized in Table 5.47.

Table 5.44. NCEI Historical Severe Winter Storm Events in Frederick County since 1996

Hazard Events	# of Events	Deaths	Injuries	Property Damage (2021$)	Crop Damage (2021$)	Total Damage (2021$)
Blizzard	1	0	0	$33,614	$0	$33,614
Cold/Wind Chill	9	0	0	$0	$0	$0
Extreme Cold/Wind Chill	6	0	0	$0	$0	$0
Frost/Freeze	46	0	0	$0	$184,015	$184,015
Heavy Snow	7	0	0	$0	$0	$0
Ice Storm	7	0	0	$74,023	$24,267	$98,290
Winter Storm	65	1	0	$299,351	$0	$299,351
Winter Weather	124	0	0	$0	$0	$0
Grand Total	**265**	**1**	**0**	**$406,988**	**$208,282**	**$615,270**

Probability and Severity of Future Occurrences

Based on the NCEI database, Frederick County has a high probability of experiencing severe winter storm events. NCEI-recorded winter weather events happen about five times a year, winter storms about two to three every year, an ice storm and a heavy snow event every three years, and some sort of cold/wind chill every one to two years. This information is summarized in Table 5.48.

Table 5.45. NCEI Probability of Severe Winter Storm Events in Frederick County

Hazard Events	# of Events	Annualized Events
Blizzard	1	0.04
Cold/Wind Chill	9	0.36
Extreme Cold/Wind Chill	6	0.24
Frost/Freeze	46	1.84
Heavy Snow	7	0.28
Ice Storm	7	0.28
Winter Storm	65	2.6

Hazard Events	# of Events	Annualized Events
Winter Weather	124	4.96
Frederick County Total	**265**	**10.6**

Loss Estimation

Based on historic damages from Frederick County Division of Public Works of $12,098,626, Frederick County may experience on average $526,027 in winter weather-related costs (road clearing and damages) annually.

As recorded by NCEI, there have been 265 severe winter weather events in the County since 1996, resulting in an expected annual number of events of 10.6. Based on the NCEI data, Frederick County can expect an average of around $25,000 in winter related damages every year. NCEI annualized loss is shown in Table 5.49.

Table 5.46. NCEI Annualized Loss from Severe Winter Storm Events in Frederick County

Hazard Events	# of Events	Annualized Events	Total Damage (2021$)	Annualized Damage (2021$)
Blizzard	1	0.04	$33,614	$1,345
Cold/Wind Chill	9	0.36	$0	$0
Extreme Cold/Wind Chill	6	0.24	$0	$0
Frost/Freeze	46	1.84	$184,015	$7,361
Heavy Snow	7	0.28	$0	$0
Ice Storm	7	0.28	$98,290	$3,932
Winter Storm	65	2.6	$299,351	$11,974
Winter Weather	124	4.96	$0	$0
Frederick County Total	**265**	**10.6**	**$615,270**	**$24,611**

Impact Summary

Primary Impacts

The primary impact of excessive cold is increased risk for frostbite, and potentially death as a result of over-exposure to extreme cold. If power outages occur and there is a lack of readily available heat sources, these impacts can become more widespread. People without homes and those that are outside during these freezing conditions are likely to see the brunt of these impacts without proper shelter beforehand. Transportation delays and disruptions to power distribution networks can make getting aid to those affected more difficult, which can further place lives at risk. The impacts of winter storms are usually minimal in terms of property damage and long-term effects.

Secondary Impacts

Winter weather has the capacity to immobilize a region, cut communities off from emergency management personnel, and make travel impossible. When winter weather is paired with freezing rain and ice storms, utilities including water, gas, and electric can be compromised. These issues put vulnerable communities and populations, such as the elderly at an increased risk.

Adverse winter weather necessitates an increase in municipal and state workforces to clear roads and additional emergency management personnel to attend to the community. Clearing of roadways and sidewalks is usually easier with a drier, more powdery snow which is also less likely to accumulate on power lines and trees. This type of snow generally occurs in temperatures below freezing, as water content decreases with temperature.

Severe winter storms have the potential to inhibit normal community services. Government costs for these events include overtime personnel wages and equipment, or contractors for road clearing. Private-sector losses are attributed to time lost when employees and customers are unable to travel. Homes and businesses suffer damage when electric service is interrupted for long periods of time. Secondary effects of extreme/excessive cold include frozen water pipes in homes and businesses.

Health threats can become severe when frozen precipitation makes roadways and walkways very slippery, when prolonged power outages occur, and when fuel supplies are jeopardized. Occasionally, buildings may be damaged when snow loads exceed the design capacity of their roofs or when trees fall due to excessive ice accumulation on branches. The water content of snow can vary significantly from one storm to another and can drastically impact the degree to which damage might occur. In snow events that occur at temperatures at or even above freezing, the water content of the snowfall is generally higher. Higher water content translates into a heavier, “wet” snowfall that more readily adheres to power lines and trees, increasing the risk of their failure. Roof collapse is also more of a concern with wetter, heavier snowfall.

Risk Assessment

Assets Exposed

Winter weather affects the entirety of Frederick County. To a large extent, the areas with the greatest risk of experiencing damage due to winter storms are those with the greatest amount of development and the most extensive networks of roads (which increases the burden of snow removal). Conversely, the travelers who must go through less-developed areas face a potentially greater risk due to the lower density of roads, which provides fewer alternate routes as well as potentially relatively steep topography. Table 5.50 shows the overall exposure, but in reality, only certain parts of structures are likely to be at any real risk, such as utility infrastructure.

Table 5.47. Winter Weather Exposure Analysis for Frederick County

Jurisdiction	Number of Parcels	Value of At-Risk Parcels	Number of Critical Facilities
City of Brunswick	3,159	$596,543,300	5
City of Frederick	24,510	$7,547,665,100	30
Town of Burkittsville	76	$11,657,200	0
Town of Emmitsburg	1,014	$175,612,800	4
Town of Middletown	1,737	$510,711,800	3

Jurisdiction	Number of Parcels	Value of At-Risk Parcels	Number of Critical Facilities
Town of Mount Airy	1,308	$336,452,100	2
Town of Myersville	621	$148,296,600	2
Town of New Market	582	$163,661,700	2
Town of Thurmont	2,559	$465,555,110	6
Town of Walkersville	2,202	$578,212,000	5
Town of Woodsboro	468	$94,704,300	2
Village of Rosemont	134	$18,603,000	0
Unincorporated Areas	61,736	$15,667,766,010	39
Frederick County (All)	**100,106**	**$26,315,441,020**	**100**

Population Exposed

All of Frederick County is vulnerable to winter storms. The number of people affected by winter storms and to what degree will depend on the type of storm that occurs, as well as its severity and tenure. Residents that live in remote areas with limited road or transportation access may be temporarily isolated if roads become impassable due to snow or ice accumulation or extended power outages occur. Socially vulnerable populations face higher risk, such as the elderly, disabled, and unhoused populations.

Vulnerability Summary

Vulnerability to the effects of winter storms on buildings depends on the age of the building (and the building codes in effect at the time of construction), type of construction, and condition of the structure (i.e., how well it has been maintained, materials used, etc.).

The entire county can be impacted by snow, ice and, extreme cold, although there is generally greater snow accumulation in the north and west due to higher elevations, and more blowing and drifting in the east and south (Figure 5.23). Severe winter storms result in the loss of utilities, increases in traffic accidents, impassable roads, and lost income since normal commuting can be hindered. Snow and ice can be extremely hazardous because visibility is reduced, and surface accumulation reduces traction and strains power lines, roofs, and other structures. Severe winter storms have been and will continue to be a significant threat to the economic and social well-being of Frederick County. Disruptions of emergency and other essential services and critical facilities are the main threats to people and property.

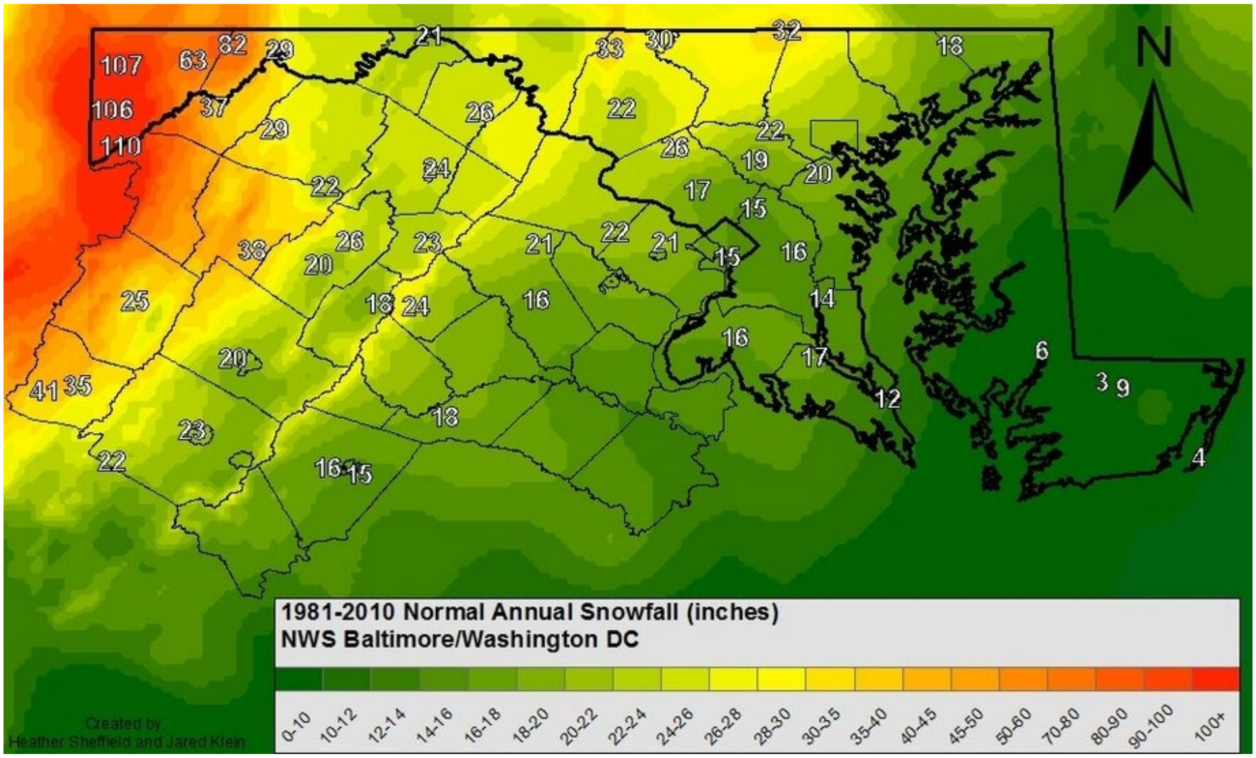


Figure 5.23. Average Annual Snowfall in Maryland, DC, and Northern Virginia [100]

Severe storm activity poses a significant threat to unprotected or exposed lifeline systems. Generally, commercial power networks are very susceptible to interruption from snow and ice conditions. Other utilities, including underground pipelines, may be impacted if not protected from exposure. All critical facilities in the County are vulnerable to the effects of severe winter storms due to the potential disruption of services and transportation systems as well as possible structure failure due to heavy snow loads.

Approximately 13.2% of the occupied housing units in Frederick County were built prior to 1940, according to the 2020 U.S. Census. A large percentage of structures in the Cities of Frederick and Brunswick and the Towns of Rosemont and Emmitsburg were built prior to 1940. These may be in well-preserved, older neighborhoods; however, some of the older structures may not be in a condition to weather these storms due to factors such as poor building quality or antiquated plumbing, and would require adequate measures to ensure that they are brought up to code to mitigate damages from severe storms.

Reducing Vulnerability

Some mitigation measures to reduce vulnerability include:

- Stocking adequate quantities of road treatment materials and pre-treating roads expedites and improves road clearing.
- Public education concerning safe driving and driving only if it is required, and also stocking up on food, water, batteries, and other supplies will prepare people for storms.

[100] NWS Baltimore/Washington

Thunderstorm

For the purposes of this hazard mitigation plan update, Thunderstorm includes non-hurricanic and non-tornadic wind, lightning, and hail. Wind associated with hurricanes, wind associated with tornados, flooding, and winter storm are evaluated in their own sections.

Hazard Identification

Hazard Description

A thunderstorm is a convective rain or snow shower accompanied by lightning and thunder.[101] The National Weather Service (NWS) defines a thunderstorm as a localized storm produced by a cumulonimbus cloud and accompanied by lightning and thunder. Thunderstorms are typically the result of warm, moist air that is pushed upwards into the atmosphere where it cools and forms into cumulonimbus clouds. As the air continues to cool, it starts to form water droplets or ice. As these droplets or ice start to fall, they may collide and combine many times into larger forms before reaching the Earth's surface. Instability can be caused by surface heating or upper tropospheric (approximately 50,000 feet) divergence of air (rising air parcels can also result from airflows over mountainous areas).

Generally, surface-heating "air mass" thunderstorms form on warm season afternoons and are not severe. Upper tropospheric "dynamically-driven" thunderstorms generally form in association with a cold front or other regional-scale atmospheric disturbance. These severe storms are associated with the presence of strong winds, thunder, and lightning. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. An estimated 100,000 thunderstorms occur each year in the United States, with approximately 10% of them classified as severe. During the warm season, thunderstorms are responsible for most of the rainfall.[102] It is also possible to experience a thunderstorm with no precipitation which can cause wildfires to occur.

Thunderstorms can form in any geographic region and are sometimes the cause of other natural phenomena such as downburst winds, heavy rain, flash floods, large hailstones, lightning, tornadoes, and waterspouts. While many thunderstorms produce relatively little damage, stronger "supercell" thunderstorms can produce heavy winds, hail, significant damaging lightning strikes, and even tornadoes. Such storms have historically caused significant damage, injury, and even death through the destruction of trees; damage to buildings, vehicles, and power lines; and direct lightning strikes.

Straight-Line Winds

Extreme wind events occur when there is a large difference in atmospheric pressure over a short distance, called a pressure gradient. High winds may occur during severe thunderstorms, in mountainous regions (wind flow down mountains), and in strong weather systems. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. The larger the pressure gradient over a certain area, the stronger the winds will generally be. Strong cold fronts and low-pressure systems separating two distinctly different air masses lead to strong winds. Typically, non-thunderstorm strong wind events occur most often in autumn, winter, and spring when the temperature difference between air masses is the greatest. Table 5.51 provides the descriptions of winds used by the NWS.

[101] Nese, Jon M. and Grenci, Lee M. Kendall/Hunt.*A World of Weather, Third Edition.* Penn State Meteorology.

[102] NOAA National Severe Storms Laboratory. (n.d) "Severe Weather 101: Thunderstorm Basics." Retrieved from https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

Table 5.48. NWS Wind Descriptions

Descriptive Term	Sustained Wind Speed (miles per hour)
Strong, dangerous, or damaging	≥40
Very Windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
None	5-15 or 10-20
Light or light and variable wind	0-5

Two basic types of damaging wind events other than tropical systems affect Maryland: synoptic-scale winds and thunderstorm winds. Synoptic-scale winds are high winds that occur typically with cold frontal passages or Nor'easters.

When thunderstorm winds exceed 58 mph, the thunderstorm is considered severe and a warning is issued. A severe thunderstorm includes damaging winds greater than 58 mph (50 knots) or greater and hail one inch or larger in diameter. Severe winds have been further broken down into three categories by the NWS Storm Events database:

- **High Wind**: Sustained non-convective winds of 35 knots (40 mph) or greater lasting for one hour or longer or winds (sustained or gusts) of 50 knots (58 mph) for any duration (or otherwise locally/regionally defined), on a widespread or localized basis. In some mountainous areas, the above numerical values are 43 knots (50 mph) and 65 knots (75 mph), respectively.
- **Strong Wind**: Non-convective winds gusting less than 50 knots (58 mph), or sustained winds less than 35 knots (40 mph) resulting in a fatality, injury, or damage.
- **Thunderstorm Wind**: Winds, arising from convection (occurring within 30 minutes of lightning being observed or detected), with speeds of at least 50 knots (58 mph), or winds of any speed (non-severe thunderstorm winds below 50 knots) producing a fatality, injury, or damage. Events with maximum sustained winds or wind gusts less than 50 knots (58 mph) should be entered as a Storm Data event only if they result in fatalities, injuries, or serious property damage.

Using the NWS severe wind categories listed above, sustained non-convective winds of 40 mph or greater lasting for one hour or longer or winds (sustained or gusts) of 58 mph for any duration, on a widespread or localized basis are considered a minimum severity event. A major severe event would be wind events of greater than 58 mph or a wind event resulting in death, injury or significant damage.

Downburst Winds

"Downbursts" cause the high winds in a thunderstorm. A downburst is a severe localized wind blasting down from a thunderstorm. Downburst activity is sometimes mistaken for tornado activity. Both storms have very damaging winds (downburst wind speeds can exceed 165 mph) and are very loud. These winds are distinguishable from tornadic activity by the pattern of destruction and debris, as tornadic winds are characterized by rotation. They are more common than tornadoes in Maryland. Downburst winds result from the sudden descent of cool or cold air toward the ground. As the air hits the ground, it spreads outward, creating high winds. Unlike tornadoes, downburst winds move in a straight line, without rotation. Depending on the size and location of downburst events, the destruction to property may be significant. Downbursts fall into two categories:

- **Microbursts** affect an area less than 2.5 miles in diameter, last 5 to 15 minutes, and can cause damaging winds up to 168 mph.
- **Macrobursts** affect an area at least 2.5 miles in diameter, last 5 to 30 minutes, and can cause damaging winds up to 134 mph.

Another widespread thunderstorm wind event is known as a derecho. Derechos are associated with lines (squall lines) of fast-moving thunderstorms that might vary in length and have the potential to travel hundreds of miles. They are made up of many microburst and macroburst wind events. Winds in these types of events can rival those of “weaker” tornadoes with gusts of 80 to 100 mph covering a wide area.

Lightning

Lightning is defined by the NWS as a visible electrical discharge (i.e. lightning bolt) produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground or between the ground and a cloud. According to the National Oceanic and Atmospheric Administration, the creation of lightning during a storm is a complicated process that is not fully understood. In the initial stages of development, air acts as an insulator between the positive and negative charges. However, when the potential between the positive and negative charges becomes too great, a discharge of electricity (lightning) occurs. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes, but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder.

In-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom. Cloud-to-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom of a second cloud. Cloud-to-ground lightning is the most dangerous. In summertime, most cloud-to-ground lightning occurs between the negative charges near the bottom of the cloud and positive charges on the ground.

To the public, lightning is often perceived as a minor hazard; however, lightning-caused damage, injuries, and deaths make lightning a significant hazard associated with any thunderstorm in any area of Maryland. Damage from lightning occurs in four ways: (1) electrocution/severe shock to humans and animals; (2) vaporization of materials along the path of the lightning strike; (3) fire caused by high temperatures associated with lightning (10,000-60,000°F); and (4) sudden power surge that can damage electrical/electronic equipment. Large outdoor gatherings (e.g., sporting events, concerts, campgrounds) are particularly vulnerable to lightning strikes that can result in injuries and deaths. In the United States, an average of 300 people are injured and 80 people are killed by lightning each year.

Hail

Hailstorms are violent and spectacular phenomena of atmospheric convection, always associated with heavy rain, gusty winds, thunderstorms, and lightning. Hail is a product of strong convection and occurs only in connection with a thunderstorm where the high velocity updrafts carry large raindrops into the upper atmosphere (where the temperature is well below the freezing point of water).

Hail is precipitation in the form of ice pellets larger than five mm that forms in thunderstorms between currents of rising air (updrafts) and currents of descending air (downdrafts) as shown in Figure 5.24. Hailstones grow in size when the frozen droplet is repeatedly blown into the higher elevations. The hailstone ascends as long as the updraft velocity is high enough to hold the hailstone. As soon as the size and weight of the hailstone overcome the lifting capacity of updraft, it begins to fall freely under the influence of gravity. Falling hailstones, under thunderstorm conditions, are accompanied by a cold downdraft of air.

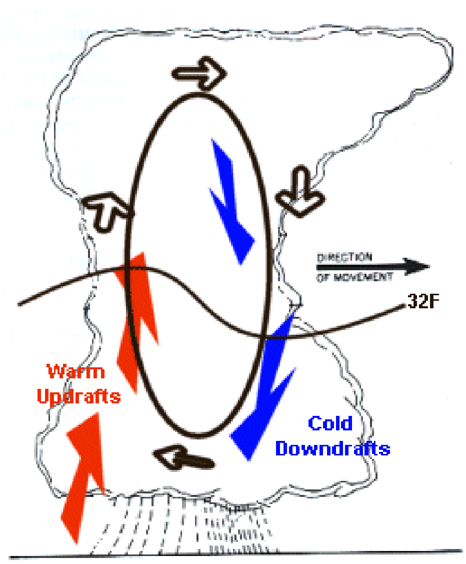


Figure 5.24. Formation of Hail[103]

Most hailstones are smaller in diameter than a dime, but stones weighing more than 1.5 pounds have been recorded. The National Oceanic and Atmospheric Administration has estimates of the velocity of falling hail ranging from 9 meters per second (m/s) (20 mph) for a 1-centimeter (cm) diameter hailstone to 48 m/s (107 mph) for an 8 cm, 0.7-kilogram stone. These events typically occur in late spring and early summer. One criterion for severe thunderstorms, as defined by the NWS, is hail that is one inch in diameter (quarter-size) or larger.

Most damaging hailstones range from the size of a golf ball ("severe") to the size of a softball or larger ("oversized"). According to the National Weather Service, most parts of the United States experience "severe" and "oversized" hailstorms. The largest recorded hailstone in the United States fell in Coffeyville, Kansas, on September 3, 1970, and measured more than 7.0 inches in diameter and weighed 1.7 pounds, generating an impact force of 578 pounds per foot. Hailstorms occur year-round at all times of day, but are more frequent in the summer months, in the evenings, and after sunset.

Location

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. All areas of Frederick County are susceptible to thunderstorms and severe weather events. Fortunately, in Maryland, injury and death due to these events is relatively uncommon. Since 1996, only 4 deaths and 15 injuries were reported to NCEI. Although thunderstorm damage is expected each year, most events do not cause significantly reported or measured damage.

Most thunderstorm damage is associated with downbursts, which typically have a greater effect on elevated areas such as hilltops, ridges, and "wind corridors" within communities. Areas with more trees in proximity to power lines and structures are more vulnerable to the effects of thunderstorm damage than more urban areas.

Hailstorms occur more frequently in the late spring and early summer and are more common in the Midwest. The land area affected by individual hailstorms is not much smaller than that of a parent thunderstorm, an average of 15 miles in diameter around the center of a storm.

[103] NOAA

Extent

The strength of a thunderstorm is typically measured in terms of its effects, namely the speed of the wind, the presence of significant lightning, and the size of hail. In general, thunderstorm winds are less than tropical cyclone speeds, but strong winds associated with downbursts can be extremely hazardous and reach speeds up to 168 mph.

NWS Storm Prediction Center issues Day 1, Day 2, and Day 3 Convective Outlooks that depict non-severe thunderstorm areas and severe thunderstorm threats across the contiguous United States. The categorical forecast specifies the level of the overall severe weather threat via numbers (e.g., 5), descriptive labeling (e.g., HIGH), and colors (e.g., magenta). The probabilistic forecast directly expresses the best estimate of a severe weather event occurring within 25 miles of a given point. The text narrative begins with a listing of severe thunderstorm risk areas by state and/or geographic region. This is followed by a concise, plain-language summary of the type(s) of threat along with timing that is focused on the highest-risk areas. The NWS uses the following categories to classify risk from thunderstorms:

- **TSTM** (light green) - **General or non-severe thunderstorms** - Delineates, to the right of a line, where a 10% or greater probability of thunderstorms is forecast during the valid period.
- **1-MRGL** (dark green) - **Marginal risk** - An area of severe storms of either limited organization and longevity or very low coverage and marginal intensity.
- **2-SLGT** (yellow) - **Slight risk** - An area of organized severe storms, not widespread in coverage with varying levels of intensity.
- **3-ENH** (orange) - **Enhanced risk** - An area of greater (relative to Slight risk) severe storm coverage with varying levels of intensity.
- **4-MDT** (red) - **Moderate risk** - An area where widespread severe weather with several tornadoes and/or numerous severe thunderstorms is likely, some of which should be intense. This risk is usually reserved for days with several supercells producing intense tornadoes and/or very large hail, or an intense squall line with widespread damaging winds.
- **5-HIGH** (magenta) - **High risk** - An area where a severe weather outbreak is expected from either numerous intense and long-tracked tornadoes or a long-lived derecho-producing thunderstorm complex that produces hurricane-force wind gusts and widespread damage. This risk is reserved for when high confidence exists in widespread coverage of severe weather with embedded instances of extreme severe weather (i.e., violent tornadoes or very damaging convective wind events).

Wind

The NWS issues the following wind alerts:

- **Wind Advisory**—when sustained non-thunderstorm winds range from 25 mph to 39 mph and/or gusts to 57 mph.
- **High Wind Watch**—when there is the potential for non-thunderstorm high wind speeds to develop and pose a hazard, or otherwise be life-threatening.
- **High Wind Warning**—when non-thunderstorm high wind speeds are occurring and may pose a hazard or are life-threatening. For a High Wind Warning to be issued, non-thunderstorm winds either must be sustained at 40 mph or greater for one hour or longer, or 58 mph or greater than 58 mph for any duration.

Lightning

While there is no established index for lightning, a lightning strike is of minimum severity when it has limited impacts on the natural and built environment (ex. tree limbs and buildings) and major severity when it causes extensive damage (ex. loss of life, fire, structural damage). The potential damages resulting from lightning strikes are primarily injury, loss of life, power outages, business interruption, fire and minor structural damage. A false sense of security often leads people to believe that they are safe from a lightning strike because it may not appear to be near their location. However, lightning can strike 10 miles away from a rain column, which puts people who are still in clear weather at risk.

Hail

The severity of hail is measured by duration, hail size, and geographic extent. All of these factors are directly related to thunderstorms, which creates hail. There is wide potential variation in these severity components. Using the NWS definition for a severe thunderstorm, dime-sized hail is considered a minimum hazard and quarter-sized hail is considered a major hazard. Quarter-sized hail can cause significant damage to agricultural crops and livestock, as well as property such as automobiles, aircraft, and roofs. Although rare, large hailstones may even cause injury or death. The amount of cover obtained during a hailstorm can greatly reduce the risk to human health during these events. The size of hailstones is a direct function of the severity and size of the storm.

Previous Occurrences

The National Oceanic and Atmospheric Administration's National Center for Environmental Information (NCEI) database is the most comprehensive source of historic data, based on reported past events that have caused damages. According to records in the database, since 1950, there have been almost $6.8 Million worth of reported property and crop damage to Frederick County, relating to severe weather events. It is quite likely that there have been more events containing damages that are not captured in the database, as NCEI consists of reported information. The database is often also biased to the more populated communities, where there are more people making reports and a higher likelihood of damages.

Table 5.52 lists the number of severe weather events by Frederick County jurisdiction, along with injuries, deaths, and damages. There have been 652 reports of severe weather since 1955, according to NCEI data. Damages recorded for these events include $6.5 million dollars of property damages and $282,964 in crop damages; not all damages are captured by the NCEI, so this is likely a lower dollar figure than actual damages. Other than the unincorporated areas of Frederick County, the City of Frederick has had the most severe weather events, and the Town of Mount Airy the least.

Table 5.49. NCEI Total Severe Weather Events, 1955 - March 2021

Jurisdiction	Events	Injuries	Deaths	Total Damages (2021$)
City of Brunswick	22	0	0	$313,552
City of Frederick	62	2	3	$1,516,025
Town of Burkittsville	7	0	0	$138,365
Town of Emmitsburg	10	3	0	$19,305
Town of Middletown	16	1	0	$99,233
Town of Mount Airy	1	0	0	$84,034
Town of Myersville	16	0	0	$19,667
Town of New Market	16	0	0	$62,165
Town of Thurmont	17	0	0	$109,985

Jurisdiction	Events	Injuries	Deaths	Total Damages (2021$)
Town of Walkersville	15	2	0	$70,270
Town of Woodsboro	8	0	0	$40,547
Village of Rosemont	3	0	0	$131,914
Unincorporated Areas	459	7	1	$4,226,066
Frederick County (All Jurisdictions)	**652**	**15**	**4**	**$6,831,131**

Table 5.53 lists the severe weather events by event type. Thunderstorm is the most numerously reported hazard, with 495 reported cases over the 71 years the NCEI has been keeping records for such events.

Table 5.50. NCEI Severe Weather Events, 1955-March 2021

Hazard	Events	Property Damages (2021$)	Crop Damages (2021$)	Total Damages (2021$)
Extreme Wind	57	$2,174,353	$145,543	$2,319,896
Hailstorm	78	$6,124	$21,438	$27,562
Lightning	22	$1,788,766	$0	$1,788,766
Thunderstorm	495	$2,578,924	$115,983	$2,694,907
Total	**652**	**$6,548,167**	**$282,964**	**$6,831,131**

There have been 6 federal disaster declarations related to severe storms in Frederick County. Some notable occurrences (e.g., damages greater than $10,000) of severe weather events are described below:

- In **April 2016**, severe wind gusts up to 62 mph were recorded in Frederick County. Downed trees were reported across the State.
- In **March 2017**, a series of storms brought damaging winds with some of the strongest winds in southeast Frederick County. NWS radars showed particularly intense areas of wind and rain in the County.
- On **May 14, 2018**, a home in Frederick caught fire after being struck by lightning during a passing thunderstorm. One man was taken to the hospital with critical injuries. Investigators estimated that the incident resulted in nearly $100,000 in damages.
- On **May 15, 2018**, tennis ball sized hailstones were reported in the City of Frederick. A passing cold front, paired with warm and humid conditions, resulted in severe storms and 2.50 in. stones. This event had the largest recorded stones in the region's history.
- In **February 2019**, damaging winds tore through DC, Maryland and Virginia for more than 24 hours straight. Frederick County experienced some of the highest and most severe wind speeds in the State with gusts up to 61 mph.
- On **August 28, 2019**, lightning stuck the chimney of a single-family home in Frederick County. There were no reports of interior damage nor injuries.
- In **2020**, 18 thunderstorm occurrences were noted in the NCEI database. Damages as a result of these storms are recorded at $56,041.

- In **2021**, 2 thunderstorms were recorded in Frederick County with property damages recorded at $23,000.
- In **April-May 2021**, NWS High Wind Warnings were issued in several counties in MD and VA. Downed trees, damage to outdoor furniture and power outages were reported in areas with high wind surges over 50 mph. Frederick County had reports of winds up to 56 mph. The Maryland Department of Highways recorded several fallen trees, the MD 911 Call Center reported downed wires on April 30.

Probability and Severity of Future Occurrences

Thunderstorms are a common occurrence in Maryland and occur on approximately 27 to 36 days each year. Figure 5.25 shows the annual mean thunderstorm days across the Contiguous United States. Lightning strikes are relatively infrequent in Maryland but can occur on any day, even if a thunderstorm is not happening.

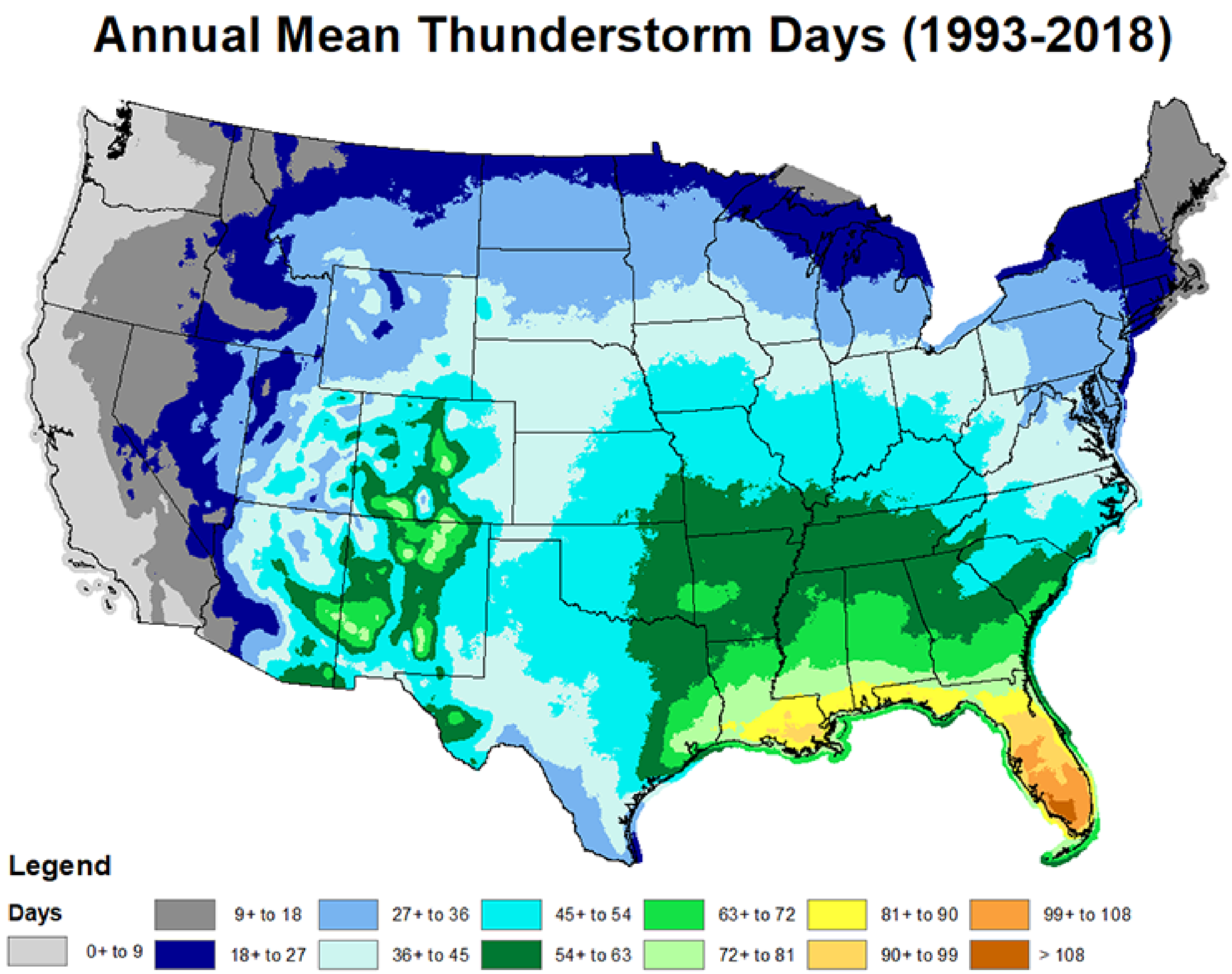


Figure 5.25. Annual Mean Thunderstorm Days (1993-2019) [104]

Windstorms, as mentioned previously, may occur as part of thunderstorms or independently. The predicted wind speed given in wind warnings issued by the NWS is for a one-minute average; gusts may be 25 to 30% higher. Hail does not occur with every thunderstorm. Although, it causes nearly $2 billion in crop and property damages, on average, each year in the United States. Figure 5.26 indicates that Maryland experiences an average of four to six severe hail days per year.

[104] NWS, Koehler, Thomas L., 2019

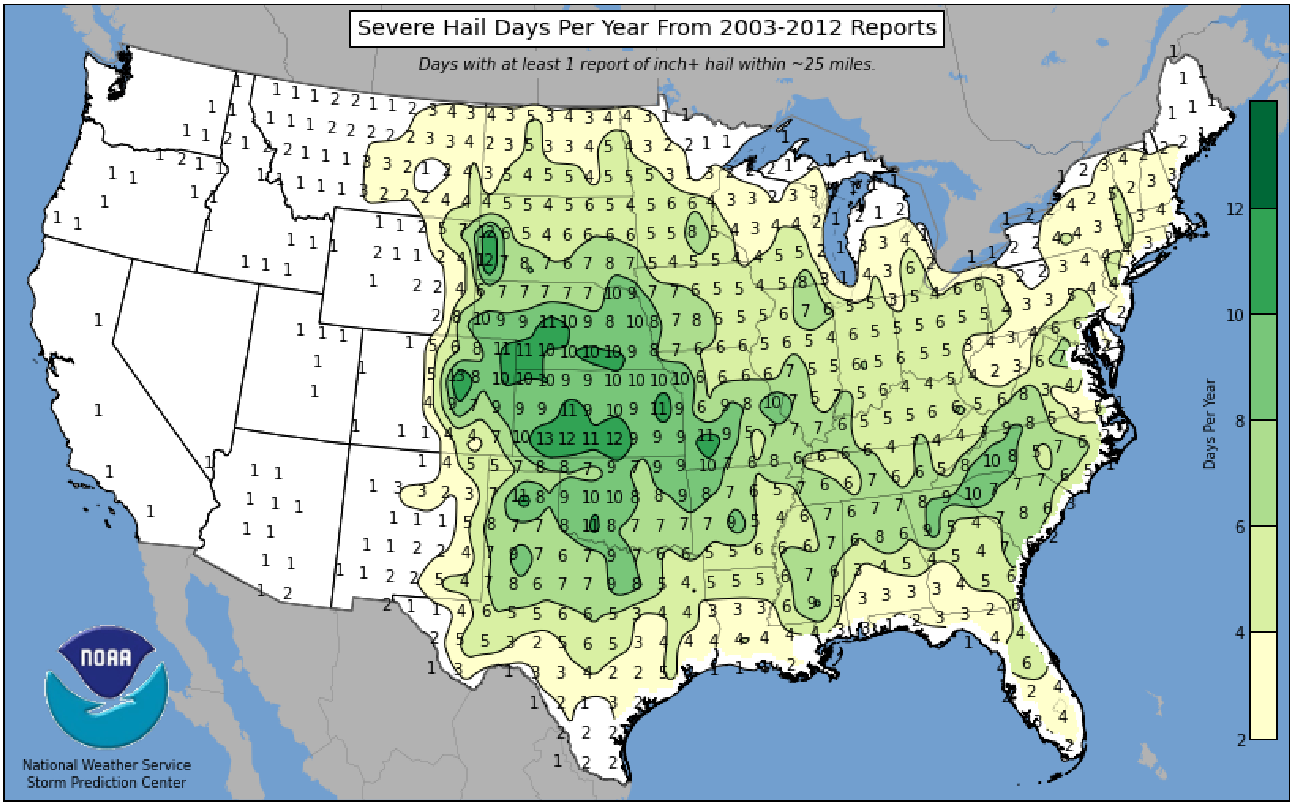


Figure 5.26. Annual Frequency of Hailstorms in the United States[105]

Estimates of future occurrence and severity have been determined based on data taken from the NCEI, shown in Table 5.54. Because of how the hazard events were recorded, hail events were annualized separately, then added to the total, as hail has been recorded by the National Oceanic and Atmospheric Administration since 1955 and the other events since 1996.

Table 5.51. Loss Estimates Due to Thunderstorms/Severe Weather

Jurisdiction	Events	Annual Events	Total Damages (2021$)	Annualized Damages (2021$)
City of Brunswick	22	0.78	$313,552	$11,125
City of Frederick	62	2.01	$1,516,025	$49,097
Town of Burkittsville	7	0.21	$138,365	$4,061
Town of Emmitsburg	10	0.40	$19,305	$772
Town of Middletown	16	0.64	$99,233	$3,969
Town of Mount Airy	1	0.04	$84,034	$3,361
Town of Myersville	16	0.52	$19,667	$634
Town of New Market	16	0.62	$62,165	$2,390
Town of Thurmont	17	0.63	$109,985	$4,078

[105] NOAA

Jurisdiction	Events	Annual Events	Total Damages (2021$)	Annualized Damages (2021$)
Town of Walkersville	15	0.53	$70,270	$2,462
Town of Woodsboro	8	0.30	$40,547	$1,496
Village of Rosemont	3	0.12	$131,914	$5,277
Unincorporated Areas	459	17.37	$4,226,066	$159,891
Frederick County (All Jurisdictions)	**652**	**24.14**	**$6,831,131**	**$252,939**

The formation of thunderstorms is linked to climate factors, but currently, the understanding of how climate change will affect the future frequency and severity of thunderstorms is still development. Some studies show that climate change may lead to more intense and frequency severe thunderstorms, but to what extent this will affect Frederick County is unclear.[106]

Thunderstorms and other heavy rainfall events are estimated to cause more than $20 billion of economic losses annually in the United States.[107] Particularly damaging, and often deadly, are mesoscale convective systems (MCSs): clusters of thunderstorms that can extend for many dozens of miles and last for hours, producing flash floods, debris flows, landslides, high winds, and/or hail. The persistent storms over Houston in the wake of Hurricane Harvey were an example of an unusually powerful and long-lived MCS.[108]

Storms have become more intense in recent decades, and several scientific studies have shown that this trend is likely to continue as temperatures continue to warm. Modeling has found that the number of severe MCSs in North America more than tripled by the end of the (21st) century. As a result, severe MCSs increased throughout North America, particularly in the northeastern and mid-Atlantic states, as well as parts of Canada, where they are currently uncommon.[108] The study also looked at the potential effect of particularly powerful MCSs on the densely populated Eastern Seaboard.[108]

Additionally, National Aeronautics and Space Administration (NASA) scientists suggest that the United States will face more severe thunderstorms in the future, with deadly lightning, damaging hail, and the potential for tornadoes in the event of climate change. A recent study conducted by NASA predicts that smaller storm events, like thunderstorms, will also be more dangerous due to climate change.[109]

Impact Summary

Primary Impacts

Many hazardous weather events are associated with thunderstorms. The primary hazard caused by thunderstorm winds is the transport of debris, which can cause casualties and property loss or even the dislodging of mobile homes from their foundation. Immobility and damage to utilities are common impacts. Roads may become impassable due to flooding, downed trees, or a landslide. High winds may also cause damage to poles and lines carrying electric, telephone, and cable television service.

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[106] The Fourth National Climate Assessment. Volume II, Impacts, Risks, and Adaptation in the United States. U.S. Global Change Research Program, 2018.; Revised February 2020. https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf.
[107] University Corporation for Atmospheric Research, "North American Storm Clusters Could Produce 80 Percent More Rain." 2017. https://news.ucar.edu/130085/north-american-storm-clusters-could-produce-80-percent-more-rain
[108] University Corporation for Atmospheric Research, "North American Storm Clusters Could Produce 80 Percent More Rain." 2017. https://news.ucar.edu/130085/north-american-storm-clusters-could-produce-80-percent-more-rain
[109]NASA. "Severe Thunderstorms and Climate Change." https://climate.nasa.gov/news/897/severe-thunderstorms-and-climate-change/

Older structures built before 1940 are often more susceptible to wind damage. Lightning is responsible for many fires around the world each year and can injure or kill people as well as damage buildings not properly grounded. Hail up to the size of softballs damages cars, windows and structures, and kills livestock caught out in the open. The most significant impact of hail is damage to crops.

Strong (up to more than 120 mph) straight-line winds associated with thunderstorms knock down trees, power lines and mobile homes.[110] Extreme wind events pose a danger to Frederick County because they can result in localized or widespread power outages, property damage, and falling trees. Injury or death to people can result from falling objects or flying debris. Extreme wind events can also blow over tractor trailers on the highway and make driving difficult in a high-profile vehicle or lightweight vehicle. They can turn trash cans, lawn and patio furniture, and other property into projectiles resulting in further property damage. Most deaths in extreme wind events are caused by trees falling onto cars or homes. Dead trees or trees weakened by drought, disease, rotting, or pest infestations are the most susceptible to falling.

Table 5.55 provides guidance used by the NWS when estimating wind speed from damages.

Table 5.52. National Weather Service Wind Speed Damage Estimations (2021)

Wind Speed	Observations
26-38 knots (30-44 mph)	Trees in motion. Light-weight loose objects (i.e. lawn furniture) tossed or toppled.
39-49 knots (45-57 mph)	Large trees bend; twigs, small limbs break, and a few larger dead or weak branches may break. Old/weak structures (e.g. sheds, barns) may sustain minor damage. Buildings partially under construction may be damaged. A few loose shingles removed from houses. Carports may be uplifted; minor cosmetic damage to mobile homes.
50-64 knots (58-74 mph)	Large limbs break; shallow rooted trees pushed over. Semi-trucks overturned. More significant damage to old/weak structures. Shingles, awnings removed from houses; damage to chimneys and antennas; mobile homes, carports incur minor structural damage; large billboard signs may be toppled.
65-77 knots (75-89 mph)	Widespread damage to trees with trees broken/uprooted. Mobile homes may incur more significant structural damage, be pushed off foundations, or overturned. Roofs may be partially peeled off industrial/commercial/warehouse buildings. Some minor roof damage to homes. Weak structures (i.e. farm buildings, airplane hangars) may be severely damaged.
78+ knots (90+ mph)	Many large trees broken and uprooted. Mobile homes severely damaged; moderate roof damage to homes. Roofs partially peeled off homes and buildings. Moving automobiles pushed off dry roads. Barns, sheds demolished.

Secondary Impacts

The most significant secondary hazard of windstorms is utility failure resulting from downed power lines and tree branches. As noted, high windstorms can cause localized or regional power outages, thus leading to exposure extreme temperatures for vulnerable populations. An example was the widespread power outages following Superstorm Sandy and the exceptionally cold temperatures which led counties to open additional

[110] NOAA. "Severe Weather 101: Thunderstorms." Retrieved from https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

shelter place for displaced residents. An additional secondary hazard is traffic accidents that may occur when power to traffic control devices is disrupted.

Hailstorms, like many of the other hazards discussed, are often accompanied by other severe weather. One secondary effect of hailstorms is the damage to critical infrastructure which in turn may lead to utility failure. Additionally, extreme hailstorms impact traffic route and may lead to transportation accidents.

Flash flooding, particularly in low lying areas, is a secondary effect of thunderstorms as intense rain often accompanies thunderstorms.

Risk Assessment

Assets Exposed

Because all areas of Frederick County are susceptible to thunderstorms and severe weather events, it can be assumed that all structures are exposed and potentially vulnerable. Taller structures are the most exposed to lightning, while structures that are not surrounded by others are more likely to be damaged by wind. All structures are in danger of hail damage.

Population Exposed

All of Frederick County is vulnerable to severe storms. The number of people affected by winter storms and to what degree will depend on the type of storm that occurs, as well as its severity and tenure. Residents that live in remote areas with limited road or transportation access may be temporarily isolated if roads become impassable due to debris or fallen trees or extended power outages occur.

Vulnerability Summary

Older critical facilities are vulnerable to wind damage due to the age of construction and potential poor condition due to lack of maintenance, especially in the more rural and isolated areas of the County. It is important to identify specific critical facilities and assets that are most vulnerable to severe weather. Evaluation criteria include the age of the building (and what building codes may have been in effect at the time of construction), type of construction, and condition of the structure (i.e., how well the structure has been maintained).

Table 5.56 details losses due to thunderstorms/severe weather which can be used to understand the areas that are historically the most vulnerable. A more detailed vulnerability analysis as described above can be done in the future for more accurate vulnerability estimates.

Table 5.53. NCEI Loss Estimation for Severe Weather

Jurisdiction	Events	Annualized Events	Property Damages (2021$)	Crop Damages (2021$)	Total Damages (2021$)	Total Annualized Damages (2021$)
City of Brunswick	22	0.78	$313,552	$0	$313,552	$11,125
City of Frederick	62	2.01	$1,516,025	$0	$1,516,025	$49,097
Town of Burkittsville	7	0.21	$132,241	$6,124	$138,365	$4,061

Jurisdiction	Events	Annualized Events	Property Damages (2021$)	Crop Damages (2021$)	Total Damages (2021$)	Total Annualized Damages (2021$)
Town of Emmitsburg	10	0.40	$19,026	$279	$19,305	$772
Town of Middletown	16	0.64	$90,861	$8,372	$99,233	$3,969
Town of Mount Airy	1	0.04	$84,034	$0	$84,034	$3,361
Town of Myersville	16	0.52	$19,388	$279	$19,667	$634
Town of New Market	16	0.62	$61,051	$1,114	$62,165	$2,390
Town of Thurmont	17	0.63	$94,672	$15,314	$109,985	$4,078
Town of Walkersville	15	0.53	$70,270	$0	$70,270	$2,462
Town of Woodsboro	8	0.30	$38,284	$2,264	$40,547	$1,496
Village of Rosemont	3	0.12	$47,880	$84,034	$131,914	$5,277
Unincorporated Areas	459	17.37	$4,060,881	$165,185	$4,226,066	$159,891
Frederick County (All)	**652**	**24.14**	**$6,548,167**	**$282,964**	**$6,831,131**	**$252,939**

Reducing Vulnerability

Key areas of focus to reduce vulnerability to damage from thunderstorms in the County include:

- Education and awareness campaigns or programs to create a culture of awareness of how residents can protect themselves and their property during a thunderstorm.
- Ensure that tree and vegetation maintenance programs are effective at removing hanging or dead trees and limbs to limit potential damage during a storm.
- Maintain and, as needed, upgrade emergency communication equipment to ensure staff can communicate during or after a storm.
- Adopt building codes and development standards to mitigate severe wind damage during thunderstorms and related wind events, such as the International Building Code, International Residential Code, or the International Code Council (ICC)-600 Standard for Residential Construction in High-Wind Regions.

Tornado

Hazard Identification

Hazard Description

A tornado is a powerful rotating column of air, extending from a thunderstorm cloud system. Tornadoes are a low probability, but high impact hazard in the region surrounding Frederick County. Tornadoes are one of the most unpredictable weather events, and one of the most destructive. A tornado is a relatively short-lived storm, but a severe tornado can cause significant damage in its tracks. Average winds in a tornado, although rarely measured precisely, are believed to range between 65 miles per hour to up over 300 miles per hour in infrequent cases.

The following are National Weather Service definitions of a tornado and associated terms:

- **Tornado**: A violently rotating column of air that is touching the ground.
- **Funnel cloud**: A rapidly rotating column of air that does not touch the ground.

A tornado path averages about four miles but may reach up to 300 miles in length. Typical widths range from 300 to 400 yards, but severe tornadoes have cut swaths a mile or more in width or have formed groups of two or three funnels traveling together. Typically, tornadoes move between 25 and 45 miles per hour, but land speeds of up to 70 miles per hour have been reported. Tornadoes rarely last more than a couple of minutes over a spot for more than 15 to 20 minutes in a ten-mile area, but their short duration does not limit their devastation of an area.

Location

Tornados can form anywhere and with little warning if the conditions are suitable. All of Frederick County is susceptible to potential tornado events. Urban areas are more vulnerable to potential damage and adverse effects of tornados due to their denser concentrations of people, structures, and critical facilities. Typically, all of Maryland experiences several tornados a year, many of which touch down in sparsely populated rural areas and cause little damage.[111]

Extent

A tornado's destructive power is estimated using the Fujita Damage Scale. The Fujita-Pearson Scale was developed in 1971 to estimate tornado intensity based on associated damages. Tornadoes and their subsequent damage can be classified into six categories using the scale. The scale assigns numerical values for wind speeds inside the tornado according to the type of damage and degree of the tornado. An Enhanced Fujita Scale (EF Scale) was developed and implemented operationally in 2007 and is now the standard used to measure the strength of a tornado. The EF Scale was developed to better align tornado wind speeds with associated damages. Table 5.57 provides a side-by-side comparison of the F Scale and the EF Scale.

Table 5.54. Fujita Scale vs. Enhance Fujita Scale

Fujita Scale			Enhanced Fujita Scale	
F Number	Fastest 1/4-mile (mph)	3-Second Gust (mph)	EF Number	3-Second Gust (mph)
0	40-72	45-78	0	65-85

[111] Maryland Division of Emergency Preparedness. "Tornados." Retrieved from https://mdem.maryland.gov/Pages/resources-Tornadoes.aspx

Fujita Scale			Enhanced Fujita Scale	
F Number	Fastest 1/4-mile (mph)	3-Second Gust (mph)	EF Number	3-Second Gust (mph)
1	73-112	79-117	1	86-110
2	113-157	118-161	2	111-135
3	158-207	162-209	3	136-165
4	208-260	210-261	4	166-200
5	261-318	262-317	5	Over 200

Most tornadoes are F0 and F1, resulting in little widespread damage. However, tornadoes with winds higher than 75 mph may begin to cause significant damage to structures. The concentrated power of a tornado can often destroy homes, down power lines, and cause significant tree damage. Tornadoes can have financial and economic impacts on communities by causing crop damage, structural damage, environmental losses and lost revenue for businesses.

Previous Occurrences

Data from NCEI shows that Frederick County experienced 38 tornado events between 1950 and 2021. These events have resulted in $6.06 million of property damages and $84,034 in crop damages. There has been one federal disaster declaration (September 14, 1979) related to tornadoes in Frederick County. Major events since 2015 are described below. Events before 2015 are included in Appendix C.

- On June 14, 2015, NWS confirmed that an EF-0 tornado hit southern parts of Frederick County. Maximum wind speeds reach 65 mph along its 1.5-mile long path. Damages were reported to trees and mailboxes.[112]
- An EF-0 tornado, with estimated maximum wind speeds of 85 mph, occurred on Thursday May 30th, 2019 near Frederick, Maryland. The 6.5-mile path of damage extended from the eastern suburbs of Frederick, through Ijamsville, to Monrovia. The tornado touched down near the Monocacy River at approximately 2:48 PM EDT (1:48 PM EST), just west of the Frederick County Public Safety Training Facility. As it moved east over the County training facility and property, it snapped and uprooted many trees, but no structural damage was reported to the building from the wind. The tornado tracked a little south of due east, uprooting and snapping trees along Reichs Ford Road. As it crossed into Ijamsville, trees were uprooted and large branches were snapped along Ijamsville Road and Mussetter Road near the Methodist church. Continuing east, trees were noted uprooted and large branches snapped in multiple directions along a path that crossed Prices Distillery Road, Whiskey Road just south of Whiskey Creek Golf Course, a new residential community along Ed McClain Road, and Green Valley Road before lifting at approximately 2:59 PM EDT (1:59 PM EST). Damage estimates were provided by the Frederick County Division of Emergency Management.
- On February 7, 2020, staff from the National Oceanic and Atmospheric Administration's National Weather Service Baltimore/Washington Weather Forecast Office located in Sterling, VA performed a survey of storm damage that occurred in eastern Frederick County, MD near Monrovia and New Market.

[112] The Herald-Mail. 2015. "Weather service confirms tornado in Frederick Co." Retrieved from https://www.heraldmailmedia.com/story/news/local/2015/06/24/weather-service-confirms-tornado-in-frederick-co/44959715/

This survey, coupled with radar analysis from the KLWX WSR-88D radar and an Federal Aviation Administration Terminal Doppler Weather Radar, concluded that a tornado rated EF-1 on the Enhanced Fujita Scale impacted portions of eastern Frederick County MD. Initial damage was to several structures at a farm in the 11000 block of Fingerboard Road, where a machine shed and barn were flattened. A silo was also heavily damaged. NWS reported wind speeds of up to 110 mph through areas between New Market and Mount Airy. There were several reports of damage to structures including mobile homes and barns. The tornado lasted for about 30 minutes. The storm caused road closures, downed power lines, and significant tree damage. Almost 7,000 homes lost power in the County. A total of five tornadoes were reported across Maryland on this day, a record-breaking number for the State.[113]

- On May 3, 2021, several tornado warnings were issued in parts of Frederick County and surrounding counties in Maryland and Virginia. It was reported that a supercell thunderstorm produced an EF-1 tornado that touched down in Frederick County. The National Weather Service recorded peak wind speeds of 90 mph along approximately three-quarter mile long path in Libertytown and Mount Pleasant. NWS reported extensive tree damage, with at least 150 downed or damaged trees and wires in Frederick County following the tornado warnings. Several power outages were also reported throughout the County. Sporadic, straight-line wind damage was also noted.[114]

Figure 5.27 below shows tornado touchdowns and tracks in Frederick County between 1950 and 2021 (NCEI Storm Events Database). The map includes all recorded tornadoes with geographic coordinates included in NCEI attribute data. It is important to note that the geographic coordinates recorded are approximate and are not entirely precise. The tornado tracks shown in the map were created using the beginning latitude and longitude, and end latitude and longitude coordinates recorded by the National Oceanic and Atmospheric Administration and are therefore approximate. Although tornadoes do typically move in a straight line as shown below, the actual tornado paths may veer off course.

[113] The Frederick News-Post. 2020. “Assessing the Damage: EF1 tornado touched down in Frederick County, National Weather Service determines.” Retrieved from https://www.fredericknewspost.com/public/ef1-tornado-touched-down-in-frederick-county-national-weather-service-determines/article_1cc03c97-64a5-5dd9-81d4-77188326d56b.html

[114] The Baltimore Sun. 2021. “Tornado touched down in Frederick County on Monday, weather service says.” Retrieved from https://www.baltimoresun.com/weather/bs-md-tornado-frederick-county-20210506-nmynh3zpjvc4tcs52vj2qho7yu-story.html

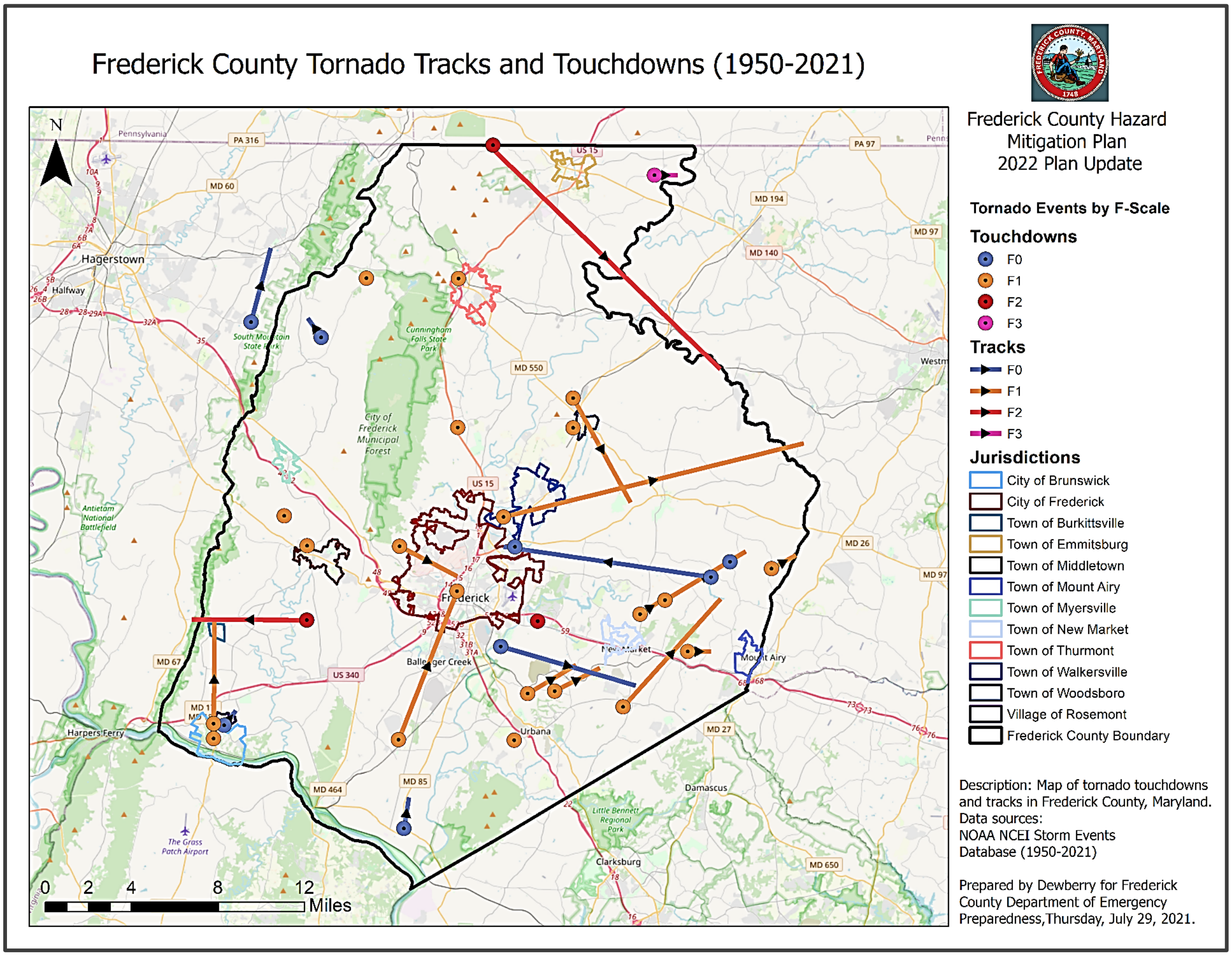

Figure 5.27. Map of Tornado Touchdowns and Tracks in and Around Frederick County

Two tornadoes in the database did not have attributed coordinates and are note shown on the map above. The two tornadoes both occurred in 1995, one was an F0 that touched down in a residential area of eastern Thurmont and caused minor structural damage to homes in the area. The other tornado was an F1 that struck the Fox Ridge community east of Libertytown and caused substantial damage to a couple of homes in the area, the storm continued through farmland before dissipating.

Ten of the tornadoes shown in Figure 5.27 included only beginning coordinates, no end coordinates were provided. These storms occurred between 1952 and 1990 which likely explains the lack of tornado tracking data, as well as the absence of event descriptions in the database. Nine of the ten tornados were classified as F1 on the Fujita Scale. One was categorized as an F2.

An F0 tornado which occurred May 25, 2004 is shown just outside of the County boundary in the map above. NCEI recorded this event as having occurred in the unincorporated areas of Frederick County, however, the event narrative describes the storm as a very weak tornado that touched down about one-half mile from the Frederick and Washington County line. Due to this storm having been attributed to Frederick County in the database, the event was included in the hazard analysis for this Plan despite being shown right outside of the County boundary. However, there were zero damage costs recorded for this storm, so this did not impact the annualized cost estimation in the following section and had very little impact on the annualized number of events.

Probability and Severity of Future Occurrences

Table 5.58 shows tornado occurrences in Frederick County by Fujita Intensity Scale ranking. As shown in the table, Frederick County has experienced F1 tornadoes most frequently. Over 60% of tornado occurrences in the last 71 years have been F1 tornadoes, while only 10% of tornadoes were ranked F2 or greater. The City of Frederick has the largest number of formally reported tornado events on record in the 71-year period, aside from the unincorporated areas of Frederick County which accounts for over 71% of the total occurrences.

Table 5.55.Tornadoes in Frederick County

Jurisdiction	Unknown	F0	F1	F2	>=F3	Total
City of Brunswick	0	0	1	0	0	1
City of Frederick	1	2	2	0	0	5
Unincorporated Areas	0	6	17	3	1	27
Town of Emmitsburg	1	0	0	0	0	1
Town of Mount Airy	0	0	1	0	0	1
Town of Thurmont	0	1	0	0	0	1
Town of Woodsboro	0	0	1	0	0	1
Village of Rosemont	0	0	1	0	0	1
Frederick County Overall	**2**	**9**	**23**	**3**	**1**	**38**

Although a tornado's magnitude and location are unpredictable, most of those that occurred in Frederick County during the last 70 years have been classified as low intensity (F1). There were three cases of F2 tornadoes and one F3 tornado event. Although these tornadoes caused no fatalities, they resulted in roadblocks, delays and the nuisance and cost of clearing fallen trees and debris.

A record number of tornados hit the State of Maryland in 2020, with 5 tornadoes occurring on February 7, 2020. The impact of climate change to tornado frequency and severity requires further research. This is mostly due to a lack of historic tornado records which presently only date back to the 1950s, so long-term trends are difficult to determine. However, it is probable that a warming climate will contribute to more frequent variability in the atmosphere, resulting in increased severe storm activity. Additionally, in a changing climate, summer thunderstorms are growing larger, and appearing more frequently. With an increased threat of thunderstorm activity, there will likely be a greater risk of tornadoes impacting Frederick County.

Loss Estimation

Annualized loss due to tornadoes is difficult to evaluate with precision. However, an evaluation can be made using the NCEI database of historical tornado occurrences. The annualized loss and events calculations show that tornadoes are a low probability, high-impact hazard in Frederick County. The number of annualized events is calculated by dividing the number of occurrences by the number of years in the period of record. Similarly, annualized losses are calculated by dividing the total losses for a given geography by the period of record and adjusting to 2021 dollars using Consumer Price Index calculations to factor in inflation since 1950.

Table 5.59 shows the total number of tornado events, as well as the annualized number of events for each jurisdiction. Based on historic damages from NCEI of $6.15 million, Frederick County may experience on average $86,641 in tornado damages annually. It is important to note, however, that NCEI only accounts for formally reported damages, so the actual loss may be greater than what is shown in the database.

The table below also shows the estimated annualized number of tornadoes in the County. Frederick County has experienced only 38 tornadoes since 1950, resulting in an expected annual number of events of 0.54 (about one every two years). However, this number in recent years has increased significantly. A record number of tornados hit the State of Maryland in 2020, with 5 tornadoes occurring on February 7, 2020, one of which caused severe damage in Frederick County.

Table 5.56. Estimated Annualized Loss Due to Tornado Events in NCEI Storm Events Database (1950-2021)

Jurisdiction	Total Events	Annualized Events	Total Loss	Annualized Loss
City of Brunswick	1	0.01	$279,195	$3,932
City of Frederick	5	0.07	$1,374,230	$19,355
Unincorporated Areas	27	0.38	$4,012,592	$56,515
Town of Emmitsburg	1	0.01	$0	$0
Town of Mount Airy	1	0.01	$252,103	$3,551
Town of Thurmont	1	0.01	$12,112	$171
Town of Woodsboro	1	0.01	$2,792	$39
Village of Rosemont	1	0.01	$218,489	$3,077
Frederick County Overall	**38**	**0.54**	**$6,151,515**	**$86,641**

There are no standard loss estimation models and tables for tornadoes. Exposure data estimates the number of structures at risk. Manufactured homes are particularly vulnerable to tornadoes.

Impact Summary

Primary Impacts

The impact of tornadoes primarily depends upon their occurrence in developed areas; tornadoes in undeveloped areas may cause damage only to a few trees and are often unreported. As development and population in the County increase, a larger number of structures and people may be subject to tornadoes.

Tornadoes rarely last more than a couple of minutes over a spot for more than 15 to 20 minutes in a ten-mile area, but their short duration does not limit devastation of an area. The destructive power of a tornado results primarily from its high wind velocities and sudden changes in pressure. Damages from tornadoes result from extreme wind pressure and windborne debris. Depending on their intensity, tornadoes can uproot trees, bring down power lines, and destroy buildings. Flying debris is the main cause of serious injury and death.

Nearly 70% of deaths from tornadoes happen to people in residential structures. Of these, over 40% are located in mobile homes, which are easily overturned and destroyed due to the low wind resistance of the structures. More populated areas in Frederick County are more likely to experience damage and causalities. In Frederick County, no deaths have occurred as a direct result of a tornado, one direct injury took place in 1952 as a result of an F1 tornado.

Secondary Impacts

Tornadoes may uproot trees and vegetation along their path, which can result in crop damages. According to NCEI, the Village of Rosemont experienced $84,034 (2021 dollars) in crop damages as a result of an F1 tornado in July of 1996. The destruction of vegetation due to tornadoes can also cause problematic erosion, deposition, and weathering.

If a tornado is powerful enough to destroy commercial structures and homes, it may cause adverse effects on public health due to exposure to hazardous waste. Harmful exposure to hazardous waste may also contaminate soil and water. Since tornadoes are generally associated with severe storm systems, they are often accompanied by hail, torrential rain, and intense lightning, which can cause secondary harm and damages.

Risk Assessment

Assets Exposed

Tornados can form anywhere and at any time the conditions are right, meaning that all buildings, property, and infrastructure in Frederick County is susceptible to tornados. Structures in urban areas are more likely to realize damage or experience adverse impacts due to the denser concentration of buildings and development; therefore, areas such as the City of Frederick have the potential to see greater amounts of damage from a tornado compared to a smaller town phased with the same hazard.

Population Exposed

Tornados can form anywhere and at any time the conditions are right, meaning that all of Frederick County is susceptible to tornados. People in urban areas are more likely to witness damage or experience adverse impacts due to the denser concentration of structures and development.

Vulnerability Summary

The most important factor in the vulnerability assessment is how likely structures are to fail when subjected to wind loads that exceed their design or to flying debris that penetrates the building. In general, building damages can range from cosmetic to complete structural failure, depending on wind speed and location of the building with respect to the tornado path, and can be analyzed by a structural engineer. For a detailed vulnerability assessment, a study on building characteristics relating to wind speed could be conducted.

Reducing Vulnerability

Measures to reduce damages from tornadoes include proper anchoring and strapping of buildings to their foundations and designing shelters and other critical facilities for appropriate wind speeds. Warning and notification systems are also extremely important in order to give people adequate time to get to a safe place if a tornado is imminent. People should be made aware of what the warnings mean and know what to do in case a warning is issued before the onset of severe weather or tornadoes.

Tropical Cyclone

Hazard Identification

Hazard Description

Hurricanes and tropical storms are two types of tropical cyclones, which are rotating, organized systems of clouds and thunderstorms.[115] These storms originate over tropical or subtropical waters and have well-defined centers circulated by strong winds. Once formed, tropical cyclones extract heat energy from the ocean and release it into the cooler temperatures of the upper troposphere.

Tropical storms refer to tropical cyclones that have maximum sustained surface wind speeds of 39 to 73 miles per hour. Hurricanes are those tropical storms with maximum sustained surface wind speeds exceeding 74 miles per hour. Hurricanes specifically refer to tropical cyclones that form in the North Atlantic and central and eastern North Pacific. The Atlantic hurricane season begins on June 1 and ends November 30, but these storms can and have formed outside this window.[116]

Hurricanes and tropical storms bring heavy rainfall, storm surge, and high winds, which can last for several days. These storms have the potential to cause significant damage due to sustained flooding, high wind, erosion, and particularly in coastal areas, strong storm surges. Typically, the damages caused by tropical storms and hurricanes are due to the extreme winds and prolonged intense rainfall.

Location

Coastal areas are more likely to be affected by tropical storms and hurricanes. The Maryland Department of Emergency Management's Know Your Zone tool identifies areas where residents may need to evacuate in an emergency or shelter at home, depending on where they live or the severity of a hurricane or tropical storm.[117] Frederick County is not a coastal area and does contain any evacuation zones. However, inland areas can still be affected by intense precipitation caused by tropical storms, hurricanes, or the remnants of these events. Prolonged rainfall can also cause flash flooding and riverine flooding, which previously has affected Frederick County.

Extent

Tropical storms and hurricanes are classified using the Saffir-Simpson Hurricane Scale (Table 5.60).[118] The Saffir-Simpson Hurricane Scale rates hurricanes from one to five based on sustained wind speeds and atmospheric pressure at the time of measurement. Sustained wind speeds are defined by the average wind speed measured over one minute. The National Weather Service uses this scale to project typical property damage and flooding levels from imminent storms.

The scale projects the storm surge heights and the type of potential damage, based on the indicated intensity. In general, projected damage rises by about a factor of four for every category increase, but actual damage will vary based on the unique bearing, location, and timing of each storm. The scale's projected typical damage serves as guidance to estimate potential storm impacts, rather than definitive consequences.

[115] NOAA. n.d. "Glossary of National Hurricane Center Terms: Tropical Cyclones." Retrieved from https://www.nhc.noaa.gov/aboutgloss.shtml
[116] NOAA. n.d. "Tropical Cyclone Climatology." Retrieved from https://www.nhc.noaa.gov/climo/
[117] Maryland Emergency Management Agency. n.d. "Known Your Zone." Retrieved from https://mdem.maryland.gov/Pages/know-your-zone-md.aspx
[118] National Park Service. 2019. "Coastal Geomorphology: Tropical Storms." Retrieved from https://www.nps.gov/articles/saffir-simpson-hurricane-scale.htm

Table 5.57. Saffir-Simpson Scale and Typical Damages

Category	Sustained Wind Speeds (mph)	Pressure (mb)	Surge (ft)	Typical Damage
Tropical Depression	< 39	–	–	–
Tropical Storm	39-73	–	–	–
1	74-95	> 980	4-5	Minimal – Damage primarily to shrubbery and trees, unanchored manufactured homes damaged, some signs damaged, no real damage to structures on permanent foundations.
2	96-110	965-980	6-8	Moderate – Some trees toppled, some roof coverings damaged, major damage to manufactured homes.
3	111-130	945-965	9-12	Extensive Damage – Large trees toppled, some structural damage to roofs, manufactured homes destroyed, structural damage to small homes and utility buildings.
4	131-155	920-945	13-18	Extreme Damage – Extensive damage to roofs, windows, and doors; roof systems on small buildings completely fail; some curtain walls fail.
5	> 155	< 920	> 18	Catastrophic Damage – Roof damage considerable and widespread, window and door damage severe, extensive glass failures, some buildings fail completely.

Previous Occurrences

Since 1972, ten named tropical storms and hurricanes have affected Frederick County, summarized in Table 5.61. Of these, seven events received presidential-declared disaster status. Only two were captured as tropical storms in the NCEI database (Tropical Storm Hanna and Hurricane Irene), and five were captured as floods, extreme wind events, or thunderstorms (Hurricanes Fran, Floyd, Isabel, Ivan, and Sandy). Two events are captured only as presidentially declared disasters (Tropical Storms Agnes and Isais). The most recent of these events occurred during the development of this Plan and is not yet captured in the NCEI dataset.

This hazard analysis focuses on named events that captured in the NCEI database, but the remnants of other storms have caused flooding and other consequences in the region are not captured in this section. For example, in 2011, the remnants of Tropical Storm Lee caused major flooding and flash flooding.

Table 5.58. Historical Hurricanes and Tropical Storms in Frederick County

Source			Event Name	Incident Period
PDD	NCEI	Local Sources		
x			Tropical Storm Agnes	6/23/1972

Source			Event Name	Incident Period
PDD	NCEI	Local Sources		
x			Hurricane Fran	9/6 to 9/9/1996
x			Hurricane Floyd	9/16 to 9/20/1999
x			Hurricane Isabel	9/18 to 9/29/2003
		x	Hurricane Ivan	9/2 to 9/25/2004
	x		Tropical Storm Hanna	9/6/2008
x	x		Hurricane Irene	8/24 to 9/5/2011
x			Hurricane Sandy	10/26/2012 to 11/4/2012
x			Tropical Storm Isaias	8/3 to 8/4/2020
		x	Hurricane Ida	9/1/2021
Total Events			**10**	

Since 2016, two named tropical storms and hurricanes affected Frederick County, both of which received presidentially declared disaster status. The most recent of these, Hurricane Ida, occurred in early September 2021, during the development of this plan. Frederick County was affected by the remnants of Hurricane Ida, and Maryland did not receive a presidentially declared disaster status. This event is not yet captured in the NCEI or other relevant datasets.

These events and their consequences are described below:

- On September 1, 2021, **Hurricane Ida** was a Category 4 hurricane with maximum sustained winds of 150 mph. The storm incurred more than $50 billion in damages in the Southeast and Northeast regions, primarily in Louisiana. The remnants of the hurricane led to widespread flooding throughout Frederick County. Dozens of roadways were inundated with upwards of eight inches of rainfall, rendering them impassable.[119]
- Between July 30 and August 5, 2020, **Hurricane Isaias** was a destructive Category 1 hurricane that caused damage across the East Coast, causing the strongest tropical cyclone-spawned tornado since Hurricane Rita in 2005. Winds from the storm caused roof damage and downed trees and wires. Across Virginia and Maryland, Isaias left about 400,000 people without power.

The following analysis only considers the two tropical storms and hurricanes contained in the NCEI database. Based on 25 years of records, two tropical storms and hurricanes have affected Frederick County. Collectively, these events incurred $5,863 in damage to structures and their contents, as shown in Table 5.62.

[119] Keller, M.G. 2021. "'Pretty rare event': High waters persist across Frederick County following Ida's pelting." *The Frederick News-Post*. Retrieved from https://www.fredericknewspost.com/news/weather/pretty-rare-event-high-waters-persist-across-frederick-county-following-idas-pelting/article_02fff08c-c9c5-5aba-8698-155ec40e669e.html

Table 5.59. Historical Tropical Storm and Hurricane Frequency and Damage

Event Name	Incident Period	Property Damage (2021$)	Crop Damage (2021$)
Tropical Storm Hanna	9/6/2008	$0	$0
Hurricane Irene	8/24 to 9/5/2011	$5,863	$0
Total		**$5,863**	**$0**

Probability and Severity of Future Occurrences

As summarized in Table 5.63, Frederick County can expect to experience .08 tropical storms and hurricanes in a given year that incur an estimated $233 in annualized damage. This analysis considers only events captured in the NCEI database.

Table 5.60. Annualized Tropical Storm and Hurricane Events and Damage

	Total Events	Cumulative Damage	Total Years of Record[120]
	2	$5,863	25
Annualized	**.08**	**$233**	

However, Frederick County experienced ten tropical storms and hurricanes, as illustrated in Table 5.61. Six of these events are not captured in the NCEI that were severe enough to receive presidentially declared disaster status. If the eight events captured between the NCEI and presidentially declared disaster list are considered, then Frederick County can expect to witness an annualized number of .16 tropical storms and hurricanes in a given year. Based on historic damages of $425,904 from NCEI and Frederick County Division of Public Works, Frederick County can expect to experience $8,691 annually in damages and road clearing costs associated with tropical storms and hurricanes.

Projecting the future frequency and severity of tropical storms and hurricane cannot rely exclusively on historical data. These events form during specific atmospheric conditions, the frequency and dynamics of which are shifting with climate change. In general, tropical storms and hurricanes may become more frequent in the future and when they do form, they are expected to be stronger and more destructive than previous trends show. The share of tropical cyclones rated Category 3 or higher is likely to increase, as ocean temperatures rise and the amount of water vapor above surface waters increases.[121]

Already, the share of tropical cyclones that are considered intense (hurricanes ranked category three or above) has increased over the past four decades.[122] Stronger storms will have higher maximum sustained wind speeds that can incur significant damage. Additionally, as sea levels rise, upstream and inland waterways will experience higher water volumes, elevating the risk for potential overflows and inundation, particularly during storm surge events. Changing precipitation patterns may also bring more intense or prolonged rainfall that

[120] The NCEI Storm Events Database began consistently recording tropical storms and hurricanes starting in 1996. (NOAA. "Storms Event Database." Retrieved from https://www.ncdc.noaa.gov/stormevents/details.jsp)
[121] International Panel on Climate Change. 2021. *Sixth Assessment Report: Weather and climate extreme events in a changing climate.* https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_11.pdf
[122] International Panel on Climate Change. 2021. *Sixth Assessment Report: Weather and climate extreme events in a changing climate.* https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_11.pdf

results in inland and flash flooding. Combined, these climate interactions may make Frederick County more vulnerable to structural damage and economic losses due to these events.

Loss Estimation

Using FEMA's Hazus-MH Hurricane Module (Version 4.2), the potential losses from a hurricane that made landfall on the East Coast were determined for Frederick County. Based on the Benefit-Cost Analysis module, this model assumes Frederick County has a 5% annual chance of experiencing tropical storm force winds, a 2.5% annual chance of experiencing a Category 1 hurricane, and .02% annual chance of experiencing a storm stronger than a Category 1.

As summarized in Table 5.64, Frederick County can expect to experience $509,500 in total losses in a given year due to a hurricane. Of this figure, 95% can be attributed to damage to building and their contents, which refers to the estimated costs to repair or replace the damage caused to the building and its contents. The County can expect to experience nearly $15,000 in relocation expenses, which may be incurred when buildings are unusable during repairs. Building owners can expect to lose more than $5,400 in rental income in a given year due to a hurricane. In a given year, Frederick County businesses can expect lose $435 and $838 in inventory and income, respectively, due to a hurricane, and workers in the region can expect to lose nearly $1,900 in wages.

Table 5.64 breaks losses down by community and apportions some of that damage to Frederick Community College, Hood College, and Mount St. Mary's University based on percentages of the census block in which they are located.

Table 5.61. Total Annualized Hurricane Loss, Whole Dollars

Jurisdiction	Buildings	Contents	Inventory	Relocation	Income	Rental	Wages	Total Loss	Total Exposure
Communities									
City of Brunswick	$8,529.91	$2,469.77	$2.00	$342.98	$8.88	$117.54	$16.91	$11,488.00	$487,501,835.36
City of Frederick	$97,980.73	$12,105.10	$55.49	$3,571.23	$292.89	$1,524.46	$538.78	$116,068.68	$14,500,579,241.94
Unincorporated Areas	$274,054.90	$37,776.60	$343.95	$9,702.86	$444.80	$3,217.49	$1,019.49	$326,560.09	$37,331,596,486.21
Town of Burkittsville	$701.80	$108.50	$0.59	$36.27	$0.38	$10.71	$0.53	$858.77	$16,282,566.30
Town of Emmitsburg	$2,643.39	$200.50	$1.47	$99.43	$14.61	$44.75	$33.25	$3,037.41	$83,456,609.85
Town of Middletown	$9,035.28	$1,018.88	$3.60	$319.32	$13.90	$105.11	$69.79	$10,565.87	$422,751,594.02
Town of Mount Airy	$7,385.76	$623.13	$0.97	$198.06	$8.48	$60.92	$11.67	$8,288.99	$303,813,256.50
Town of Myersville	$2,466.17	$159.41	$0.21	$67.44	$1.74	$21.75	$5.65	$2,722.37	$37,432,653.31
Town of New Market	$1,422.00	$131.89	$0.45	$48.70	$3.31	$15.70	$7.93	$1,629.99	$74,407,910.22
Town of Thurmont	$7,547.66	$730.30	$7.82	$211.49	$10.40	$81.63	$44.36	$8,633.66	$451,586,911.13
Town of Walkersville	$11,363.50	$2,160.73	$12.66	$409.84	$18.94	$137.65	$40.83	$14,144.16	$820,133,665.51

Jurisdiction	Buildings	Contents	Inventory	Relocation	Income	Rental	Wages	Total Loss	Total Exposure
Town of Woodsboro	$2,074.82	$336.36	$5.80	$74.70	$6.68	$26.32	$8.59	$2,533.27	$16,639,132.52
Village of Rosemont	$971.65	$251.44	$0.42	$41.63	$0.36	$12.38	$0.56	$1,278.43	$23,559,482.92
Total	**$427,549.08**	**$58,209.66**	**$435.51**	**$15,194.28**	**$838.42**	**$5,409.73**	**$1,879.31**	**$509,515.99**	**$55,161,545,983.25**
Colleges & Universities									
Frederick Community College	$58.08	$14.79	$0.00	$6.32	$4.18	$0.59	$9.76	$93.73	$71,216,735.56
Hood College	$506.92	$75.58	$0.02	$37.67	$20.86	$9.28	$48.09	$698.40	$123,116,633.96
Mount St. Mary's University	$114.15	$4.61	$0.01	$2.32	$0.10	$3.13	$0.23	$124.55	$82,648,239.18

Impact Summary

Primary Impacts

Tropical cyclones involve both atmospheric and hydrologic factors that contribute to potential consequences. Affected areas may experience extreme and prolonged rainfall, severe winds, thunderstorms, lightning, and, in some cases, tornadoes. Intense rainfall can produce devastating flooding, including flash flooding and riverine flooding, particularly in inland areas. Flooding can lead to widespread damage of homes, businesses, and critical facilities.

Hurricanes also produce high winds that stir up airborne debris and downed trees, both of which can lead to significant building damage and power outages. Like flooding, severe winds can produce localized or widespread power or utility outages, property damage, and falling trees. If improperly installed or anchored, mobile homes may be especially vulnerable to damage from high winds. Extreme wind events can also blow over tractor trailers on the highway and make driving difficult in a high-profile or lightweight vehicle. They can turn trash cans, lawn and patio furniture, and other property into projectiles resulting in further property damage.

Flying debris, broken tree limbs or branches, and falling objects can even cause serious injuries and death. Most deaths due to extreme wind are caused by trees falling onto cars or homes. Dead trees or trees weakened by drought, disease, rotting, or pest infestations are the most susceptible to falling.

Secondary Impacts

Tropical cyclones may involve extended rainfall or far-reaching wind damage that disrupts utilities, like power, water and wastewater treatment, and communications, for days. After a storm passes, thoroughfares may remain impassable due to standing water, fallen trees or debris, or structural damage to roads and bridges.

These disruptions can lead to compound economic effects. For example, local businesses may have to close due to structural or content damage, utility outages, or blocked transportation corridors. Further, lower-income households may have limited disposable income to spend on home repairs or temporary shelter, if their residence becomes unsafe to occupy due to damage. Localities may also have to spend significant money on public safety response efforts and public works repairs, potentially straining operating budgets.

Public Health Impacts

The potential for wide-spread and prolonged utility outages raises the risk for adverse effects to public health. Tropical cyclones typically occur during the summer months, when air temperatures and humidity levels are highest. Power outages may cut off air conditioning or other cooling facilities for extended periods, elevating the risk for heat-related illnesses particularly for children under four years of age, people over 65 years of age, and those who have pre-existing or underlying conditions, like obesity.[123] Socially vulnerable populations, like lower-income households, the elderly, and people with disabilities, may live on fixed incomes and be less able to cope with loss of perishable food, lack of water, or the need to find temporary shelter. In some cases, gasoline shortages or inability to travel may prevent individuals from traveling to cooling stations or accessing food and water outside the home.

[123] Centers for Disease Control and Prevention. 2012. "Natural Disasters and Severe Weather: Extreme Heat." Retrieved from https://www.cdc.gov/disasters/extremeheat/faq.html

Risk Assessment

Assets Exposed

Structures in coastal areas are more exposed compared to inland areas, like Frederick County. However, tropical cyclones produce heavy rainfall that can lead to inland flooding, risking damage to assets. A summary of the potential assets exposed to tropical cyclones can be found in Table 5.64. Based on these results, the total exposure of assets in Frederick County to hurricanes exceeds $55 billion. Of this exposure, assets cumulatively valued at $37 billion – more than two-thirds of all exposure – lies within the unincorporated areas of Frederick County. In Frederick County, developed and urban areas, like the City of Frederick, are more likely to experience damage from hurricanes due to their concentration of buildings, businesses, infrastructure, and other assets. In the City of Frederick, the total value of assets exposed to hurricanes is approximately $14.5 billion, or more than a quarter of the County's total exposure.

Population Exposed

Frederick County is not a coastal area and does not contain any hurricane evacuation routes. However, the number of people affected by hurricanes and tropical storms will depend on the scale and duration of a particular event. Residents that live in floodplains or near water bodies may be more likely to experience flooding, if a storm produces enough rainfall. People that live in urban areas with significant impervious surfaces may witness pluvial flooding and even ponding of water, which can last several days after a storm. Powerful hurricanes may require local or regional evacuations if buildings are not expected to withstand the high winds.

Vulnerability Summary

Though not a coastal area, Frederick County is still vulnerable to the adverse impacts of hurricanes. Communities and development near water bodies, like the Potomac and Monocacy Rivers, may witness inland flooding, if an event produces significant precipitation. Hurricanes also produce strong winds can still affect inland areas, like Frederick. Between inland flooding and strong winds, hurricanes can lead to power outages if they damage or knock down power lines, travel disruptions if floodwaters or debris block transportation corridors, and cause significant structure damage.

In Frederick County, the City of Frederick experiences the highest hurricane exposure due to its denser development and concentration of people, buildings, businesses, and infrastructure, and its intersection with the Monocacy River. Other areas that face higher exposure to hurricanes include the City of Brunswick and the Town of Walkersville. The City of Brunswick lies along the Potomac River, and just north of the City of Frederick, the Town of Walkersville intersects with the Monocacy River. Both of these rivers have previously been affected by extreme precipitation due to hurricanes.

Reducing Vulnerability

Key areas of focus to reduce vulnerability to tropical cyclones in the County include:

- Adopt building codes and development standards to mitigate storm surge and severe wind damage, such as the International Building Code, International Residential Code, or the International Code Council (ICC)-600 Standard for Residential Construction in High-Wind Regions.
- Require that all critical facilities meet requirements of Executive Order 11988 and be built 1 foot above the 500-year flood elevation (considering wave action).
- Construct seawalls or other structures or consider relocation for existing vulnerable critical facilities outside of high-risk inundation areas.

- Incorporate passive ventilation in building and site design to allow outdoor air to enter the structure in a controlled way and reduce the potential for significant damage.

Non-Climate-Influenced Hazards

Earthquake

Hazard Identification

Hazard Description

The earth's surface is covered by solid rock approximately 50 miles thick, referred to as the lithosphere. The lithosphere is made up of the Earth's crust, which ranges in size from about 22 miles thick for continents to about five miles thick for the oceans, and the upper mantle which is composed of solidified magma. This lithosphere "floats" above a thick layer of molten rock known as the lower mantle. The lithosphere is divided into large and small sections that geologists call plates.

Earthquakes occur when those geologic plates slide against each other, resulting from the sudden release of energy that creates seismic waves. Most movements between plates are extremely small, generating tiny earthquakes that cannot be sensed by people. Other less frequent movements between plates can be quite large, generating powerful earthquakes that can shake the ground surface and cause widespread damage. Earthquakes can be violent enough to destroy whole cities.

The term "earthquake" is used to describe any seismic event — whether natural or caused by humans — that generates seismic waves. Earthquakes are caused mostly by rupture of geological faults, but also by other events such as volcanic activity, landslides, mine blasts, and nuclear tests. An earthquake's point of initial rupture is called its focus or hypocenter. The epicenter is the point at ground level directly above the hypocenter.

Location

Earthquakes also occur along the East Coast of the United States, but the mechanisms causing these earthquakes are not well understood, as these earthquakes occur within the plate rather than at plate boundaries (USGS, 2003). Earthquake activity that occurs within a tectonic plate is a known as 'intraplate seismicity'. While these quakes occur with less frequency than plate boundary quakes, the impacts from them can still be extensive and severe.

The mid-Atlantic and central Appalachian region, including Maryland, is characterized by a moderate amount of low-level earthquake activity, but their cause or causes are largely a matter of speculation. In Maryland, there are numerous faults, but none are known or suspected to be active. Because of the relatively low seismic energy release, this region has received relatively little attention from earthquake seismologists.

Extent

Although other natural hazards account for greater annual loss in the United States, earthquakes pose a large risk in terms of sudden loss of life and property. Risk factors that impact the severity and extent of damage include:

- **Amount of seismic energy released**: The greater the vibrational energy, the greater the chance for destruction.
- **Duration of ground movement**: This is one of the most important parameters of ground motion for causing damage.
- **Depth of the focus, or hypocenter**: The shallower the focus (the point of an earthquake's origin within the earth), usually the greater the potential for destructive seismic waves reaching the earth's surface.

Even stronger magnitude events with a much greater focus depth typically produce only moderate movement at ground level.

- **Distance from epicenter**: The potential for damage tends to be greatest near the epicenter (the point on the ground directly above the focus) and decreases away from it.
- **Geologic setting**: A wide range of foundation materials exhibits a similarly wide range of responses to seismic vibrations. For example, in soft unconsolidated material, earthquake vibrations last longer and develop greater amplitudes, which produce more ground movement, than in areas underlain by hard bedrock. Likewise, areas having active faults are at greater risk.
- **Population and building density**: In general, risk increases as population and building density increase.
- **Types of buildings**: Wooden frame structures tend to respond to earthquakes better than do more rigid brick or masonry buildings. Taller buildings are more vulnerable than one- or two-story buildings when located on soft, unconsolidated sediments, but taller buildings tend to be the more stable when on a hard bedrock foundation.
- **Time of day**: Experience shows there are fewer casualties if an earthquake occurs in late evening or early morning because most people are at home and awake and thus in a good position to respond properly.

All these factors affect each other and add up to the severity of the earthquake.

Measurement of the severity of an earthquake can be expressed in several ways, the two most common being intensity (using human judgment) and magnitude (using seismographs). The Modified Mercalli Intensity (MMI) Scale is an intensity scale expressed in Roman numerals, which reports the amount of shaking and effects at a specific location based on expert judgment. The scale has twelve classes and ranges from I (not felt) to XII (total destruction). The lower intensities are described in terms of people's reactions and sensations, whereas the higher intensities relate to observable structural damage.

Magnitude is an objective measure of earthquake severity and is related to the amount of seismic energy released at the focus of an earthquake. It is based on the amplitude of seismic waves as recorded on seismographs. The standard way to measure magnitude is by using Moment Magnitude, which in 2002 replaced the Richter Scale as the scale commonly used earthquake magnitude scale by the US Geological Survey. The moment magnitude provides an estimate of earthquake size that is valid over the complete range of magnitudes, a characteristic that was lacking in previous magnitude scales.

Another way of measuring the potential damage of an earthquake is the peak ground acceleration. The peak ground acceleration is measured as a percentage and refers to the maximum percentage of acceleration of the movement of the ground. A higher peak ground acceleration means a more rapid movement of the ground and a higher probability of structural damage.

Since the 2010 Frederick County Hazard Mitigation Plan, USGS has released updated national seismic hazard maps to account for new methods, models, and data. Figure 5.28 shows peak ground acceleration for the United States. This represents the fastest measured change in speed for a particle at ground level that is moving horizontally due to an earthquake with a 2% probability of exceedance in 50 years.[124] Values are given in %g, where g is acceleration due to gravity, or 9.8 meters per second squared. All communities in Frederick County are located within the peak ground acceleration rank of 4%g to 6%g (shown in light blue on the map). Table 5.65 correlates the MMI scale with magnitude and the peak ground acceleration method.

[124] Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Yuehua, Rezaeian, Sanaz, Harmsen, S.C., Boyd, O.S., Field, Ned, Chen, Rui, Rukstales, K.S., Luco, Nico, Wheeler, R.L., Williams, R.A., and Olsen, A.H., 2014, Documentation for the 2014 update of the United States national seismic hazard maps: U.S. Geological Survey Open-File Report 2014–1091, 243 p., http://dx.doi.org/10.3133/ofr20141091.

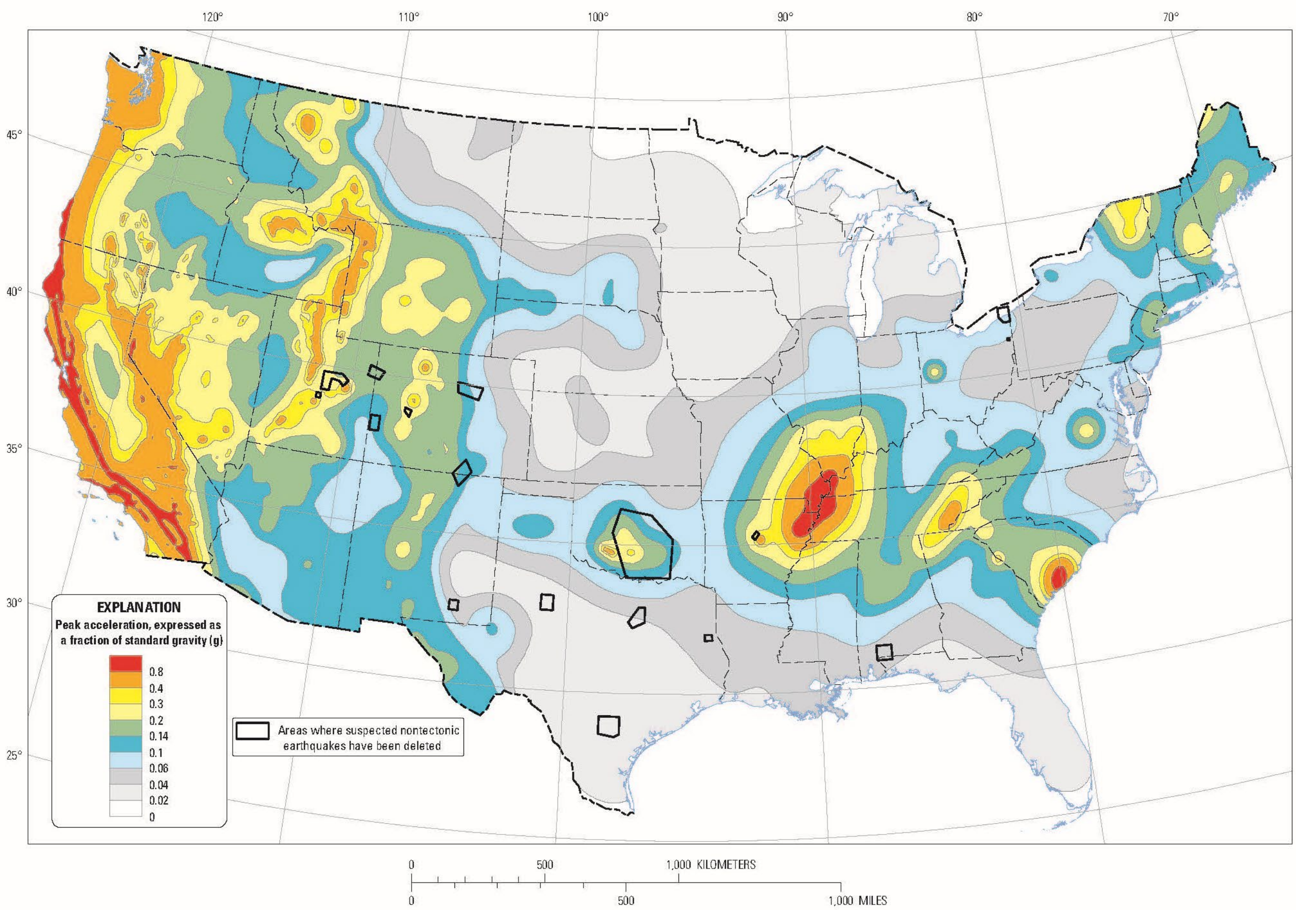

Figure 5.28. Peak Ground Acceleration (%g) with 2% Probability of Exceedance in 50 Years

Table 5.62. Magnitude, Modified Mercalli Intensity Scale and Peak Ground Acceleration Comparison

Moment Magnitude	MMI	Acceleration (%g) Peak Ground Acceleration	Perceived Shaking	Potential Damage
1.0 – 3.0	I	<0.17	Not Felt	None
3.0 – 3.9	II-III	.17-1.4	Weak	None
4.0 – 4.4	IV	1.4-3.9	Light	None
4.5 – 4.9	V	3.9-9.2	Moderate	Very Light
5.0 – 5.4	VI	9.2-18	Strong	Light
5.5 – 5.9	VII	18-34	Very Strong	Moderate
6.0 – 6.4	VIII	34-65	Severe	Moderate to Heavy
6.5 – 6.9	IX	65-124	Violent	Heavy
7.0 or higher	X-XII	>124	Extreme	Very Heavy

Source: FEMA Publication 386-2, "Understanding Your Risks"

Previous Occurrences

Even though the greatest seismicity in the United States occurs along the Pacific Coast, major earthquakes have also occurred in the central and eastern United States. The last earthquake to cause appreciable damage in the eastern United States occurred in 1886 near Charleston, South Carolina. It had an estimated magnitude of 6.5 to 7, which is equal to an MMI intensity of IX, and was felt over an area of two million square miles. Even in Maryland, the magnitude was a 4 to 5. [125]

No significant earthquake incidents have been recorded in Frederick County. Several earthquakes in adjacent states have been felt in Maryland. These out of state areas with more seismic activity include southwestern Virginia, central Virginia, and the Atlantic seaboard northward from Wilmington, Delaware. [126]

The following are some notable earthquake events that have been felt in Frederick County:

- On **August 23, 2011**, a 5.8 magnitude and MMI of VII earthquake occurred in Louisa County, Virginia. The earthquake was felt by many in Maryland, with light to moderate perceived shaking within the County. Frederick County Public Works Division, Department of Highway and Facility Maintenance records did not indicate any loss or require infrastructure repairs due to this event. Figure 5.29 shows the shaking intensity of this event.
- On **July 16, 2010**, an earthquake of 3.6 magnitude was reported in Montgomery County, Maryland. The epicenter was located near Germantown, Md., but was felt across the entire region. A 2.0-magnitude aftershock was reported about 8.5 miles away at 5:16 a.m. in the area of Barnesville Road in Boyds, Maryland. No damage was reported. [127]
- An earthquake 12 miles south of Lancaster, Pennsylvania with a 4.1 on the Richter Scale was felt in much of Maryland on Easter Sunday, **April 22, 1984**. Most notable effects in Maryland were in the northeastern part of the State. [128]
- Several earthquakes with a magnitude of 2.7 were located in Union Bridge (northeast of Frederick County) occurred in **1902 and 1903**. Based on the magnitude and distance, these events may have been felt in the County, although this is unlikely. [129]

[125] Maryland Geologic Survey. *Earthquakes and Maryland.* http://www.mgs.md.gov/documents/mdquakes03.pdf Last date from 2011.
[126] Maryland Geologic Survey. *Earthquakes and Maryland.* http://www.mgs.md.gov/geology/geohazards/earthquakes_and_maryland.html accessed August 2015.
[127] "3.6-Magnitude Earthquake Shakes D.C. Region." NBC4. http://www.nbcwashington.com/news/local/36-Magnitude-Earthquake-Shakes-DC-Region-98589124.html.
[128] Maryland Geologic Survey. *Earthquakes and Maryland.* http://www.mgs.md.gov/documents/mdquakes03.pdf Last date from 2011.
[129] Maryland Geologic Survey. *Earthquakes and Maryland.* http://www.mgs.md.gov/documents/mdquakes03.pdf Last date from 2011.

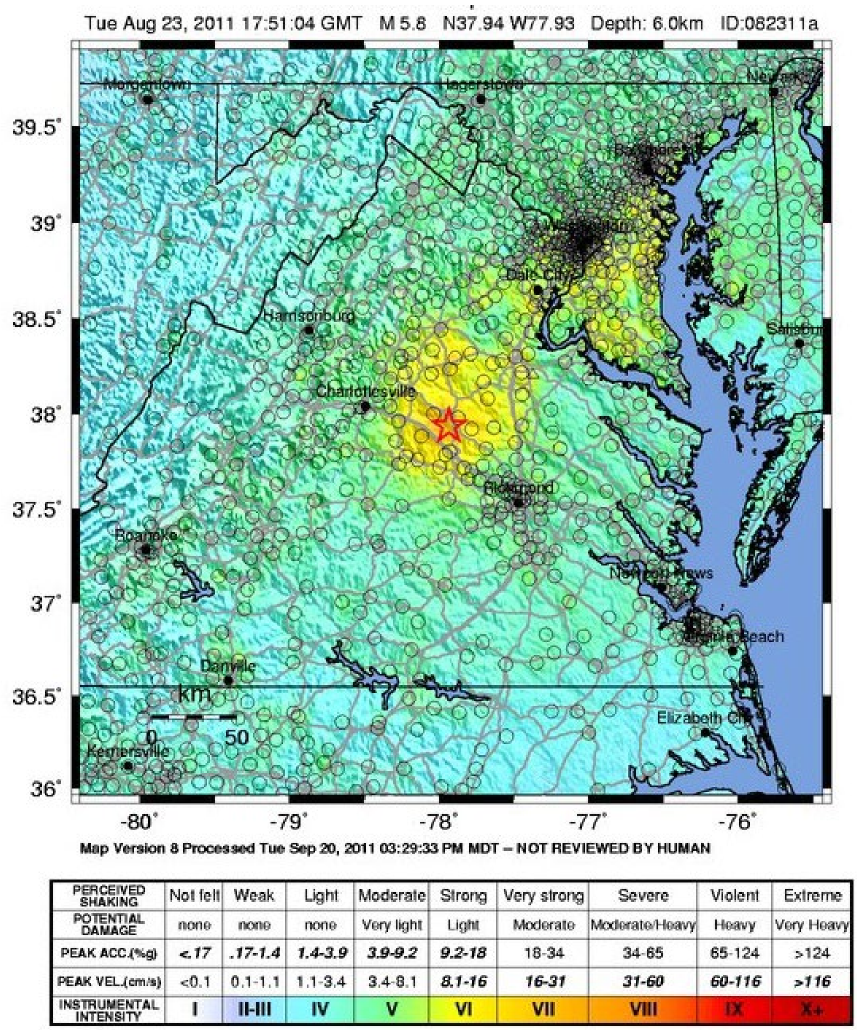

Figure 5.29. August 23, 2011 ShakeMap[130]

Probability and Severity of Future Occurrences

Earthquakes are not considered significant hazards in Frederick County, and the probability of these events occurring within the region, or affecting the region, is unlikely. The closest offshore fault lies east of Charleston, South Carolina and has the potential to impact Frederick County in the event of a moderate to severe earthquake event. However, due to the low probability of occurrence, buildings are seldom designed to deal with an earthquake threat; therefore, they are extremely vulnerable. If even a minor event were to occur, the damage could be severe.

Loss Estimation

Earthquakes are generally considered to be low-probability, high-impact events. Loss estimates created using FEMA's Hazus-MH v4.2 show annualized losses for the whole county at $187,850.20 (Table 5.66). A comparison between the total exposure for the County against the estimated losses indicates that, on an annual basis, less than 0.0004% of the total exposure is vulnerable to earthquakes.

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[130] USGS Earthquake Hazards Program

Table 5.63. Annualized Loss from Earthquake

Jurisdiction	Buildings	Contents	Inventory	Relocation	Income	Rental	Wages	Total Loss	Total Exposure
Communities									
City of Brunswick	$806.30	$137.35	$0.75	$181.51	$18.42	$62.05	$26.49	$1,232.87	$487,501,835.36
City of Frederick	$33,813.76	$7,318.97	$125.60	$6,500.62	$2,196.60	$3,050.23	$3,242.32	$56,248.09	$14,500,579,241.94
Unincorporated Areas	$80,795.70	$15,733.32	$414.71	$13,719.61	$2,178.81	$5,232.96	$2,899.88	$120,974.99	$37,331,596,486.21
Town of Burkittsville	$29.97	$5.20	$0.05	$5.49	$0.57	$1.90	$0.98	$44.16	$16,282,566.30
Town of Emmitsburg	$142.36	$26.06	$0.12	$27.22	$4.83	$13.99	$6.96	$221.54	$83,456,609.85
Town of Middletown	$537.36	$84.40	$0.55	$95.12	$12.42	$33.20	$21.30	$784.36	$422,751,594.02
Town of Mount Airy	$683.85	$127.49	$1.01	$111.38	$15.55	$37.82	$23.39	$1,000.50	$303,813,256.50
Town of Myersville	$41.04	$5.88	$0.03	$7.54	$0.93	$2.41	$1.37	$59.19	$37,432,653.31
Town of New Market	$185.43	$34.98	$0.37	$30.39	$3.83	$10.37	$4.82	$270.18	$74,407,910.22
Town of Thurmont	$917.56	$184.30	$3.87	$169.79	$43.34	$63.65	$63.23	$1,445.74	$451,586,911.13
Town of Walkersville	$2,423.67	$472.07	$15.63	$432.25	$65.25	$149.86	$87.66	$3,646.39	$820,133,665.51
Town of Woodsboro	$37.35	$8.01	$0.30	$7.01	$1.72	$2.40	$2.03	$58.83	$16,639,132.52

Jurisdiction	Buildings	Contents	Inventory	Relocation	Income	Rental	Wages	Total Loss	Total Exposure
Village of Rosemont	$38.49	$6.09	$0.06	$7.17	$0.48	$2.36	$0.53	$55.19	$23,559,482.92
Frederick County (Total)	**$121,620.60**	**$24,375.50**	**$563.60**	**$21,521.10**	**$4,574.00**	**$8,756.10**	**$6,439.30**	**$187,850.20**	**$55,161,545,983.25**
Colleges									
Frederick Community College	$144.96	$29.13	$0.06	$28.13	$3.53	$11.50	$6.96	$224.27	$71,216,735.56
Hood College	$254.24	$80.75	$0.14	$67.25	$22.95	$17.75	$41.55	$484.64	$123,116,633.96
Mount St. Mary's University	$141.59	$25.93	$0.12	$27.07	$4.77	$13.86	$6.94	$220.29	$82,648,239.18

Source: Hazus-MH v4.2

Impact Summary

Primary Impacts

Earthquakes can cause damage directly to buildings, infrastructure, and the landscape. Infrastructure systems that can be particularly affected are communication, water, and electricity. In addition, there is significant threat of injury and loss of life as a result of collapsing structures and falling debris. Damage from an earthquake can range from cracks in plaster or sidewalks to complete building and infrastructure collapse. Earthquake events can lead to disruption of utilities (e.g., gas, electric, and communications) and injuries or even fatalities.

Secondary Impacts

Earthquakes can last from a few seconds to more than five minutes, and they may also occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris, because the tremors shake, damage, or demolish buildings and other structures. Disruption of communications, electrical power supplies, and gas, sewer, and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides, or releases of hazardous material, compounding their disastrous effects.

Strong earthquakes often trigger secondary effects which have a high loss potential as well and are usually the prime factor for determining whether an earthquake is categorized as a catastrophe. Secondary effects can include landslides (in hilly or mountainous areas), amplification, surface rupture, flash flooding (including dam failures), subsidence, fires (from ruptured gas lines and downed utility lines), liquefaction of soil hazardous materials releases, and regional changes in land elevation.

Risk Assessment

Assets Exposed

Because the epicenter of an earthquake cannot be predicted, it can be assumed that all structures are equally at risk. However, because the severity on the Moment Magnitude scale tends to be lower than 5.0, the potential damage to these structures tends to be light at most, with the majority of earthquakes causing no damage, even if shaking is felt. This includes all critical facilities.

Population Exposed

Frederick County's experiencing an earthquake is unlikely. However, an earthquake's epicenter cannot be predicted, which makes all of Frederick County residents vulnerable, should an earthquake occur. The number of people affected by an earthquake and to what degree will depend on the severity of event that occurs.

Vulnerability Summary

Older buildings throughout the County are expected to be the most vulnerable to an earthquake. Dense urban areas are also more vulnerable to widespread damage due to buildings in close proximity potentially causing secondary damage around them.

Reducing Vulnerability

Ensuring that future development is built to the latest recommended building codes will likely provide enough protection to reasonably reduce vulnerability, considering the hazard is very unlikely to occur. Key areas of focus to reduce vulnerability to earthquakes in the County include:

- Adopt and enforce building code provisions that aim to mitigate earthquake damage risk.
- Incorporate structural and non-structural seismic strengthening strategies into ongoing development and existing capital projects.

Development Trends Analysis

In 2019, Frederick County adopted the Livable Frederick Master Plan as an approach to policy and general growth strategy that would provide a clear direction for the County with future change in mind through 2050. A Comprehensive Plan Map and several other planning documents were developed to constitute Frederick County's Comprehensive Plan, with the Livable Frederick Master Plan serving as the guiding document for all future updates and coordination.

Livable Frederick Comprehensive Planning includes a thorough and forward-looking hazard mitigation and climate adaptation approach. The hazard risk assessment detailed above considers current development in its analyses, but since the Comprehensive Plan has identified Community Growth Areas, proposed highway plans, and proposed community facilities, it is important that we view these future additions in the context of hazard risk.

Livable Frederick Vision Statement

It is the year 2040. Frederick County is a vibrant and unique community where people live, work, and thrive while enjoying a strong sense of place and belonging.

Background

Based on 2015 data from the Frederick County Planning Department, the County's land area totals 626.6 square miles or 401,032 acres. Of this, agricultural uses make up 59.2%, residential uses make up 20.9%(with an additional 2%of planned unit development), commercial and industrial uses make up 2%, institutional uses make up 0.3%, and mixed-use development makes up 0.3%. The predominant land use is agriculture. According to the 2010 Comprehensive Plan, the Walkersville Region contains the highest percentage of agricultural use, with 88%of the land area devoted to agriculture. The Frederick Region, which is dominated by the City of Frederick, has the lowest percentage of agricultural land use at 40.5%.

The County recognizes the impacts that haphazard development could have on the natural environment or significant historic resources and views this as a priority. Growth is conducted in a manner that protects the County's sensitive resources, including: streams and their buffers, SFHAs, habitats of threatened and endangered species, steep slopes, the Monocacy Scenic River, areas of prime agricultural soils outside of community growth areas, groundwater resources (specifically well-head protection areas), wetlands, limestone conglomerate/carbonate rock areas, and historic and archaeological resources.

According to the Frederick County Planning Department, no development has occurred in the floodplain in the past 10 years.

Proposed Future Development

The future development depicted in the following maps represent officially adopted growth area boundaries, transportation network additions, approved residential development projects, and proposed community facilities. It is important to note that the LFMP went beyond strictly planned future development to consider future changes in needs and priorities. It used scenario planning to analyze regional and local dynamics as well as changing housing and employment market demands to create four hypotheses about future growth within the County. While all four possibilities are distinct, there is no one goal scenario. These four scenarios and their relationship to future hazard risk can be assessed in the next iteration of the Hazard Mitigation and Climate Adaptation Plan.

Figure 5.30 illustrates the officially adopted growth and development in Frederick County and Figure 5.31 illustrates the residential development pipeline as of July 2021. The residential development pipeline includes all county and municipal projects that have received some type of development approval, so they may or may not be under construction. As of September 2021, the pipeline totals (lots/units that have not been constructed nor granted permits) are: 6,109 Frederick County units, 7,178 City of Frederick units, and 1,749 other municipal units.

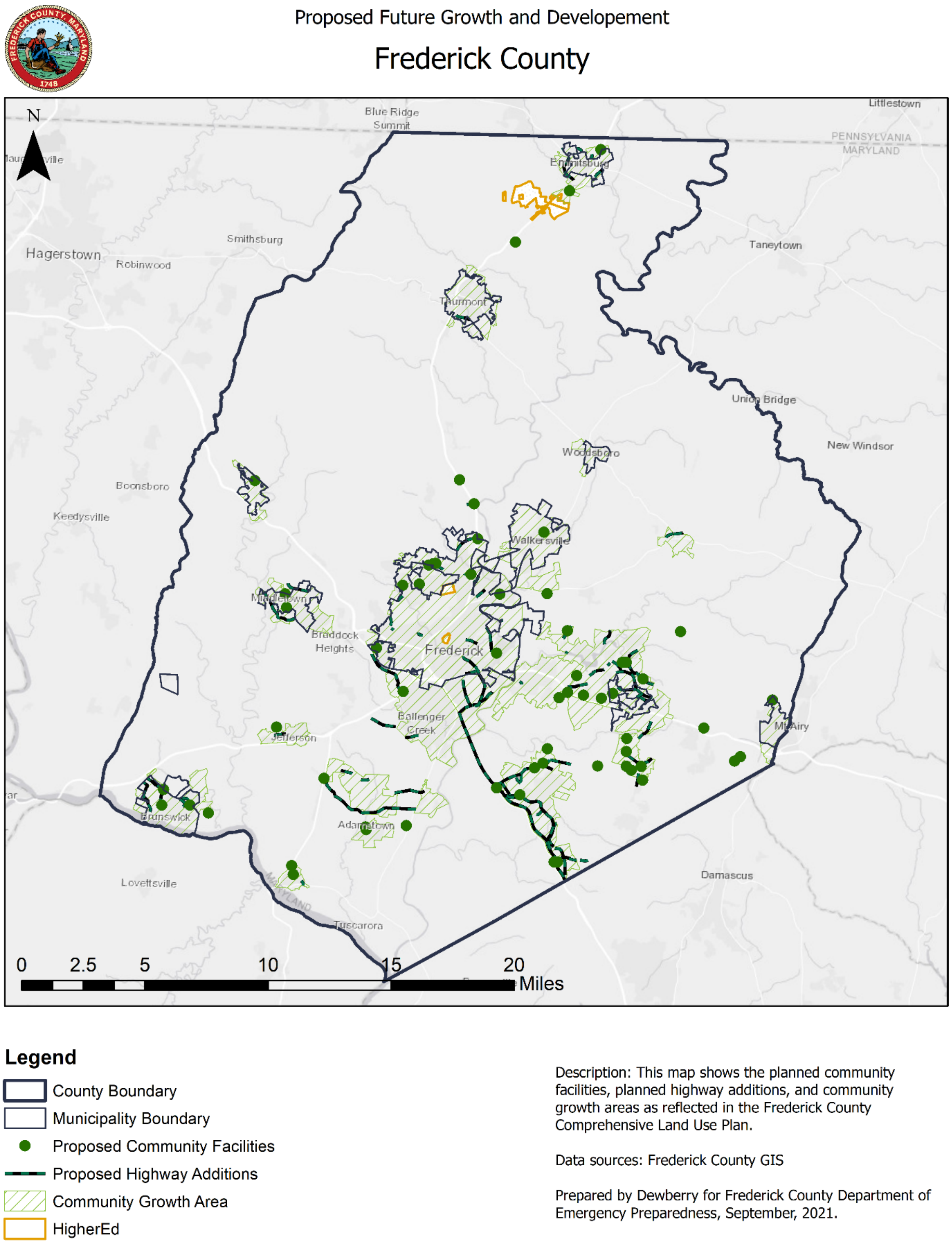


Figure 5.30. Proposed Future Growth and Development in Frederick County

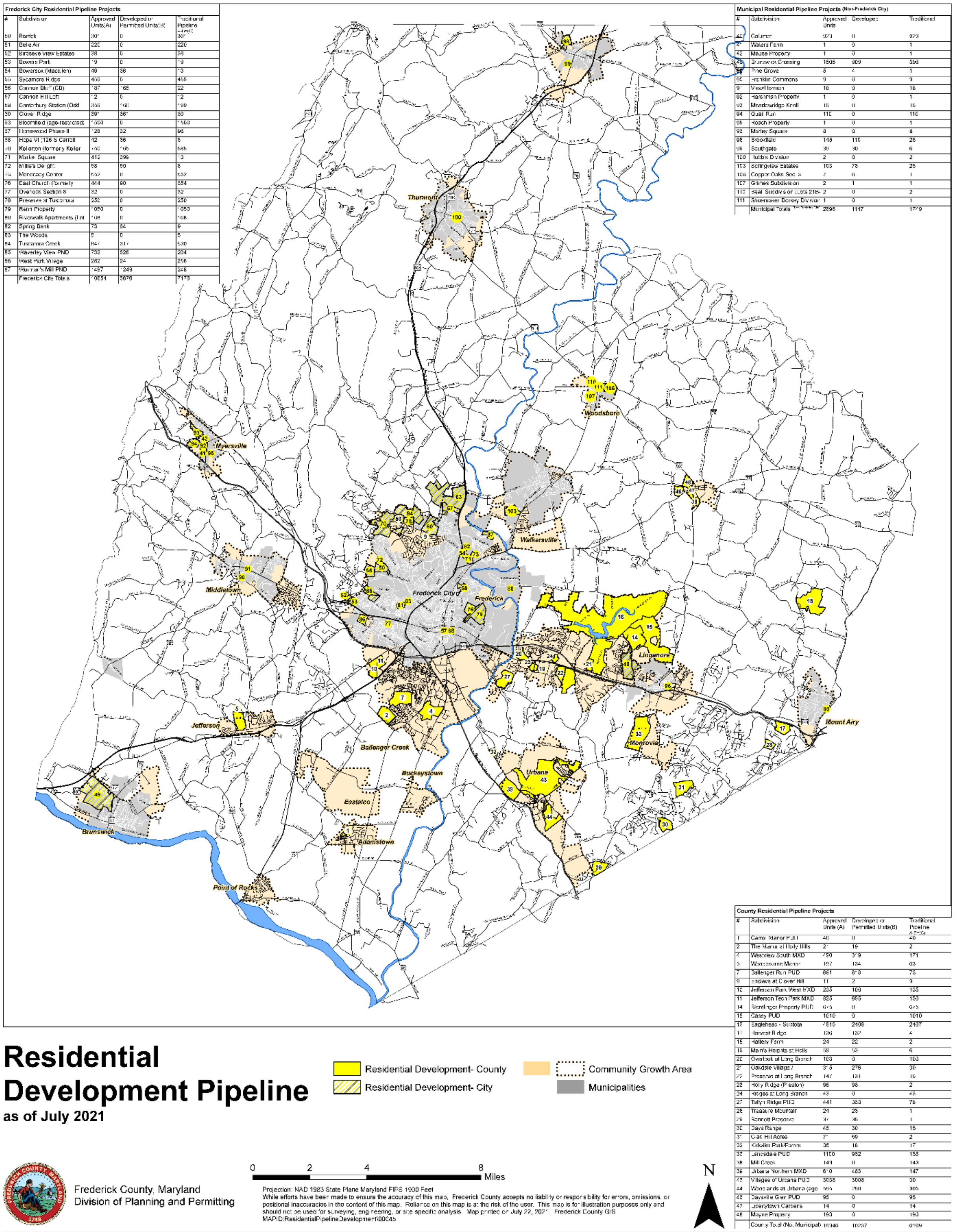


Figure 5.31. Residential Development Pipeline as of July 2021

Hazard Risk to Future Development

As development increases, risk and exposure to hazards increase. In order to mitigate the effects of hazards, future land use planning has to consider the approximate locations and impacts of various hazard events by siting development in lower-risk areas of the community. The following maps (Figure 5.32 through Figure 5.35) depict the future development areas and assets from Figure 5.30 overlaid with various hazard risk areas.

Additional mapping that showcases specific areas of note in the maps are included in Appendix E. Overall, these maps show that the City of Frederick Community Growth Area faces increased risks from multiple hazards when compared to other Growth Areas. As further planning and development occurs throughout the County, this cursory analysis can be used to help identify projects that should be considered for additional hazard mitigation actions.

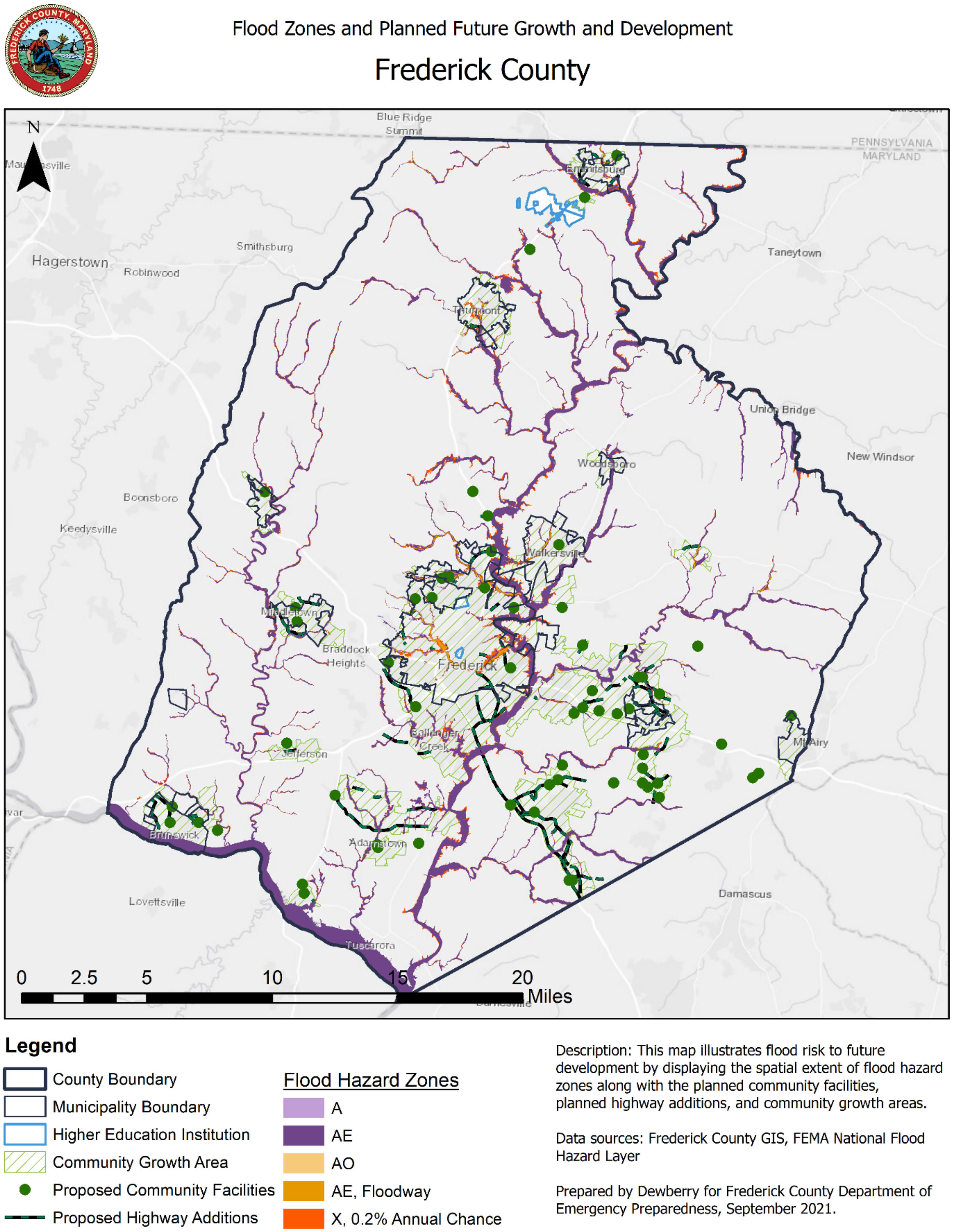
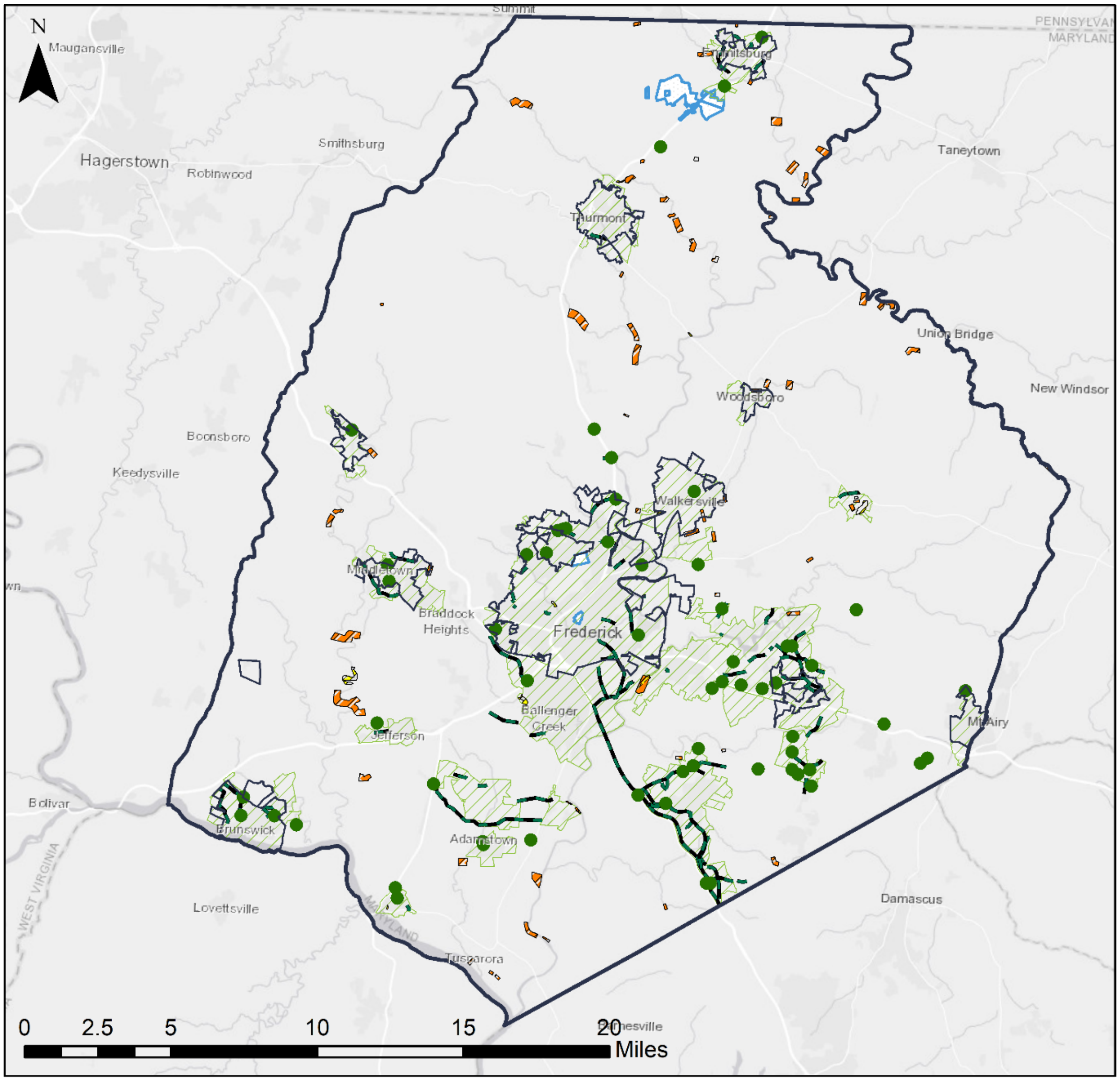


Figure 5.32. FEMA Flood Zones and Planned Development Areas and Assets

Frequently Flooded Areas and Planned Future Growth and Development

Frederick County



Legend

- County Boundary
- Municipality Boundary
- Higher Education Institution
- Community Growth Area
- Proposed Community Facilities
- Proposed Highway Additions
- Roadway Flood Areas
- Park Flood Areas

Description: This map illustrates flood risk to future development by displaying the spatial extent of frequently flooded roads and parks along with the planned community facilities, planned highway additions, and community growth areas.

Data sources: Frederick County GIS

Prepared by Dewberry for Frederick County Department of Emergency Preparedness, September 2021.

Figure 5.33. Frequently Flooded Areas and Planned Development Areas and Assets

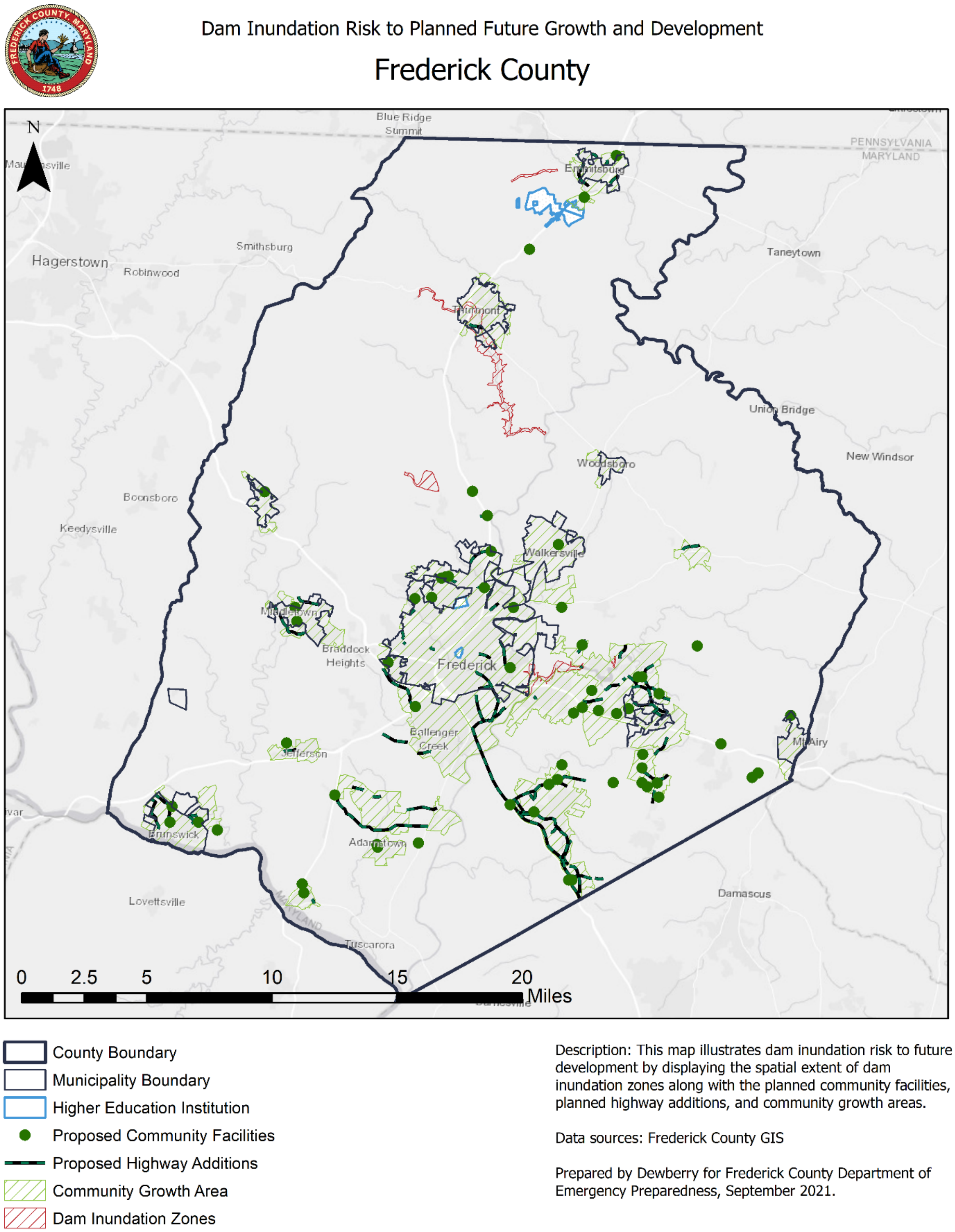


Figure 5.34. Dam Inundation Zones and Planned Development Areas and Assets

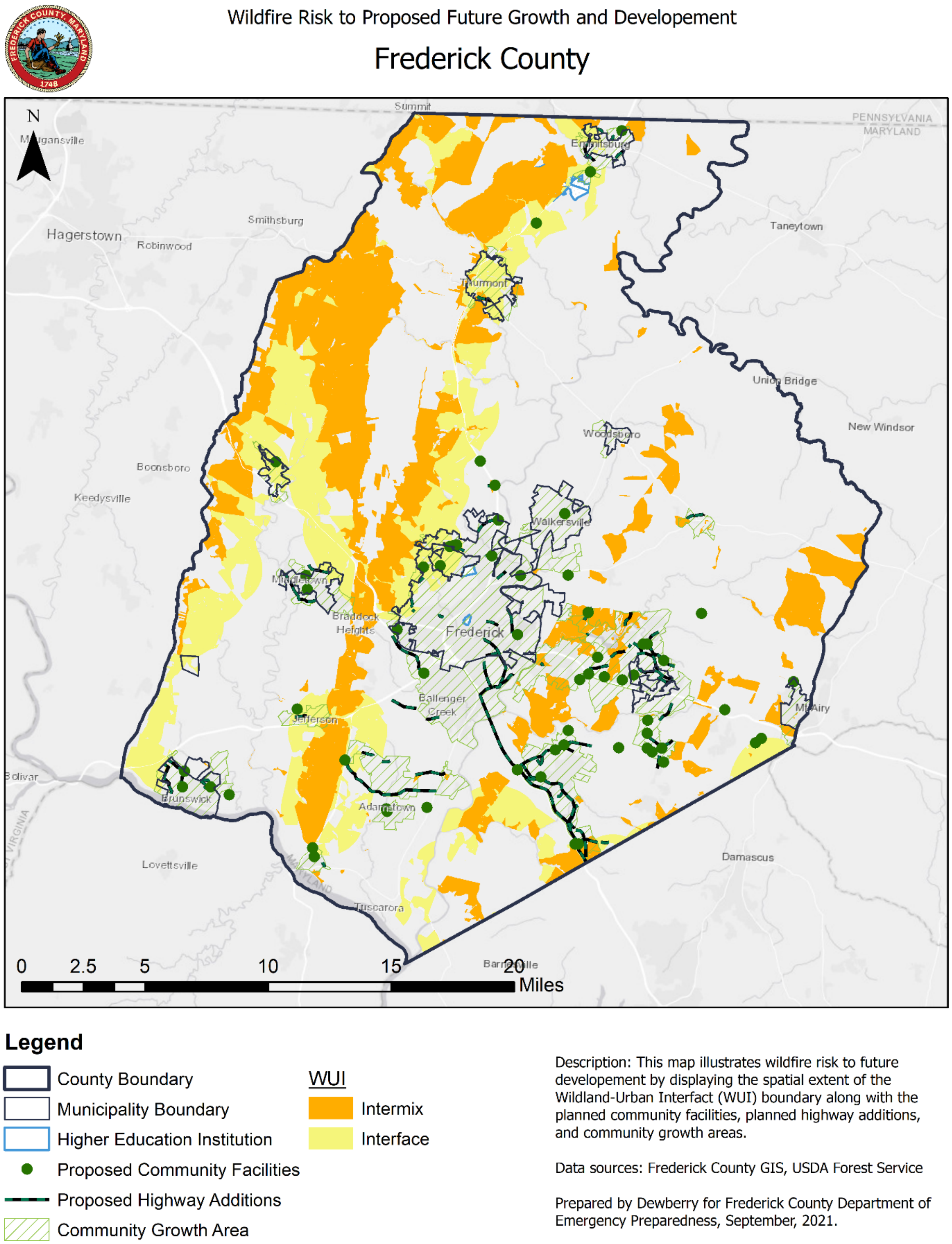


Figure 5.35. WUI and Planned Development Areas and Assets

CHAPTER 6. CAPABILITY ASSESSMENT

Frederick County has a number of resources it can access to implement hazard mitigation initiatives. These resources include both private and public assets at the local, state, and federal levels.

Capability and Capacity Assessment Overview

A detailed Hazard Mitigation Capabilities Assessment Questionnaire was prepared and distributed to the County and municipalities in August 2021. The questionnaire was designed to assess the community's ability to reduce future losses from hazards like floods and winter storms through its various policies and programs. The intent of the capability assessment was to provide an inventory of existing policies, programs, practices, and operational responsibilities that have or may have a major role in supporting the community's mitigation program. The results of the questionnaire are integral to the development of a mitigation strategy, the backbone of the local hazard mitigation plan 2021 revision. The several dozen questions presented in the questionnaire covered several agencies in the jurisdictions, particularly the County. These agencies included the Planning and Permitting Division, Division of Public Works, and Division of Public Safety. Table 6.1. Mitigation Planning Capability Analysis summarizes the capabilities of the local county and municipalities that will facilitate the implementation of the mitigation strategy.

National Flood Insurance Program

The NFIP is a federal program that enables property owners in participating communities to purchase insurance for flood losses since homeowner insurance policies do not cover damage from flood. Flood insurance is designed to provide an alternative to post-disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. For a community to participate in the NFIP it must adopt FEMA's flood risk maps, the Flood Insurance Study, and floodplain management regulations that reduce future flood damages.

Floodplain management regulations are the cornerstone of NFIP participation. Communities that participate in the NFIP are expected to adopt and enforce floodplain management ordinances, including regulation of new construction in the Special Flood Hazard Area (SFHA). These regulations apply to all types of floodplain development (not just building construction) and ensure that development activities will not cause an increase in future flood damages.

Nationally, flood damage is reduced by nearly $1 billion annually through community implementation of sound floodplain management requirements and the purchase of flood insurance by property owners. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80% less damage annually than those which predate floodplain management regulations or were not built to compliance. In Frederick County, buildings are required to be elevated to or above the Base Flood Elevation, which is the predicted level of the 1-percent annual chance flood. Buildings in the SFHA that require reconstruction due to damage, rehabilitation, addition, or other improvements that exceeds 50 percent of the building's market value must meet the same requirements as new development. The County's Zoning Administration tracks substantially improved structures through permits for all communities except the City of Frederick. The

Frederick County Division of Emergency Management utilizes the Orion damage assessment software to allow residents to record damage and repair costs which supplements the in-person damage assessments that County officials conduct during substantial damage assessments.

Frederick County and several of its incorporated communities have developed strong floodplain management programs that exceed the minimum NFIP regulatory standards. Most notably, in the unincorporated areas of the County, new development is not permitted in the County's designated floodplains unless approved by the County Board of Appeals. While new development is being guided away from known areas at risk of flooding, Frederick County, nonetheless, has existing neighborhoods that periodically flood. Table 5.13 in Chapter 5 provides an overview of repetitive loss properties in the County that are a priority for mitigating. The Frederick County Zoning Administration reviews, processes, and approves zoning certificates and Board of Appeals applications, administers floodplain regulations, and enforces the Frederick County Zoning Ordinance.

All incorporated jurisdictions in Frederick County are participating in the regular, as opposed to emergency, NFIP. There are no incorporated jurisdictions that are not participating. Table 5.13. summarizes community participation in the NFIP in Frederick County. The current effective maps for the County are from September 2007, with preliminary products issued on December 2, 2020. The notable exception is the Town on Mount Airy, which has a current map date and initial FIRM date of October 2, 2015. Frederick County is also currently undergoing a Flood Insurance Rate Map (FIRM) update. This is done to more accurately reflect the riverine flood hazards for a base flood event. The new maps are expected to go into effect in summer of 2022. The current FIRM and preliminary FIRM (as of January 2022) is available on Frederick County's website through the Division of Planning and Permitting.

Table 6.1. Community Participation in the National Flood Insurance Program (as of August 2021)

Community Name	Initial Flood Hazard Boundary Map Identified	Initial Flood Insurance Rate Map Identified	Current Effective Map Date	Date of NFIP Entry
Frederick County	07/19/74	06/01/78	09/19/07	06/01/78
City of Brunswick	06/28/74	01/07/77	09/19/07(M)	01/07/77
Town of Burkittsville	N/A	09/19/07	09/19/07	08/16/10
Town of Emmitsburg	03/29/74	09/17/80	09/19/07	09/17/80
City of Frederick	10/18/74	06/15/78	09/19/07	06/15/78
Town of Middletown	01/14/77	10/23/81	09/19/07(M)	10/23/81
Town of Mount Airy	N/A	10/02/15	10/02/15	05/27/14
Town of Myersville	12/06/74	12/15/78	09/19/07(M)	12/15/78
Town of New Market	N/A	09/19/07	09/19/07	12/31/07
Village of Rosemont	N/A	09/19/07	09/19/07	08/30/10
Town of Thurmont	06/28/74	09/28/79	09/19/07	09/28/79
Town of Walkersville	06/28/74	09/30/80	09/19/07	09/30/80

Community Name	Initial Flood Hazard Boundary Map Identified	Initial Flood Insurance Rate Map Identified	Current Effective Map Date	Date of NFIP Entry
Town of Woodsboro	01/13/78	12/15/78	09/19/07(M)	12/15/78

As of August 2021, there were 638 flood insurance policies in effect throughout the County, with total annual premiums of $710,037 covering more than $179 million in property. The majority (346) of these policies are for properties in the unincorporated areas of Frederick County. The loss statistics from FEMA's Community Information System database for the County indicate that there have been 269 flood insurance claims processed by the NFIP since 1978. These statistics are summarized in Table 5.14.

Table 6.2. Flood Insurance Policy Statistics and Claims (as of August 2021)

Community Name	No. of Policies	Total Premium	Total Coverage	Total Claims since 1978	Total Payments
Brunswick	15	$10,888	$3,618,800	11	$66,268
Burkittsville	N/A	N/A	N/A	N/A	N/A
Emmitsburg	7	$4,343	$1,560,200	13	$40,951
City of Frederick	229	$230,940	$71,531,400	60	$319,906
Middletown	7	$3,302	$2,450,000	1	$0
Mount Airy	N/A	N/A	N/A	N/A	N/A
Myersville	1	$442	$350,000	0	$0
New Market	4	$1,641	$1,092,000	0	$0
Rosemont	1	$1,337	$1,000,000	0	$0
Thurmont	8	$11,041	$1,648,100	2	$7,856
Walkersville	19	$9,132	$5,554,000	1	$0
Woodsboro	1	$494	$350,000	0	$0
Unincorporated Areas	346	$436,477	$90,799,100	181	$1,585,198
Total	**638**	**$710,037**	**$179,953,600**	**269**	**$2,020,179**

Flood insurance is available to anyone in the County, including structures outside of the mapped SFHA, provided they are located in an NFIP-participating community. In some cases, therefore, the number of policies includes policies for structures that are outside the mapped SFHA.

Table 6.3 summarizes Letters of Map Change information. Letters of Map Change refer to different types of revisions or amendments to FEMA maps to officially remove a property and/or structure from the SFHA. These changes are determined when a property owner who believes their property was incorrectly identified as a SFHA submits an application to FEMA to determine whether the property's location or elevation means it would not be inundated by the base flood. The Frederick County floodplain manager, Tolson DeSa, and the other Zoning

Administration staff in the Division of Planning and Permitting track and assist with Letters of Map Change throughout the County when necessary.

Table 6.3. Letters of Map Change by Community

Community Name	Letters of Map Change
Frederick County	369
City of Brunswick	18
Town of Burkittsville	0
Town of Emmitsburg	12
City of Frederick	147
Town of Middletown	4
Town of Mount Airy	Unknown
Town of Myersville	4
Town of New Market	5
Town of Thurmont	19
Town of Walkersville	18
Town of Woodsboro	4
Total	**600**

Community Rating System (CRS)

Communities that regulate development in floodplains are able to participate in the NFIP. In return, the NFIP makes federally backed flood insurance policies available for properties in the community. The Community Rating System (CRS) was implemented in 1990 as a program for recognizing and encouraging community floodplain management activities that exceed the minimum NFIP standards. There are ten CRS classes: Class 1 requires the most credit points and gives the largest flood insurance premium reduction; Class 10 receives no premium reduction. These discounts are applied per each CRS community and apply to all flood insurance policyholders within the jurisdiction.

The City of Frederick entered the CRS in October 2012 and participates as a “Class 7” community. This allows city residents in the SFHA to receive a 15% discount on their flood insurance premiums for policies purchased under the NFIP. Residents in non-SFHA areas receive a 5% discount on their policies. Frederick County participated in an informal CRS review as a part of the 2021 HMCAP update. More information on this is included below.

Community Rating System Review Activity

On December 8, 2021, Frederick County participated in an informal Community Rating System (CRS) review activity with Hazard Mitigation Planning Committee members and Tolson DeSa, Frederick County’s Certified Floodplain Manager (specific participation can be found in Chapter 2). This activity was facilitated by Dewberry consultants. The goal of the activity was to understand the CRS level that the County would enter at if it were to join the CRS and determine a potential level of effort for doing so.

Utilizing a CRS Activity Toolkit that Dewberry developed, participants from the County reviewed the elements from Frederick County's floodplain ordinance that would receive credit based on eligible CRS activities and determined other county activities that would also receive credit. The Toolkit was based on the 2017 CRS Coordinator's Manual, the CRS Resources website, and other publicly available sources in addition to the information provided by FEMA Regional staff and various subject matter experts.

The overall approach was conservative with the number of points each evaluated activity would receive in order to gauge a realistic program enrollment class. It was determined that the County could likely achieve a class 9 with a low level of effort as the County is already doing activities that would qualify, and it would only need to focus on the documentation element. A class 8 is also feasible based on already existing activities, but it would require more documentation, and therefore a moderate level of effort.

The County representatives believed that due to the NFIP discounts available to class 8 and class 9 communities and the limited number of NFIP-participating structures throughout the County, the level of effort to enroll in the program would not currently provide the greatest return on invested county time. Additionally, the County is working to resolve zoning issues identified during the most recent Community Assistance Visit with FEMA. This work would need to be fully completed before the initial community review for CRS enrollment process can begin.

Overall, Frederick County's decision was to continue further detailed evaluation of potential CRS activities and submit a letter of interest to FEMA. This will allow time for the NFIP's new Risk Rating 2.0 rates to take effect and provide a better opportunity for the County to understand the overall benefit of enrollment. A final decision will be made on whether to enroll in the program or not would be made after the initial CRS community review visit. A mitigation action regarding this activity can be found in Chapter 7.

Community Assistance Visits

The NFIP offers a Community Assistance Program that offers a Community Assistance Visit to a community by a FEMA staff member or staff of a state agency on behalf of FEMA. This visit provides technical assistance to the community and assures that the community is adequately enforcing its floodplain management regulations.

Generally, a Community Assistance Visit consists of a tour of the floodplain, an inspection of community permit files, and meetings with local appointed and elected officials. If any administrative problems or potential violations are identified during a Community Assistance Visit the community will be notified and given the opportunity to correct those administrative procedures and remedy the violations to the maximum extent possible within established deadlines. FEMA or the state will work with the community to help them bring their program into compliance with NFIP requirements.

The majority of the communities in the HMCAP have participated in a Community Assistance Visit, and the dates of their most recent visits are shown in Table 6.4. As mentioned in Community Rating System Review Activity section above, Frederick County is working on resolving zoning issues that were identified during their most recent visit in 2019.

Table 6.4. Community Assisted Visit Dates by Community

Community Name	Community Assisted Visit Date
Frederick County	12/2/2019
City of Brunswick	11/20/2013
Town of Burkittsville	N/A
Town of Emmitsburg	06/22/2011
City of Frederick	01/18/2017
Town of Middletown	11/20/2013
Town of Mount Airy	Unknown
Town of Myersville	11/21/2013
Town of New Market	N/A
Town of Thurmont	12/11/2013
Town of Walkersville	11/21/2013
Town of Woodsboro	12/07/2012
Total	**--**

Floodplain Management Capability Analysis

An important capability is the administration and enforcement of the floodplain management ordinance. Through the administration of floodplain ordinances, each local government can ensure that all new construction or substantial improvements to existing structures located in the SFHA are built with first-floor elevations above the Base Flood Elevation (BFE). Each municipality has a separate floodplain management ordinance. The County provides floodplain management ordinance administration and enforcement functions, except in the City of Frederick, which does its own administration and enforcement. The municipalities use the services of the Frederick County Zoning Administration in the Division of Planning and Permitting for these functions. Table 6.5 provides an overview of floodplain management capabilities throughout Frederick County.

Table 6.5. Floodplain Management Capability Matrix

Floodplain Management Capabilities	Frederick County	Brunswick	Burkittsville	Emmitsburg	Frederick (City)	Middletown	Mount Airy	Myersville	New Market	Rosemont	Thurmont	Walkersville	Woodsboro
Floodplain Management Ordinance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No
Floodplain Administrator	Yes	No	Yes	Yes	Yes	Yes	Yes+	Yes	Yes	No	Yes	Yes	Yes
SFHA structure count tracking	Yes	Yes+	Yes+	Yes+	Yes	Yes+	Yes+	Yes+	Yes+	Yes+	Yes+	Yes+	Yes+
Participates in NFIP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Joined	1978	1977	2010	1980	1978	1981	2014	1978	2007	2010	1979	1980	1978

Floodplain Management Capabilities	**Frederick County**	**Brunswick**	**Burkittsville**	**Emmitsburg**	**Frederick (City)**	**Middletown**	**Mount Airy**	**Myersville**	**New Market**	**Rosemont**	**Thurmont**	**Walkersville**	**Woodsboro**
Effective FIRM Date	9/19/2007												
Additional Freeboard Requirements (ft.)	2 ft.	2 ft.	NA	2 ft.	1 ft.	None	3 ft.	None	--	--	None	None	--
NFIP Manager	Yes	No	Yes	Yes	Yes	--	Yes[+]	Yes	--	--	Yes	No	--
Restrictive Ordinances	1-19-9.100	*	N/A	Floodplain ordinance	Floodplain ordinance	--	Chapter 38[+]	Chapter 80	--	--	**	--	--
Floodplain ordinance includes current FIRM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Public information & assistance	Yes	Yes[+]	Yes[+]	Yes[+]	Yes	Yes[+]	Yes[+]	Yes[+]	Yes[+]	Yes[+]	Yes[+]	Yes[+]	Yes[+]
Inform public about changes to FIRM	Letter; Meeting	Letter; Meeting	Letter; Meeting	Letter; Meeting	Letter; Meeting	Letter; Meeting	Letter; Meeting	Letter; Meeting	Letter; Meeting	Letter; Meeting	Letter; Meeting	Letter; Meeting	Letter; Meeting

Floodplain Management Capabilities	Frederick County	Brunswick	Burkittsville	Emmitsburg	Frederick (City)	Middletown	Mount Airy	Myersville	New Market	Rosemont	Thurmont	Walkersville	Woodsboro
Participates in CRS	No	No	No	No	Yes	No	No	No	No	No	No	No	No

* Setback, limited fill, historic flooding, flooding soils, variance to build in floodplain

** Setback, limited fill

+ Capability provided through Frederick County (Mount Airy receives assistance from Carroll County, MD)

-- No response provided by the locality

Mitigation Planning Capability Analysis

Building codes are important in mitigation; codes developed regionally consider the hazards present in a region of the country. Consequently, structures that are built to applicable codes are inherently resistant to localized strong winds, floods, and earthquakes.

Each municipality has a separate floodplain management ordinance and stormwater management ordinance. The County administers the building codes for all but the City of Frederick. Each municipality has either a stand-alone stormwater regulation (City of Frederick) or has adopted the County's stormwater ordinance. The Soil Conservation District approves erosion and sediment control plans for land-disturbing activities. The County provides inspection and enforcement functions except in the City of Frederick, which does its own inspection and enforcement. The municipalities use the services of the Frederick County Department of Permits and Inspection for building inspections. The County has an inventory of historic structures, public and private parks, and open space for unincorporated areas of the County and municipalities. Table 6.6 provides an overview of mitigation planning capabilities throughout Frederick County.

Table 6.6. Mitigation Planning Capability Matrix

Planning Capabilities	Frederick County	Brunswick	Burkittsville	Emmitsburg	Frederick (City)	Middletown	Mount Airy	Meyersville	New Market	Rosemont	Thurmont	Walkersville	Woodsboro
Comprehensive Plan	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
With Hazard Mitigation Element	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Subdivision Regulations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zoning Ordinance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Stormwater Management Program+	Yes	Yes+	Yes+	Yes	Yes	Yes	Yes	Yes+	Yes	Yes+	Yes+	Yes	Yes+
Building Code that Addresses Natural Hazards	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Extreme Heat	--	No	--	No	No	--	No	--	--	--	--	--	--

Planning Capabilities	Frederick County	Brunswick	Burkittsville	Emmitsburg	Frederick (City)	Middletown	Mount Airy	Meyersville	New Market	Rosemont	Thurmont	Walkersville	Woodsboro
Extreme Wind	Yes	Yes	NA	No	Yes	--	Yes	--	NA	NA	--	--	--
Severe Winter Storm	Yes	Yes	NA	No	Yes	--	No	--	NA	NA	--	--	--
Thunderstorms /Lightning	--	Yes	NA	No	Yes	--	No	--	NA	NA	--	--	--
Tornadoes	--	Yes	NA	No	No	--	No	--	NA	NA	--	--	--
Tropical Storm/ Hurricane	--	Yes	NA	No	No	--	No	--	NA	NA	--	--	--
Flooding	Yes	Yes	NA	Yes	Yes	--	Yes	--	NA	NA	--	--	--
Wildfires/ WUI Fires	--	No	NA	No	No	--	No	--	NA	NA	--	--	--
Earthquakes	Yes	Yes	NA	No	Yes	--	No	--	NA	NA	--	--	--

Planning Capabilities	**Frederick County**	**Brunswick**	**Burkittsville**	**Emmitsburg**	**Frederick (City)**	**Middletown**	**Mount Airy**	**Meyersville**	**New Market**	**Rosemont**	**Thurmont**	**Walkersville**	**Woodsboro**
Land Subsidence	--	Yes	NA	No	No	--	No	--	NA	NA	--	--	--
Designated Building Official	Yes	No	No	Yes	Yes	No	Unsure	No	No	No	No	No	NA
Regular Inspections	Yes	N/A	NA	No	Yes	N/A	N/A	N/A	NA	No	N/A	N/A	NA

+ Administered at the County level

-- No response provided by the locality

Mitigation Project Capabilities Analysis

Successfully and consistently carrying out hazard mitigation projects is the primary goal of hazard mitigation planning. The communities in Frederick County aim to conduct a variety of mitigation project types to offer the best chance at comprehensive hazard risk reduction. This includes improvements to local plans, codes, and regulations; structure and infrastructure protection; and natural systems protection, among others. Table 6.7 provides an overview of mitigation project capabilities throughout Frederick County.

Table 6.7. Mitigation Project Capability Matrix

Project Capabilities	Frederick County	Brunswick	Burkittsville	Emmitsburg	Frederick (City)	Middletown	Mount Airy	Meyersville	New Market	Rosemont	Thurmont	Walkersville	Woodsboro
Mitigation projects to improve local plans and regulations	Yes	Yes	No	No	Yes	Yes	Unsure	Yes	No	NA	Yes	No	No
Structure and infrastructure mitigation projects	Yes	Yes	No	No	Yes	No	Unsure	No	No	No	Yes	No	No
Private Buildings or Property Protection	--	N/A	NA	N/A	No	N/A	--	N/A	No	NA	--	N/A	NA
Public Buildings or Property Protection	Yes	Yes	NA	N/A	Yes	N/A	--	N/A	No	NA	--	N/A	NA
Critical Facilities Protection	--	Yes	NA	N/A	Yes	N/A	--	N/A	No	NA	Yes	N/A	NA

Project Capabilities	Frederick County	Brunswick	Burkittsville	Emmitsburg	Frederick (City)	Middletown	Mount Airy	Meyersville	New Market	Rosemont	Thurmont	Walkersville	Woodsboro
Natural systems protection	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No
Natural or cultural resources inventory	Yes	No	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No
Erosion or sediment control mitigation projects	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No

-- No response provided by the locality

Emergency Communication and Response Capability Analysis

Although this plan is focused on mitigation, Table 6.8 provides an overview of emergency communication and response capabilities as they also play a crucial role in hazard risk reduction.

Table 6.8. Emergency Communication and Response Capability Matrix

Emergency Communication and Response Capabilities	Frederick County	Brunswick	Burkittsville	Emmitsburg	Frederick (City)	Middletown	Mount Airy	Myersville	New Market	Rosemont	Thurmont	Walkersville	Woodsboro
Emergency Operations Plan	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No
Warning Sirens	Yes	No	Church bells	Yes	No	Yes	No	Yes	Yes (at fire station)	No	Yes (at fire station)	Yes (at town hall)	No
With NOAA Weather Radio	Yes	N/A	No	No	N/A	Yes	No	No	-	No	No	N/A	-
Public Information Program	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No

Emergency Communication and Response Capabilities	Frederick County	Brunswick	Burkittsville	Emmitsburg	Frederick (City)	Middletown	Mount Airy	Myersville	New Market	Rosemont	Thurmont	Walkersville	Woodsboro
Additional Capabilities	Emergency Text Alerts	-	-	Emergency Alert System	Participation in CRS Program.	-	--	Channel 99 Comcast; Website	-	-	Emergency /Disaster Preparedness and Response Plan – Water Treatment Facilities; Hunting Creek Dam EAP	-	-

+ Capability through Frederick County

-- No response provided by the locality

Plan Assessment

A review of enabling statutes, ordinances, planning documents, and building codes revealed that some aspects of the municipal regulations strongly supported mitigation capabilities. Table 6.5. County-Level Plan Assessment and Table 6.6. Municipal-Level Plan Assessment identify County- and municipal-level plans and opportunities to enhance the County's and municipalities' mitigation efforts if specific sections are strengthened or revised. Though many of the plans mentioned below are somewhat dated, they are the most current plans as of October 2021. For the municipal plans, the responsible party would be the affected municipality.

Table 6.9. County-Level Plan Assessment

Plan Name	Description	Mitigation Integration Options
2010 Frederick County Comprehensive Plan	This Plan updates the 1998 Countywide Comprehensive Plan, which was a policy document that provided guidance for subsequent updates to the County's 8 region plans. The Plan initiates a new planning process for the County and includes the following elements: agricultural and rural communities, green infrastructure, economy, water resources, transportation, and growth management.	A hazard mitigation element is included in the 2010 Comprehensive Plan, Chapter 3, pages 3 to 11. It is only a brief description of hazards, which includes a table listing the hazards and their priority. There is one action item regarding sinkholes. In the next Comprehensive Plan, include all "Plans and Ordinances" action items from the Hazard Mitigation Plan. Also, consider including a chapter that specifically addresses current and future development in hazard prone areas.
2012 Frederick County Land Preservation, Parks and Recreation Plan	The Land Preservation, Parks and Recreation Plan provides the necessary framework from which to develop an integrated and coordinated approach to 3 primary elements, parks and recreation, agricultural land preservation, and natural resource conservation. The State requires the plan to be updated every 6 years in order for the County to remain eligible for Program Open Space funding. All land acquisition and park development funded through Program Open Space must be consistent with the approved State and County Land Preservation, Parks and Recreation Plan.	The Plan includes waterbody buffer ordinance floodplain regulations on pages 51 and 52, which address development in flood-prone areas. Consider adding element to address wildfires.

Plan Name	Description	Mitigation Integration Options
1990 Monocacy Scenic River Study and Management Plan	The River Management Plan was prepared by the Maryland Department of Natural Resources to provide a blueprint for restoring the water quality of the Monocacy River and managing this riparian resource wisely. The Plan includes detailed information on the river's ecology, geology, and its exploration and settlement history, plus cultural and other historical elements. Water quality and land uses in the river's watershed are also a main focus of the management plan.	Maryland Department of Natural Resources is responsible for this plan. If it were to be updated, the County could advocate to include language relevant to hazard mitigation.
2007 Frederick County Historic Preservation Plan	The first County Historic Preservation Plan was adopted in 1997 and updated in 2007. It is a broad statement of historic preservation goals, objectives, and strategies and a description of the existing resources for preservation. The 1997 Plan provided the foundation for establishing the County's Historic Preservation Commission and the Historic Preservation Ordinance.	In the next Plan, include a goal to mitigate the impact of hazards on historic sites and resources. Also consider adding a section that discusses historical sites in hazard-prone areas, the potential impacts of different hazards, and potential mitigation options.
2004 Catoctin Mountain National Scenic Byway Corridor Management Plan	The Catoctin Mountain National Scenic Byway follows U.S. Route 15 from the Pennsylvania border to the Potomac River. In 2003, the corridor was designated a State Scenic Byway and a National Scenic Byway. The Management Plan provides a description of the intrinsic qualities (historic, recreational, natural, cultural etc.) of the corridor as the basis for understanding the important resources along the corridor and details strategies for conserving its intrinsic qualities and managing improvements and changes. The Catoctin Mountain Scenic Byway became part of The Journey Through Hallowed Ground National Heritage Area in May 2008.	If a plan update is deemed necessary, include language that addresses natural hazard risk and mitigation.

Plan Name	Description	Mitigation Integration Options
2008 Frederick County Agricultural Strategic Plan	This Plan was prepared through the County's Office of Economic Development as an update of an Agricultural Market Analysis and Strategic Plan prepared in 2001. The 2008 Strategic Plan conducted an assessment of the agricultural industry and sectors in the County including an analysis of the strengths, weaknesses, opportunities, and threats of the agricultural economy. The Plan includes recommendations under 3 areas: market developments, training and education, and regulatory support for agriculture.	In the next Plan, include strategies for educating the agricultural community on the impacts of hazards on agricultural resources and strategies for risk reduction.
2007 Transportation Development Plan	Assesses current services and recommends transit improvements and expansion for the following 5- to 10-year period. The current Transportation Development Plan was adopted in 2007. TransIT Services also works with an appointed committee, the Transportation Services Advisory Council, to identify transportation trends and issues and increase awareness of transportation alternatives.	As part of the development of the next Plan, meet with the Plan developers to discuss the impacts of hazards on the road system and identify viable road improvement projects that would be eligible for mitigation funding.
2004 Lake Linganore Source Water Protection Plan	This Plan addresses water quality and quantity issues of Lake Linganore and Linganore Creek, which are used as a drinking water source by the City of Frederick and the County. The plan looks at the portion of the Linganore Creek watershed that drains into Lake Linganore and addresses issues related to agriculture, land development, infrastructure and maintenance, homeowner impacts, and education/outreach. In 2006 an Action Plan for the Linganore Source Water	This Plan is not controlled by the County. If the Plan is updated, the County should meet with the Plan developers to discuss relevant hazards.

Plan Name	Description	Mitigation Integration Options
	Protection Plan was prepared that identifies specific action items.	
2014 Frederick County Water and Sewerage Plan	The purpose of the Water and Sewerage Plan is to provide an overview of the goals, policies, and procedures for implementing water and sewerage plans. The Plan includes descriptions of both County and municipal water and sewerage systems including assessments of current demands/use and available capacities. The mapping component includes the various water/sewerage plan classifications, which identifies existing service areas and planned service areas. This Plan is required by the State and is updated every 3 years.	In the next Plan, include strategies for mitigating the risk of flooding on the sewer system, particularly drainage improvements intended to handle heavy downpours during storms.

Table 6.10. Municipal-Level Plan Assessment

Plan Name	Description	Mitigation Integration Options
2021 City of Frederick Climate Action Plan (Government Operations)	The Climate Action Plan for Governance Operations serves as the foundation for the City's greenhouse gas reduction efforts and resilience planning. It is intended to encourage broader community action and support the State of Maryland's climate goals. The plan addresses both the causes and the impacts of climate change in the context of City government operation, including those relating to City-owned and operated facilities, streetlights and signals, water and wastewater treatment plants, vehicles, and equipment.	Reference to the 2016 Frederick County Hazard Mitigation Plan is included in the plan. More integration could be had in the "Enhancing Climate Resilience" chapter which could include some of the climate adaptation and hazard mitigation actions that are in the HMCAP to further increase their likelihood of completion.
2010 Brunswick Master Plan	The 2010 Brunswick Master Plan is an update of all previous plans that have	Consider including a section that specifically addresses current and

	been adopted since 1967. The original Plan was designed to serve as a guide for the future of Brunswick, with recommendations for land use, transportation patterns, capital improvements, and public facilities. The Plan provides information about demographic profiles, the environment and sensitive areas, land use, transportation, water resources, municipal growth, and community facilities.	future development in hazard-prone areas.
2015 Burkittsville Comprehensive Plan	This Plan is intended for use until 2035. This document was prepared by the Burkittsville Planning and Zoning Commission in 2015 in order to provide direction for public policy and decision making in the Town. Burkittsville notably contains some of the most significant historic resources in Frederick County.	Continue protection of vulnerable areas within Burkittsville by enforcing FEMA floodplains along Burkitts Run and Samuels Run, and enforcing development restrictions within designated floodplains and wetlands.
2017 East Street Corridor Small Area Plan (City of Frederick)	The plan provides guidance for new development and redevelopment in the East Street Corridor and includes recommendations for future development in the area. Recommendations include the location of new structures and ensuring compatibility in a mixed-use environment.	Consider adding a section that specifically addresses current and future development in hazard-prone areas.
2015 Emmitsburg Comprehensive Plan (Revised 2021)	The 2015 Comprehensive Plan sets forth policies governing growth, development, and conservation in Emmitsburg. The 2015 update builds on the 2009 Comprehensive Plan relative to policies which govern growth, development, and conservation, and sets goals for the next 20-25 years.	The Plan discusses the use of vegetated buffers along streams and in floodplains to mitigate flooding impacts. Consider including a section that specifically addresses current and future development in hazard-prone areas.

2013 The Golden Mile Small Area Plan (City of Frederick)	This Plan is intended to encourage the redevelopment of the U.S. Route 40 Corridor through the use of incentives, public and private investment, and legislative policies that will provide additional tax base, economic revitalization, jobs, and business opportunities to the City.	The Plan discusses the use of Low Impact Development such as green roofs, permeable and porous pavements, and grass swales to mitigate the impacts of hazards such as flooding/stormwater runoff, erosion, and the urban heat island effect. In the next Plan, consider including a section that specifically addresses current and future development in hazard-prone areas.
2020 City of Frederick Comprehensive Plan	This Plan is a guide for the location, character, and extent of proposed public and private development in the City of Frederick, Maryland. It also provides guidance on how the City's development regulations should be updated, enhanced, and streamlined to facilitate Plan implementation.	In the next Plan, consider adding a section that specifically addresses current and future development in hazard-prone areas.
2020 Middletown Comprehensive Plan	This Plan provides a framework to provide future decision-making concerning growth, development, and the provision of public services in Middletown.	In the next Plan, consider adding a section that specifically addresses current and future development in hazard-prone areas.
2014 Mount Airy Master Plan (2023 Master Plan in progress)	The Master Plan guides land use decisions made by the Planning Commission and Town Council. The Plan addresses physical growth, is long range in scope, and is comprehensive. The Plan highlights the limiting impact that the town's water system capacity has had and will have on future growth. The town has explored a variety of mitigation options including bringing a new well online. The plan has a goal focused on preservation and protection of Mount Airy's environmental and cultural resources. The Plan also includes a section on floodplains and steep slopes.	Continue to address protection of groundwater resources.

2016 Town of Myersville Comprehensive Plan	This Plan provides guidance ranging from transportation, land use, public facilities, and protection of vulnerable areas. The Plan is intended to provide guidance for decision making and public policy for the next 20 years. The Plan includes a comprehensive section on environmental sensitive areas.	2016 Town of Myersville Comprehensive Plan
2016 New Market Master Plan	This Plan identifies community values as provided by residents and local leaders, and serves as a guide to local planning and elected officials when reviewing development proposals, zoning issues, and public works projects.	In the next Plan, consider a section that specifically addresses current and future development in hazard-prone areas.
City of Frederick Parks and Recreation Master Park Plan (in progress)	As of October 2021, The City of Frederick is in Phase 2 of developing a Parks and Recreation Master Plan. Phase 3 will involve incorporation of feedback and research completed in Phases 1 and 2 in order to develop a final report.	This Plan will aim to provide guidance for future development of the City's parks, recreation programming, and facilities. The plan will aim to integrate energy efficiency and sustainable strategies.
2010 Thurmont Master Plan	This Plan identifies community values as expressed by citizens and elected officials and provides guidance for decision-making by town officials when reviewing development plans, rezoning requests, annexations, and planning for community facilities.	In the next Plan, consider a section that specifically addresses current and future development in hazard-prone areas.
2011 Walkersville Comprehensive Plan (2021 Comprehensive Plan in progress)	This Plan is intended to maintain Walkersville's small-town character, allow for future development to support limited growth, protect natural, historic, and scenic resources, and maintain a high quality of life for residents.	The Town of Walkersville adopted Frederick County's Forest Resource Ordinance. The Forest Resource Ordinance was adopted so that new development will occur in such a way that the conservation, protection, and planting of trees to produce forested areas would stabilize soil, reduce stormwater runoff, remove pollutants from the air, create buffers and protected environments for wildlife, mitigate heat islands, conserve and

		enhance the County's aesthetic appearance, and protect the public's health and safety. In the next Plan, consider adding a section that specifically addresses current and future development in hazard-prone areas.
2008 Town of Woodsboro Comprehensive Plan	This Plan is a long-range plan which provides a framework for growth and development activity in the Town of Woodsboro. The Plan provides guidance for decision-making for zoning, infrastructure, and community facilities, as well as goals and objectives for natural and cultural resources, transportation, land use, housing and community facilities.	In the next Plan, consider a section that specifically addresses current and future development in hazard-prone areas.

CHAPTER 7. MITIGATION AND ADAPTATION STRATEGY

Strategy Development

In the Hazard Mitigation Planning Committee and public meetings conducted on October 14, 2021 and October 28, 2021, respectively, local government representatives discussed the findings of the risk assessment and its implications for the updated mitigation strategy. Hazard Mitigation Planning Committee members then had an opportunity to update the Plan's goals and objectives during the follow-up meetings held in late November and early December 2021. From these discussions, as well as follow-up emails and calls, three new goals were formed. These three broader, strategic goals replaced the nine hazard- and action-specific goals in the 2016 Plan. This transition was done as a way to better reflect the ongoing vision of the County; integrate with the Maryland State Mitigation Plan and Livable Frederick Master Plan; and align with broader resilience priorities of county and municipality leadership. The Hazard Mitigation Planning Committee believe these goals will help direct the County for the next 5 years and act as a link to the longer planning horizon for future iterations of the HMCAP.

After the Hazard Mitigation Planning Committee developed mitigation goals for the communities, the Committee developed new objectives to support accomplishment of the goals. These objectives were sourced from modified goals and objectives from the 2016 Plan, as well as new additions based on current priorities.

Finally, the mitigation and adaptation actions were developed after a review of the risk assessment findings, public feedback and priorities from the hazard mitigation survey, and local priorities as shared by the local planning teams. Select mitigation actions from the 2016 plan were carried forward, and additional new actions were added to address remaining hazard issues.

National Mitigation Framework

The National Mitigation Framework covers one of the five mission areas that make up FEMA's National Preparedness System: Prevention, Protection, Mitigation, Response, and Recovery. It focuses on a culture of preparedness which means recognizing risk and building resilience as a whole community to withstand future disasters and bounce back better.

Whole Community

"A focus on enabling the participation in national preparedness activities of a wider range of players from the private and nonprofit sectors, including nongovernmental organizations and the general public, in conjunction with the participation of all levels of government in order to foster better coordination and working relationships." – *The National Preparedness Goal*

This HMCAP follows the seven core capabilities for those involved in mitigation outlined in the Framework:[131]

[131] https://www.fema.gov/sites/default/files/2020-04/National_Mitigation_Framework2nd_june2016.pdf

- **Threats and Hazards Identification**: Identify the threats and hazards that occur in an area using the best available data.
- **Risk and Disaster Resilience Assessment**: Assess hazard risks using scientifically recommended techniques that consider current and future conditions.
- **Planning**: Incorporate the risk assessment results into the mitigation planning process.
- **Community Resilience**: Engage the whole community in a planning process that considers the built environment, natural environment, economy, and human health.
- **Public Information and Warning**: Share the risk assessment and mitigation strategy with the public through clear, consistent, and accessible messaging.
- **Long-term Vulnerability Reduction**: Implement the mitigation and adaptation plan to build and sustain resilient systems, communities, and critical infrastructure and key resources lifelines.
- **Operational Coordination**: Use the action plans to coordinate with relevant stakeholders and leaders while consistently integrating mitigation plans and actions into other community plans and systems.

Integration of Climate Adaptation

The 2022 Plan update offered an opportunity for Frederick County's Hazard Mitigation Plan to become a joint Hazard Mitigation and Climate Adaptation Plan. This entailed bolstering the climate impacts section to take a deeper look at future conditions in Frederick County and the region as a whole, as well as further integrating these impacts into the risk assessment. Doing this allows for a more comprehensive approach to hazard mitigation which fully assesses current and future hazard risks.

Once future conditions are captured in the risk assessment, they are inherently integrated into the mitigation and adaptation strategy which uses the HIRA as its foundation. In practice, this led to an increased focus on flooding, especially pluvial flooding, throughout the County. This is evidenced in the mitigation actions. To help identify actions that were heavily influenced by climate adaptation goals and objectives, a **green header** has been added to the relevant actions in the action plans below.

Goals and Objectives

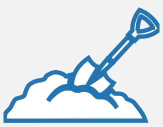
This section presents a series of goals and objectives (Table 7.1) to help Frederick County and its municipalities identify and select mitigation actions to address its vulnerabilities, as discussed in Chapter 6. The selected mitigation actions will help the County avoid, prevent, or otherwise reduce damages from hazards. The goals on the next page represent Frederick County's vision for reducing damages due to natural hazards.

Definitions

Goals: general guidelines that explain what you want to achieve; usually broad, long-term policy statements representing global visions.

Objectives: define strategies or implementation steps to attain the identified goals; specific and measurable.

Table 7.1. Mitigation and Climate Adaptation 2022 Goals and Objectives

Mitigation Category	Goal	Objective
Physical Projects 	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
		Objective 2: Increase the resilience of critical facilities and infrastructure.
		Objective 3: Encourage property owners to maintain insurance that covers all hazards, including flood insurance through the National Flood Insurance Program.
		Objective 4: Prioritize equity and vulnerable populations in the implementation of physical hazard mitigation projects.
Capability and Capacity Building 	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
		Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance.
		Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
		Objective 8: Ensure County residents can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Public Awareness and Education	Goal C: Improve the public's awareness of potential hazards, education on	Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events.

Mitigation Category	Goal	Objective
	resilience planning, and incentives for mitigation actions.	Objective 10: Increase the public's awareness of their natural hazard risks. Objective 11: Provide the public with more opportunities to actively participate and provide input regarding hazard mitigation and climate adaptation activities.
Forward-Looking Policy and Planning 	Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.	Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts.
		Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
		Objective 14: Plan to retrofit infrastructure to make it resilient to future climate impacts.

Hazard Mitigation and Climate Adaptation Actions

This chapter contains the list of mitigation and climate adaptation actions and potential projects that outline the steps necessary to achieve the County's goals and objectives. The goals, objectives, and actions outlined make up Frederick County's mitigation strategy. Mitigation actions from the 2016 plan that were not carried forward into the HMCAP can be found in Appendix B with a description of their status as of September 2021.

Action Prioritization

The Hazard Mitigation Planning Committee and Local Planning Teams used the STAPLE/E (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) criteria to select and prioritize the most appropriate mitigation and adaptation alternatives (Table 7.2). 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.

Table 7.2. STAPLE/E Selection and Prioritization Criteria for Alternatives

STAPLE/E	Considerations
Social	• Is the proposed action socially acceptable to the community(s)? • Are there equity issues involved that would mean that one segment of a community is treated unfairly? • Will the action cause social disruption?
Technical	• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of other community(s) goals?
Administrative	• Can the community(s) implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
Political	• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
Legal	• Is the community(s) authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? • Are there legal side effects? Could the activity be construed as a taking? • Is the proposed action allowed by a comprehensive plan, or must a comprehensive plan be amended to allow the proposed action? • Will the community(s) be liable for action or lack of action? • Will the activity be challenged?
Economic	• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account? • Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the community(s)? • What burden will this action place on the tax base or local economy? • What are the budget and revenue effects of this activity? • Does the action contribute to other community goals, such as capital improvements or economic development? • What benefits will the action provide?
Environmental	• How will the action affect the environment?

STAPLE/E	Considerations
	• Will the action need environmental regulatory approvals? • Will it meet local and state regulatory requirements? • Are endangered or threatened species likely to be affected?

A priority level of high, medium, or low was assigned to each action based on the STAPLE/E assessment. This prioritization method was selected because the Hazard Mitigation Planning Committee believed it would foster a realistic expectation of what could be accomplished in the next five years. The prioritization process has been significantly enhanced compared to the 2016 method which mainly focused on funding availability to assign priority rankings.

Some identified projects are referenced in other plans, which is noted by the "Plan Integration" sections of the action tables. Some of these plans have their own ranking and priority indices that incorporate different factors than this HMCAP, so the priority rankings shown below may not reflect the ranking for other divisions, departments, and offices in the County.

Action Plans

An explanation of the mitigation and adaptation action plan format is provided below. Rows that are not applicable to a specific action have been removed for the sake of space. **Only high-priority actions have full action plans below.**

Action [Jurisdiction Abbreviation] – [Action#]	
Description of Action	The mitigation or adaptation action written out
Applicable Goal(s)	The main goals that the action supports (other goals may be supported in a more limited capacity)
Applicable Objective(s)	The main objectives that the action supports (other objectives may be supported in a more limited capacity)
Relevant Hazard	The main hazards that the action is mitigating (other hazards may be mitigated in a more limited capacity)
HMCAP Priority	The priority that the local planning teams assigned to the action based on STAPLE/E criteria with the 5-year planning horizon in mind
Responsible Organizations	The person, department, or community that will lead and take ownership of the implementation of the action
Estimated Costs	A tentative estimate of the cost of the action
Possible Funding Sources	The most likely funding sources (not comprehensive)
Timeline for implementation	When the action would start (does not include time until completion)
Plan Integration	The other county or municipal plans that support the action (some actions may appear in both plans; some are adapted for this plan)

Action [Jurisdiction Abbreviation] – [Action#]	
Status since 2016	The status of the action's implementation as of September 2021

Key for Action Header Colors:

Action Carried Over from 2016 Plan	Action Added During 2022 Plan Update	Action Added During 2022 Plan Update & Significantly Supports Climate Adaptation*

*As there is a strong connection between traditional hazard mitigation actions and climate adaptation actions, there is considerable overlap between the two action categories (i.e., many of the actions support both). However, for the purpose of easy identification, the actions that significantly support climate adaptation are highlighted.

County-Wide Actions

Codes & Standard

Action FC-1	
Description of Action	Although no changes to the County floodplain ordinances are required at this time, the State of Maryland recommends that the following changes to the State Model Ordinance be considered to strengthen those ordinances based on lessons learned from Hurricane Isabel. The recommended changes will be included when FEMA's update of the County's floodplain is complete: • An increase in the freeboard requirement can be implemented by modifying the Flood Protection Elevation definition. Currently, the standard in the unincorporated areas of the County is 1 foot of freeboard; changing it to 2 or 3 feet will implement a higher level of protection. • It is also recommended that "repetitive loss" be added to the development regulated by the County ordinances. This will allow extension of the Increased Cost of Compliance coverage in flood insurance policies, which pays up to $30,000 in additional coverage to bring repetitive loss as well as substantially damaged properties into compliance with the floodplain ordinance. The community must be willing to treat repetitive loss properties the same as new and substantially improved structures to qualify. If this is adopted, they must require that repetitive loss properties meet all code requirements as new structures, but they will be making Increased Cost of Compliance payments available to these structures.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.

Action FC-1	
	Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure. Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	Division of Emergency Management, municipalities
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	6 to 10 years
Status since 2016	Ongoing

Action FC-2	
Description of Action	Proceed with submitting a letter of interest to FEMA and coordinate a visit from the Insurance Services Office for a CRS audit. Obtain the Building Code Effectiveness Grading Schedule (BCEGS) building code evaluation to support Community Rating System (CRS) activities. Provide technical assistance to local jurisdictions to incorporate climate projections and climate-related hazards into building codes and design standards.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure. Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Multiple Hazards

Action FC-2	
HMCAP Priority	Medium
Plan Integration	2021 State of Maryland Hazard Mitigation Plan

Action FC-3	
Description of Action	Develop design standards and incentives to actively encourage the installation of nature-based solutions on county- and municipal-owned buildings/facilities to reduce the building/facility's carbon footprint, provide additional shade, reduce heat from the roof surface and surrounding air, and assist with water runoff during rain events.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure. Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Plan Integration	2021 State of Maryland Hazard Mitigation Plan

Action FC-4	
Description of Action	Evaluate codes and ordinances to address issues related to hazard mitigation/climate resilience, including resilience to power outages, groundwater levels and intrusion, and stormwater flooding resilience.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.

Action FC-4	
	Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Permits and Inspections, Division of Emergency Management, Office of Sustainability and Environmental Resources, Development Review
Estimated Costs	Staff time
Possible Funding Sources	BRIC
Timeline for implementation	Ongoing
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 – Buildings; 2021 State of Maryland Hazard Mitigation Plan; Metropolitan Washington 2030 Climate and Energy Action Plan

Action FC-5	
Description of Action	Implement the recommendations of the Maryland Department of the Environment in "Advancing Stormwater Resiliency in Maryland: Maryland's Stormwater Management Climate Change Action Plan", as required. Highlights include: • Changes to MD Stormwater Design Manual -- The Maryland Department of the Environment is considering updating the Manual to increase design standards for Environmental Site Design to Maximum Extent Practicable from 2.7" to 3" for the 1-year storm for new development and redevelopment. • Local Watershed Studies -- The Maryland Department of the Environment plans to draft regulations to require localities and state and federal agencies to "generate comprehensive watershed studies (if funding exists) for all known flood event watersheds." The studies will be the basis for local, state, and federal, watershed-specific flood management plans. • New Stormwater Management Regulations -- The Maryland Department of the Environment plans to adopt new stormwater management regulations in early 2023. The new regulations may "factor in climate change, including more frequent and intense storms, future precipitation projections, and...comprehensive watershed management studies.”

Action FC-5	
	Through the Maryland Municipal Stormwater Association, participate in workgroups to develop upcoming requirements and give feedback to the Maryland Department of the Environment.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Objective	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure. Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Flood
HMCAP Priority	Medium
Responsible Organizations	Office of Sustainability and Environmental Resources
Plan Integration	Climate Emergency Mobilization Work Group Volume 1 – Resilience; Metropolitan Washington 2030 Climate and Energy Action Plan; Advancing Stormwater Resiliency in Maryland (A-StoRM): Maryland's Stormwater Management Climate Change Action Plan

Action FC-6	
Description of Action	Update building and zoning codes as needed to allow for and promote the implementation of cool roofs, green roofs, and green infrastructure to reduce the urban heat island effect and help mitigate extreme heat in population centers.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure. Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.

Action FC-6	
	Objective 14: Plan to retrofit infrastructure to make it resilient to future climate impacts.
Relevant Hazard	Extreme Heat
HMCAP Priority	Low
Plan Integration	Metropolitan Washington 2030 Climate and Energy Action Plan

Planning & Studies

Action FC-7	
Description of Action	Develop structural corrective action plans (paving/elevation programs) for Frederick County's pre-identified frequently flooded roadways.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities to mitigate damage or improve the resilience of existing structures from all hazards Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Flood
HMCAP Priority	High
Plan Integration	Metropolitan Washington 2030 Climate and Energy Action Plan
Responsible Organizations	Division of Emergency Management, Division of Public Works, Maryland State Highway Administration
Estimated Costs	$500,000 per year
Possible Funding Sources	HMGP, BRIC
Timeline for implementation	5 years
Status since 2016	Ongoing

Action FC-8	
Description of Action	Incorporate the planimetric layer that shows all building footprints, plus other assets such as roads and sidewalks, with the SFHA for the County and the City of Frederick.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	Division of Planning, Division of Emergency Management
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	2 to 5 years
Status since 2016	Ongoing

Action FC-9	
Description of Action	Update Frederick County's evacuation plan to include issues such as staging areas, feeding plans for displaced persons, bathrooms, signs, temporary housing, decontamination, and isolation and quarantine facilities. An integral part of this plan will be introducing the concept of evacuation in stages. As part of this plan, destination points, such as schools, should be identified for shelters. Points to consider in developing the evacuation plan: experts in emergency planning, transportation planning, and traffic engineering should be involved in developing the plan; canned messages should be developed for use with the public and the media; consideration of closed circuit televisions for the County and the State Highway Administration to help aid traffic flow during evacuations; add in previously developed COVID-19 isolation and quarantine facilities; and plan should consider non-congregating sheltering sites, such as hotels, to allow for isolation and quarantining when necessary.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.

Action FC-9	
Applicable Objective(s)	Objective 8: Ensure County residents can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Plan Integration	Metropolitan Washington 2030 Climate and Energy Action Plan
Status since 2016	Not started

Action FC-10	
Description of Action	Review shelter sites and keep partnership agreements current. Identify additional locations that could be equipped and identified as shelters based on the needs and population centers in the County. Work with the Red Cross to conduct an assessment of existing shelters in the County to determine their condition and adequacy with respect to beds, etc. Develop a database of shelters and their locations and determine which ones would need to be retrofitted, particularly with respect to schools. The Red Cross and Frederick County's Emergency Management Department should share information about local shelters on an at least annual basis. Information should include the location of each shelter, its capacity, its backup power availability, and any other relevant information.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 8: Ensure County residents can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Division of Emergency Management
Estimated Costs	Staff time, professional consulting fees for architect/engineer
Possible Funding Sources	N/A

Action FC-10	
Timeline for implementation	In progress
Status since 2016	Complete and ongoing. Memorandum of Understanding agreement and shelter plans/sites are in the process of being updated.

Action FC-11	
Description of Action	Conduct a county-wide needs assessment for distributed energy generation. Identify where available backup generators could best be utilized in this effort.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Plan Integration	Metropolitan Washington 2030 Climate and Energy Action Plan

Action FC-12	
Description of Action	Conduct a flood issues study (watershed plan for climate-related stormwater flooding per the Maryland Department of the Environment's Municipal Separate Storm Sewer System program) that considers: • the pluvial flood analysis in this Plan • future flooding projections • analysis of inundated buildings • flood insurance claims in Frederick County • issues reported through the Community Flood Map and Hazard Mitigation Survey • population density • high hazard dams • historic rescue locations, 911 calls, and flood complaint calls, and • road closures.

Action FC-12	
	Direct resources for stormwater retrofitting related to Municipal Separate Storm Sewer System permit compliance to mitigate the identified flooding issues. Incorporate flood resilience into Municipal Separate Storm Sewer System permit and integrate with HMCAP and Water Resources Element of Comprehensive Plan.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts.
Relevant Hazard	Flood
HMCAP Priority	High
Plan Integration	Climate Emergency Mobilization Work Group - Volume 1 – Buildings; Climate Emergency Mobilization Work Group - Volume 1 – Resilience; Metropolitan Washington 2030 Climate and Energy Action Plan
Responsible Organizations	Division of Public Works; Office of Sustainability and Environmental Resources; Department of Emergency Management
Estimated Costs	TBD
Possible Funding Sources	Division of Public Works and Office of Sustainability and Environmental Resources Operating and Capital budgets
Timeline for implementation	2 to 5 years

Action FC-13	
Description of Action	Expand on the pluvial flood analysis that was completed as a part of the 2022 HMCAP update with a goal of following the recommended enhancements outlined in Chapter 5.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.

Action FC-13	
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts.
Relevant Hazard	Flood
HMCAP Priority	Medium
Plan Integration	2021 State of Maryland Hazard Mitigation Plan

Action FC-14	
Description of Action	Evaluate new and existing county and local government buildings, critical facilities, and infrastructure for solar potential. Prioritize these based on their ability to sustain safe, clean, efficient, and reliable backup solar power systems aligned with location and site characteristics, fuel supply availability, and operational needs.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Office of Sustainability and Environmental Resources, Division of Public Works
Estimated Costs	TBD
Possible Funding Sources	TBD
Timeline for implementation	2 to 3 years
Plan Integration	Livable Frederick; 2021 State of Maryland Hazard Mitigation Plan

Action FC-15	
Description of Action	Integrate the HMCAP into future updates of the Livable Frederick Master Plan. Future Development plans will be reviewed in the context of the spatial hazards identified in the HMCAP. Hazard mitigation measures will be proposed and considered for development planned within a hazard area.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Plan Integration	Livable Frederick

Action FC-16	
Description of Action	Work with the Maryland Department of the Environment, dam owners, and state regulators to determine the hazard classification of any dams that have an undetermined ranking. Create an Emergency Action Plan for all dams with a hazard potential of "significant" or higher that do not already have one. The Emergency Action Plan should include breach inundation mapping for use in future hazard analysis. By October 2022, the Maryland Department of the Environment will have inundation shapefiles for all dams in Frederick County and will be confirming or reclassifying the dams. Upon request, MDE Can supply a scope of work (recently co-developed with MD Department of Natural Resources) to solicit engineering firms to perform comprehensive dam investigations and screening level risk analyses so County/City owned dams can begin the hazard classification process. The County will conduct investigations and risk assessments that further define the dam risk using a risk prioritization methodology defined in section H.14 of the FY21 Rehabilitation of High Hazard Potential Dam Notice of Funding Opportunity.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.

Action FC-16	
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Dam and Levee Failure
HMCAP Priority	Low

Action FC-17	
Description of Action	Work with state regulators to conduct a review of all high hazard dams and identify opportunities for upgrades, repair, removal, or any other structural or nonstructural measures to rehabilitate. For county/city-owned dams, conduct an alternatives analysis that complies with National Environmental Policy Act (NEPA) requirements to identify a preferred plan for dam rehabilitation and the estimated cost for design and construction. Finally, plan the chosen dam rehabilitation projects and work to develop conceptual, preliminary, or final design plans and specifications.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Dam and Levee Failure
HMCAP Priority	Medium

Action FC-18	
Description of Action	Develop Risk and Vulnerability Assessment and Climate Resilience Strategy that includes risks to building assets (both internal operations and community-wide). Incorporate the resilience of county-owned infrastructure in the Capital Improvement Plan. Communicate the results with the public

Action FC-18	
	to educate them about the need for flood insurance, retrofits of stormwater on private property, and availability of programs to assist properties.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events. Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts.
Relevant Hazard	Flood
HMCAP Priority	Medium
Responsible Organizations	Office of Sustainability and Environmental Resources, Emergency Management; Division of Public Works, Department of Engineering & Construction Management
Potential Funding	$300,000 available for community-wide Climate and Energy Action Plan to occur in FY23, internal CRVA already funded
Plan Integration	County Executive's Climate Initiative; Climate Emergency Mobilization Work Group Volume 1 – Resilience; Metropolitan Washington 2030 Climate and Energy Action Plan

Action FC-19	
Description of Action	Create a community-wide Climate and Energy Action Plan with the City of Frederick and other interested entities that includes greenhouse gas emissions, a mitigation strategy, a climate risk and vulnerabilities assessment, and a climate resilience strategy.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.

Action FC-19	
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance. Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Office of Sustainability and Environmental Resources
Estimated Costs	Internal Climate and Energy Action Plan funded and underway, Community-wide Climate and Energy Action Plan funded for FY23 in amount of $300,000, to be conducted with $100,000 from City of Frederick
Possible Funding Sources	Capital Improvement Plan
Timeline for implementation	3 years

Outreach & Education

Action FC-20	
Description of Action	Improve current hazard mitigation messaging to ensure it is clear, concise, consistent, and can be delivered in each municipality using previously-established media sources and public outreach mechanisms.
Applicable Goal(s)(s)	Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events. Objective 10: Increase the public's awareness of their natural hazard risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Status since 2016	Ongoing

Action FC-21	
Description of Action	Install a series of rainfall and stream gauges to be placed in strategic locations in Frederick County and its municipalities. The gauges will allow enhanced, electronic, National Weather Service monitoring of conditions that may prompt hazardous flash-flooding incidents in Frederick County. In addition, early warning and educational signage and barricades will be purchased for the identified high traffic volume roadways with historically documented high-water hazards.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 5: Support data collection, studies, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 10: Increase the public's awareness of their natural hazard risks.
Relevant Hazard	Flood
HMCAP Priority	Medium
Status since 2016	Ongoing

Action FC-22	
Description of Action	Identify owners of Repetitive Loss (RL) and Severe Repetitive Loss (SRL) properties and provide information on how they can participate in future property relocation or acquisition projects through FEMA's Flood Mitigation Assistance program. Owners not interested in relocation or acquisition should be informed of the benefits of elevating structures and utilities. Provide technical assistance with grant applications and serve as a subgrantee, as appropriate.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 3: Encourage property owners to maintain insurance that covers all hazards, including flood insurance through the National Flood Insurance Program.

Action FC-22	
	Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events. Objective 11: Provide the public with more opportunities to actively participate and provide input regarding hazard mitigation and climate adaptation activities.
Relevant Hazard	Flood
HMCAP Priority	Low
Status since 2016	Wording changes made to expand scope. Ongoing action.

Action FC-23	
Description of Action	Improve public education related to wildfire/urban interface fire through the purchase and delivery of education and outreach materials related to Firewise Maryland. This would also include developing community wildfire protection plans for Frederick County's highest risk areas for wildfire and posting the fire danger reports issued by the Maryland Department of Natural Resources.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events. Objective 10: Increase the public's awareness of their natural hazard risks.
Relevant Hazard	Wildfire
HMCAP Priority	Medium
Status since 2016	No progress

Action FC-24	
Description of Action	Reach out to all building owners in the current or increased floodplain (as of June 2022 updated FIRM effective date) and assist them in including their building in a grant application for flood mitigation projects and/or securing flood insurance.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 3: Encourage property owners to maintain insurance that covers all hazards, including flood insurance through the National Flood Insurance Program. Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance. Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events.
Relevant Hazard	Flood
HMCAP Priority	High
Plan Integration	Metropolitan Washington 2030 Climate and Energy Action Plan
Responsible Organizations	Division of Planning and Permitting; Division of Emergency Management; Office of the County Executive - Communications Department
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	2 to 5 years

Action FC-25	
Description of Action	Develop a project portfolio comprised of county-wide climate adaptation and hazard mitigation success stories and best practices and post them on

Action FC-25	
	a Frederick County website for local jurisdictions and residents to refer to during mitigation efforts. Create video about changes since Hurricane Agnes for 50-year anniversary.
Applicable Goal(s)	Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Division of Emergency Management, Office of Sustainability and Environmental Resources
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	1 year
Plan Integration	2021 State of Maryland Hazard Mitigation Plan

Action FC-26	
Description of Action	Work with jurisdictions to promote partnerships with local organizations to develop "community resilience hubs" to: • Identify the most climate-vulnerable communities and assess the potential to establish resilience hubs in those communities, • Leverage relationships with community organizations and leaders to identify the needs of the community and neighborhood-scale resilience solutions, • Partner with energy providers to develop resilience hubs with an uninterruptable energy supply, and • Support residents, coordinate communication, distribute resources, and help communities become more self-determining and socially connected before, during, and after hazard events.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.

Action FC-26	
	Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance. Objective 11: Provide the public with more opportunities to actively participate and provide input regarding hazard mitigation and climate adaptation activities.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Plan Integration	2021 State of Maryland Hazard Mitigation Plan; Metropolitan Washington 2030 Climate and Energy Action Plan

Action FC-27	
Description of Action	Provide training to County and municipal personnel about incorporating climate change vulnerabilities, climate adaptation techniques, and hazard mitigation into all programs.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance. Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Low

Action FC-28	
Description of Action	Work with the colleges/university campuses to provide accounts and training for the disaster data management tool (Orion) to increase the efficiency of damage surveys and reporting after a hazard event and to

Action FC-28	
	better position for PA reimbursements and future hazard mitigation grant applications.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium

Action FC-29	
Description of Action	Increase subscription to Everbridge tool for citizens to receive updates on hazards
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 8: Ensure County residents can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts. Objective 10: Increase the public's awareness of their natural hazard risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 - Resilience

Private Property & Critical Infrastructure

Action FC-30	
Description of Action	Implement physical mitigation projects that will result in the protection of public or private property from natural hazards. Eligible projects include, but are not limited to: • Generators • Acquisition of hazard-prone properties • Elevation of flood-prone structures • Minor structural flood control projects • Relocation of structures from hazard-prone areas • Retrofitting of existing buildings and facilities • Infrastructure protection measures • Stormwater management improvements • Advanced warning systems and hazard gauging systems (e.g., stream gauges, I-flows) • Targeted hazard education • Flood diversion • Stream restoration
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Plan Integration	Metropolitan Washington 2030 Climate and Energy Action Plan
Responsible Organizations	Division of Emergency Management
Status since 2016	Ongoing

Action FC-31	
Description of Action	Improve the rural water supply in areas with significant wildfire/urban interface fire hazards by installing and repairing dry hydrants. Minimize new residential developments that rely on wells and dry hydrants by prohibiting

Action FC-31	
	the expansion of the Rural Residential Land Use Designation into Agricultural and Natural Resource areas.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Wildfire
HMCAP Priority	Low
Plan Integration	Draft Sugarloaf Treasured Landscape Management Plan - Policy 4.3; Metropolitan Washington 2030 Climate and Energy Action Plan
Status since 2016	None

Action FC-32	
Description of Action	As part of the internal operational and community-wide Climate Resilience Strategies, identify locations for microgrids to provide continuation of operations when the main grid is down, especially for critical facilities. Utilize microgrids and battery backup systems to make the facility at 585 Himes Ave more resilient to the impacts of hazards. Provide education to the public on the benefits of microgrids.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.

Action FC-32	
	Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Plan Integration	Livable Frederick; Climate Emergency Mobilization Working Group, Volume 1 – Energy; County Executive's Climate Initiative; Metropolitan Washington 2030 Climate and Energy Action Plan
Responsible Organization	Office of Sustainability and Environmental Resources, Division of Public Works, Division of Emergency Management
Status since 2016	Revised wording of the action for 2021 update

Action FC-33	
Description of Action	Conduct mitigation projects on bridges to address inadequate waterway openings and inadequate capacity for emergency response equipment.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Plan Integration	Metropolitan Washington 2030 Climate and Energy Action Plan
Responsible Organizations	Division of Public Works - Department of Engineering and Construction Management
Estimated Costs	TBD
Possible Funding Sources	HMGP, BRIC
Timeline for implementation	2 to 5 years

Action FC-34	
Description of Action	Create a plan and implement projects to increase culvert (and other stormwater infrastructure) capacity throughout the County based on the State's updated regulations. Provide technical assistance to municipalities to replace undersized or deteriorated culverts to make them resilient to future climate impacts and flooding conditions.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance. Objective 14: Plan to retrofit infrastructure to make it resilient to future climate impacts.
Relevant Hazard	Flood
HMCAP Priority	High
Plan Integration	Metropolitan Washington 2030 Climate and Energy Action Plan
Responsible Organizations	Division of Public Works - Department of Engineering and Construction Management (provider of technical assistance)
Estimated Costs	TBD
Possible Funding Sources	Division of Public Works Operating and Capital budgets
Timeline for implementation	2 to 5 years

Action FC-35	
Description of Action	Use Federal funds (e.g., American Rescue Plan Act of 2021) to expand broadband capabilities to improve emergency communications and make broadband infrastructure more resilient.

Action FC-35	
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 8: Ensure County residents can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium

Action FC-36	
Description of Action	Work with Potomac Edison to improve the resilience of power supply infrastructure. Smaller municipalities often have power outages due to thunderstorms and high-wind events. Keep all municipalities up-to-date on progress.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium

Action FC-37	
Description of Action	Increase water storage in stormwater infrastructure during the retrofitting of ponds without creating any high hazard dams. Increase infiltration in stormwater retrofits as possible within site constraints. (County completed

Action FC-37	
	dredging project in Lake Linganore in 2021). Eliminate high hazard dams when possible through retrofitting.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Drought, Flood, Dam and Levee Failure
HMCAP Priority	High
Responsible Organizations	Office of Sustainability and Environmental Resources
Estimated Costs	TBD based on project
Possible Funding Sources	HMGP, BRIC
Timeline for implementation	1-5 years
Plan Integration	Climate Emergency Mobilization Work Group Volume 1 – Resilience; Metropolitan Washington 2030 Climate and Energy Action Plan

Equity & Vulnerable Populations

Action FC-38	
Description of Action	Conduct a study to identify the vulnerable neighborhoods that are the least hazard resilient and prioritize them for new flooding infrastructure, winter weather adaptation, and/or extreme heat adaptation projects.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 4: Prioritize equity and vulnerable populations in the implementation of physical hazard mitigation projects.

Action FC-38	
	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Flood, Winter Storm, Extreme Heat
HMCAP Priority	Low
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 – Resilience; Metropolitan Washington 2030 Climate and Energy Action Plan

Action FC-39	
Description of Action	Expand County's Power Saver Retrofits program (which provides weatherization and heating, ventilation, and air conditioning upgrades at no cost to participants) to help residents remain cool in their homes during high degree days. Increase funding to program beyond the contribution from the Maryland Energy Administration in order to address the critical needs for low-to-moderate income households. Target traditionally underserved populations, including those in environmental justice areas.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 4: Prioritize equity and vulnerable populations in the implementation of physical hazard mitigation projects. Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events.
Relevant Hazard	Extreme Heat
HMCAP Priority	High
Responsible Organizations	Office of Sustainability and Environmental Resources
Estimated Costs	$500 - $5,000 per house
Possible Funding Sources	Maryland Energy Administration & general county funds
Timeline for implementation	2 years

Action FC-39	
Plan Integration	County Executive's Climate Initiative; Climate Emergency Mobilization Work Group Volume 1 – Resilience; Metropolitan Washington 2030 Climate and Energy Action Plan

Action FC-40	
Description of Action	Engage the public on their climate risks with an emphasis on potentially vulnerable populations by: • Integrating climate projections, risks, and strategies into existing community outreach programs, • Continuing to build partnerships with community groups and leaders to improve communication and engagement strategies, • Assessing the vulnerability of potentially vulnerable communities (social, ecological, economic, public health) to climate impacts, • Providing direct assistance (technical and financial) to potentially vulnerable populations, and • Developing metrics to measure the effectiveness of outreach efforts with diverse communities.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance. Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events. Objective 4: Prioritize equity and vulnerable populations in the implementation of physical hazard mitigation projects. Objective 11: Provide the public with more opportunities to actively participate and provide input regarding hazard mitigation and climate adaptation activities.

Action FC-40	
	Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Office of Sustainability and Environmental Resources, Division of Planning and Permitting, Division of Economic Development, Division of Emergency Management
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	2-3 years
Plan Integration	Metropolitan Washington 2030 Climate and Energy Action Plan

Action FC-41	
Description of Action	Implement measures to equitably address urban heat islands by: • Developing thermal mapping to identify urban heat island hot spots, impacted vulnerable populations, and potential areas for mitigation actions, • Assessing existing and future cooling centers based on extreme heat projections and needs of vulnerable populations (consider accessibility, language interpreters, backup power support, medical assistance, and food and water supplies), • Supporting urban forestry programs and incentives to maximize canopy in vulnerable communities, and • Implementing cool roofs, green roofs, and green walls.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.

Action FC-41	
	Objective 4: Prioritize equity and vulnerable populations in the implementation of physical hazard mitigation projects. Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts. Objective 14: Plan to retrofit infrastructure to make it resilient to future climate impacts.
Relevant Hazard	Extreme Heat
HMCAP Priority	Medium
Plan Integration	Metropolitan Washington 2030 Climate and Energy Action Plan

Municipality-Specific Actions

City of Brunswick

Action BR-1	
Description of Action	Identify, map in GIS, and prioritize high yield options to reduce the impact of stormwater flooding throughout the City, which is characterized by steep flood-prone slopes leading downstream to the Potomac River.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Flood
HMCAP Priority	Medium
Status since 2016	No progress

Action BR-2	
Description of Action	Revise existing floodplain ordinance and adopt the Maryland model floodplain ordinance. The City of Brunswick follows Frederick County's building code and will adopt an updated building code through the County.

Action BR-2	
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Flood
HMCAP Priority	Medium
Status since 2016	In progress

Action BR-3	
Description of Action	Expand home inspections with trained personnel that accompany construction permits for repairs, retrofits, and new buildings to ensure replaced or new materials are consistent with maximum use of cool roofs, building ventilation, and below ground flood protection.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance.
Relevant Hazard	Flood
HMCAP Priority	Medium

Action BR-4	
Description of Action	Utilize Everbridge to deliver early warning alerts for extreme cold and extreme heat. Messaging should include recommended actions and safe locations.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.

Action BR-4	
Applicable Objective(s)	Objective 8: Ensure County residents can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts. Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events. Objective 10: Increase the public's awareness of their natural hazard risks.
Relevant Hazard	Extreme Heat
HMCAP Priority	Medium
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 - Energy

Action BR-5	
Description of Action	Increase green infrastructure, such as expanding riparian buffers, urban tree canopy, and stormwater management structures, to reduce impervious cover in flood-prone areas
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood
HMCAP Priority	Medium

Action BR-7	
Description of Action	Evaluate the sequencing of agency approvals for new building development projects to determine the best point at which to incorporate stormwater and wastewater practices review, as well as other hazard mitigation practices review.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.

Action BR-7	
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	City of Brunswick Administration Department (Planning Office) and Department of Public Works
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	1 to 2 years

Action BR-8	
Description of Action	Work with homeowners, businesses, and the building and services sectors to identify and require flood protection technologies in retrofits to existing homes and buildings to minimize flooding damage/threats during major renovation, improvement, and expansion efforts.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Flood
HMCAP Priority	Low

Action BR-9	
Description of Action	Reach out to all building owners in the current or increased floodplain (as of June 2022 updated FIRM effective date) near E and W Potomac Streets and assist them in including their building in a grant application for flood mitigation projects or securing flood insurance.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.

Action BR-9	
	Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 3: Encourage property owners to maintain insurance that covers all hazards, including flood insurance through the National Flood Insurance Program. Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance. Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events.
Relevant Hazard	Flood
HMCAP Priority	Medium

Action BR-10	
Description of Action	Use the pluvial analysis from this HMCAP to identify areas vulnerable to pluvial flooding for potential nature-based mitigation projects, like bioswales. Use other mitigation techniques where necessary.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood
HMCAP Priority	Medium

Action BR-11	
Description of Action	Complete a Gumspring Corridor stream armoring and pipe upsizing project.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.

Action BR-11	
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood
HMCAP Priority	Medium

Action BR-12	
Description of Action	Complete the Martins Creek and Petersville Read Creek flood study.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	City of Brunswick Administration Department (Planning Office)
Estimated Costs	TBD
Possible Funding Sources	HMGP, BRIC, CDBG
Timeline for implementation	1 year

Action BR-13	
Description of Action	Install a stormwater pipe at Greenwood and West E Street.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood
HMCAP Priority	Medium

Action BR-14	
Description of Action	Conduct a comprehensive stormwater analysis by drainage area across the city.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Flood
HMCAP Priority	Medium

Town of Burkittsville

Action BU-1	
Description of Action	Determine if it possible to create a new ordinance that requires homeowners to maintain and mitigate any issues with bodies of water on their properties.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Flood
HMCAP Priority	Medium

Action BU-2	
Description of Action	Identify flood mitigation actions that could be performed on historic homes with identified issues. Ask the County for technical assistance in including them in a flood mitigation grant, if appropriate.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.

Action BU-2	
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood
HMCAP Priority	Medium

Action BU-3	
Description of Action	Identify building owners that may want to be included in a wind mitigation grant application. Ask the County for technical assistance in including them in in an application.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Low

Action BU-4	
Description of Action	Build a storm drain system consisting of inlets, manholes, and a pipe network to collect and provide safe conveyance of stormwater runoff from streets and rooftops to treatment facilities and/or off the streets. Upgrade and/or replace culverts as necessary. Create environmental site design treatment facilities as required to regulate stormwater quality. There is currently no storm drain system within Main Street.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.

Action BU-4	
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 14: Plan to retrofit infrastructure to make it resilient to future climate impacts.
Relevant Hazard	Flood, Severe Winter Storm
HMCAP Priority	High
Plan Integration	Town of Burkittsville Green Streets and Stormwater Master Plan
Responsible Organizations	Mayor
Estimated Costs	$1,527,463
Possible Funding Sources	BRIC
Timeline for implementation	5 years

Action BU-5	
Description of Action	Gain the cooperation of and coordinate with private property owners to implement a natural resources management and restoration project. This may include culvert upgrades at alleys, buffers installation, stream restoration and relocation, and designed stream buffer wetlands.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 11: Provide the public with more opportunities to actively participate and provide input regarding hazard mitigation and climate adaptation activities.
Relevant Hazard	Flood
HMCAP Priority	High

Action BU-5	
Plan Integration	Town of Burkittsville Green Streets and Stormwater Master Plan
Responsible Organizations	Mayor
Estimated Costs	$3,530,862.50
Possible Funding Sources	HMGP, BRIC
Timeline for implementation	5 years

Town of Emmitsburg

Action EM-1	
Description of Action	Adoption of a "Cluster Development Ordinance" to strengthen flood plain buffers and limit infrastructure maintenance.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Flood
HMCAP Priority	Low
Status since 2016	None

Action EM-2	
Description of Action	Coordinate with the State Highway Administration to repair North Seton Bridge across Flat Run to mitigate flooding and erosion issues.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Flood

Action EM-2	
HMCAP Priority	Low

Action EM-3	
Description of Action	Implement a flood mitigation project at North Seton Avenue, such as a project to address water running to North Seton Bridge (Green Street on North Seton Ave) to mitigate the ingress/egress issues at the North Gate residential development or a stormwater basin at Northgate to alleviate flooding at Provincial Turnpike and North Seton Ave.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	Town of Emmitsburg Planning & Municipal Separate Storm Sewer System
Estimated Costs	TBD
Possible Funding Sources	Capital budget
Timeline for implementation	2 to 3 years

Action EM-4	
Description of Action	Coordinate with the relevant developer to make sure the bridge on Irishtown Road (culvert bridge) is replaced.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Flood

Action EM-4	
HMCAP Priority	Medium

Action EM-5	
Description of Action	Mitigate the erosion on Flat Run with a streambank restoration project. Perform dredging to fix the current buildup issues.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Flood
HMCAP Priority	Medium

Action EM-6	
Description of Action	The Leadership in Energy and Environmental Design Pilot Credit "Design for Enhanced Resilience" will be attempted for all new County/City facilities, all major renovations to existing County/City buildings, and all development projects receiving financial assistance or special approvals from the County/City.
Applicable Goal(s)	Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts. Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Town of Emmitsburg Executive
Estimated Costs	TBD
Possible Funding Sources	Town budget

Action EM-6	
Timeline for implementation	1 to 2 years
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 - Buildings

Action EM-7	
Description of Action	Initiate application, permitting, inspection, and interconnection process-simplification efforts.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Low

Action EM-8	
Description of Action	Increase green infrastructure, such as expanding riparian buffers, urban tree canopy, and stormwater management structures, to reduce impervious cover in flood-prone areas
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	Town of Emmitsburg Planning & Municipal Separate Storm Sewer System
Estimated Costs	TBD
Possible Funding Sources	HMGP, BRIC, CDBG
Timeline for implementation	2 to 5 years

Action EM-9	
Description of Action	Assess and plan for future retrofit and new construction of conveyance and storage systems for wastewater and stormwater service
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	Town of Emmitsburg Planning & Municipal Separate Storm Sewer System
Estimated Costs	TBD
Possible Funding Sources	Capital budget, CDBG
Timeline for implementation	1 to 2 years

Action EM-10	
Description of Action	Implement green infrastructure projects along roadways and across floodplains and explore stream restoration projects to address increased precipitation and protect infrastructure from new storm flows, building resiliency to the increased severity of weather events.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.

Action EM-10	
	Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 14: Plan to retrofit infrastructure to make it resilient to future climate impacts.
Relevant Hazard	Flood
HMCAP Priority	Medium
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 - Resilience

Action EM-11	
Description of Action	Create a voluntary "plant a tree" program in at least one socially vulnerable area.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 4: Prioritize equity and vulnerable populations in the implementation of physical hazard mitigation projects.
Relevant Hazard	Extreme Heat, Flood
HMCAP Priority	Medium

Action EM-12	
Description of Action	Use the pluvial analysis from this HMCAP to identify areas vulnerable to pluvial flooding for potential nature-based mitigation projects, like bioswales. Use other mitigation techniques where necessary.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood
HMCAP Priority	Medium

Action EM-13	
Description of Action	Explore and implement efforts to increase overall stormwater/Green infrastructure capacities to address the implications of increased precipitation (greater than 1” rainfall events).
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 14: Plan to retrofit infrastructure to make it resilient to future climate impacts.
Relevant Hazard	Flood
HMCAP Priority	Low

Action EM-14	
Description of Action	Educate building owners on proper hail damage mitigation techniques. This may include installing structural bracing, shutters, and laminated glass in windowpanes and including hail-resistant roof coverings or flashing in the building design to minimize damage.
Applicable Goal(s)	Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 9: Use public information and education programs to support community members’ decision-making on how to protect themselves and their property from natural hazard events.
Relevant Hazard	Severe Winter Storm
HMCAP Priority	Low

Action EM-15	
Description of Action	Require retrofitting/hardening any reused county- or city-owned buildings that will house critical facilities.

Action EM-15	
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Low

Action EM-16	
Description of Action	Promote the acquisition of floodway land (future repetitive loss properties) as green space.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Low

Action EM-17	
Description of Action	Implement sewer relining and water line replacement project.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Low

City of Frederick

Action FR-1	
Description of Action	Identify the 7 areas of localized flooding (not mapped by FEMA). Develop means of mitigation or determine a course of action if mitigation is not possible. Possible strategies include making improvements to existing drainage systems to relieve flooding or purchasing the property where mitigation is not possible.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Flood
HMCAP Priority	Medium
Status since 2016	USACE studying three areas, and strategy description updated with two more areas for a total of seven

Action FR-2	
Description of Action	Develop a flood warning system for citizens who do not use a cell phone. Coordinate with Emergency Services to utilize existing public warning systems.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 8: Ensure County residents can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard	Flood
HMCAP Priority	Low
Status since 2016	None

Action FR-3	
Description of Action	Retrofit drainage where major roads frequently flood at Waverly Drive (Frederick Towne Mall, major city mall subject to flooding by Rock Creek).
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	City of Frederick Public Works, Engineering, and Planning
Estimated Costs	City engineer to do preliminary analysis to determine costs at each location
Possible Funding Sources	HMGP, FMA
Timeline for implementation	6 to 10 years
Status since 2016	Ongoing. Drainage retrofits completed for West Patrick Street and Gas House Pike near Monocacy River areas.

Action FR-4	
Description of Action	Develop a GIS map of all city sinkholes that includes information on sinkholes, not just locations. Require that sinkhole topography be included in all site plans in affected areas.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Karst and Land Subsidence
HMCAP Priority	Medium
Status since 2016	Ongoing. Sinkhole locations are mapped, but additional information needs to be collected as they occur.

Action FR-5	
Description of Action	Identify a model sinkhole ordinance and adopt it.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Karst and Land Subsidence
HMCAP Priority	Medium
Status since 2016	None

Action FR-6	
Description of Action	Establish a regular maintenance inspection and preventive program for sinkholes on/near city streets.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Karst and Land Subsidence
HMCAP Priority	Medium
Status since 2016	None

Action FR-7	
Description of Action	Adopt the 2021 International Building Code as the base code and the 2018 International Green Construction Code as a compliance path. Coordinate adoption with City's scheduled updates to the build code, which occurs approximately every three years.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.

Action FR-7	
	Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure. Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Low
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 - Buildings

Action FR-8	
Description of Action	The Leadership in Energy and Environmental Design Pilot Credit "Design for Enhanced Resilience" will be attempted for all new County/City facilities, all major renovations to existing County/City buildings, and all development projects receiving financial assistance or special approvals from the County/City.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards. Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Low
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 - Buildings

Action FR-9	
Description of Action	Increase home energy and weatherization assistance in socially vulnerable neighborhoods; implement a heat illness surveillance program, and increase

Action FR-9	
	education and outreach program (buddy program, etc.) to combat risks from rising temperatures and heat waves.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 4: Prioritize equity and vulnerable populations in the implementation of physical hazard mitigation projects. Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance. Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events.
Relevant Hazard	Extreme Heat
HMCAP Priority	Low
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 - Resilience

Action FR-10	
Description of Action	Work with homeowners, businesses, and the building and services sectors to identify and require flood protection technologies in retrofits to existing homes and buildings to minimize flooding damage/threats during major renovation, improvement, and expansion efforts.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance.

Action FR-10	
	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Flood
HMCAP Priority	Medium
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 - Resilience

Action FR-11	
Description of Action	Explore and implement efforts to reduce compaction of lawns in residential development, and to increase overall stormwater/Green infrastructure capacities to address the implications of increased precipitation (greater than 1” rainfall events).
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Flood
HMCAP Priority	Medium
Plan Integration	Livable Frederick - Climate Resiliency

Action FR-12	
Description of Action	Assist at least 5 structure owners in including their structure in a grant application for wind and/or flood retrofitting projects. At least two of these homeowners should qualify as socially vulnerable, if possible.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.

Action FR-12	
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 4: Prioritize equity and vulnerable populations in the implementation of physical hazard mitigation projects.
Relevant Hazard	Tropical Cyclone, Tornado, Flood, Severe Weather
HMCAP Priority	Low

Action FR-13	
Description of Action	Require retrofitting/hardening any reused county- or city-owned buildings that will house critical facilities.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium

Action FR-14	
Description of Action	Conduct a risk and resilience study for water treatment facilities and implement recommendations from study.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure. Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.

Action FR-14	
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium

Town of Middletown

Action MI-1	
Description of Action	Reduce potential flooding damage by including waterbody buffer requirements in all zoning districts that do not have them.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	Town of Middletown Planning Commission
Estimated Costs	$1,000 for legal review and public hearing scheduling process
Possible Funding Sources	Town's general fund
Timeline for implementation	6 to 12 months
Status since 2016	Ongoing. Accomplished in some places (approximately 45%) and in progress in other areas.

Town of Mount Airy

Action MA-1	
Description of Action	Conduct a Vulnerability Assessment of the Town's infrastructure highlighting weaknesses in the system.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.

Action MA-1	
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Town of Mount Airy Administration, Engineering, and Public Works
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	2 to 3 years
Status since 2016	None

Action MA-2	
Description of Action	Install/replace emergency backup generators at all critical facilities.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Status since 2016	In progress. Replaced 70KW generator at wastewater treatment plan and installed a generator for maintenance shop.

Town of Myersville

Action MY-2	
Description of Action	Provide Myersville residents with information on how to mitigate against the most prominent hazards in the County, as well as general hazard information. Online tools, public meetings, and other various outreach

Action MY-2	
	materials will be utilized to maximize outreach. Materials development will be done in collaboration with Frederick County.
Applicable Goal(s)	Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events. Objective 10: Increase the public's awareness of their natural hazard risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium

Town of New Market

Action NM-1	
Description of Action	Implementation of a recently signed developer agreement to design and construct a new parkway. This will create an alternate east-west route through town and create new town evacuation route options, thereby mitigating problems that could occur in town during an emergency with a blockage of Main Street/Maryland Route 144.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 8: Ensure County residents can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Town of New Market, private development partners
Estimated Costs	TBD
Possible Funding Sources	Private investment
Timeline for implementation	1 to 2 years
Status since 2016	None

Village of Rosemont

Action RS-1	
Description of Action	Post hazard mitigation information on village website and send out emails to the Rosemont resident listserv.
Applicable Goal(s)	Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events. Objective 10: Increase the public's awareness of their natural hazard risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Town of Rosemont Burgess
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	Ongoing
Status since 2016	In progress. Email list is not comprehensive.

Action RS-2	
Description of Action	Contact private property owner(s) in North Rosemont where there is a drainage issue and determine if they are eligible and would like to be included in a flood mitigation grant. Work with the County for technical assistance.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance.

Action RS-2	
	Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events.
Relevant Hazard	Flood
HMCAP Priority	Low

Town of Thurmont

Action TH-1	
Description of Action	Reinforce stream banks along Hunting Creek in locations where the stream passes through town. Banks are eroding causing risks to private homes and businesses that are adjacent to the stream.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Status since 2016	None

Action TH-2	
Description of Action	Revise existing ordinances to integrate resilience concepts. Encourage cluster development and preservation of open space.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.

Action TH-2	
	Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Status since 2016	In progress. Cluster and open space preservation ordinances have been completed and will continue to be improved.

Action TH-3	
Description of Action	Obtain generators of various sizes for two water treatment facilities. Acquire mobile generators and retrofit hookups for remote pump stations for backup capability.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Multiple Hazards
HMCAP Priority	High
Responsible Organizations	Town of Thurmont, Frederick County Division of Emergency Management
Estimated Costs	Varies by project
Possible Funding Sources	Department of Homeland Security Emergency Services
Timeline for implementation	1 year
Status since 2016	In progress. One of the two facilities have been wired so far.

Action TH-4	
Description of Action	Seek funding to mitigate flooding concerns at the Public Works Office via relocation, elevation, levee construction, and/or streambank restoration.

Action TH-4	
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the resilience of critical facilities and infrastructure.
Relevant Hazard	Flood
HMCAP Priority	Low
Status since 2016	In progress. Public Works Office has undergone some armoring, but Thurmont would like to replace the facility in a safer location.

Action TH-5	
Description of Action	Reach out to all building owners in the current or increased floodplain (as of June 2022 updated FIRM effective date) and assist them in including their building in a grant application for flood mitigation projects and/or securing flood insurance.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 3: Encourage property owners to maintain insurance that covers all hazards, including flood insurance through the National Flood Insurance Program. Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance. Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events.
Relevant Hazard	Flood

Action TH-5	
HMCAP Priority	Medium

Action TH-6	
Description of Action	The Leadership in Energy and Environmental Design Pilot Credit "Design for Enhanced Resilience" will be attempted for all new County/City facilities, all major renovations to existing County/City buildings, and all development projects receiving financial assistance or special approvals from the County/City.
Applicable Goal(s)	Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 12: Integrate hazard mitigation, climate adaptation, and resilience planning into other planning efforts. Objective 13: Increase the number of policies and ordinances that consider future conditions and encourage specific actions to address risks.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 - Buildings

Action TH-7	
Description of Action	Increase green infrastructure, such as expanding riparian buffers, urban tree canopy, and stormwater management structures, to reduce impervious cover in flood-prone areas
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	Town of Thurmont Planning & Zoning, Municipal Separate Storm Sewer System

Action TH-7	
Estimated Costs	TBD
Possible Funding Sources	BRIC, CDBG
Timeline for implementation	2 to 5 years

Action TH-8	
Description of Action	Assess and plan for future retrofit and new construction of conveyance and storage systems for wastewater and stormwater service.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood
HMCAP Priority	High
Responsible Organizations	Town of Thurmont Planning and Zoning, Municipal Separate Storm Sewer System
Estimated Costs	TBD
Possible Funding Sources	Capital budget, CDBG
Timeline for implementation	1 to 2 years

Action TH-9	
Description of Action	Implement green infrastructure projects along roadways and across floodplains and explore stream restoration projects to address increased precipitation and protect infrastructure from new storm flows, building resiliency to the increased severity of weather events.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.

Action TH-9	
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 14: Plan to retrofit infrastructure to make it resilient to future climate impacts.
Relevant Hazard	Flood
HMCAP Priority	Medium
Plan Integration	Climate Emergency Mobilization Working Group, Volume 1 - Resilience

Action TH-10	
Description of Action	Create a voluntary "plant a tree" program in at least one socially vulnerable area.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 4: Prioritize equity and vulnerable populations in the implementation of physical hazard mitigation projects.
Relevant Hazard	Extreme Heat, Flood
HMCAP Priority	Medium
Plan Integration	Aligns with Town's Tree City USA designation.

Action TH-11	
Description of Action	Use the pluvial analysis from this HMCAP to identify areas vulnerable to pluvial flooding for potential nature-based mitigation projects, like bioswales. Use other mitigation techniques where necessary.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.

Action TH-11	
Relevant Hazard	Flood
HMCAP Priority	Medium

Action TH-12	
Description of Action	Explore and implement efforts to increase overall stormwater/Green infrastructure capacities to address the implications of increased precipitation (greater than 1” rainfall events).
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal D: Adapt to climate change and natural hazards through forward-looking policies, plans, and ordinances that aim to reduce negative impacts.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 14: Plan to retrofit infrastructure to make it resilient to future climate impacts.
Relevant Hazard	Flood
HMCAP Priority	Low

Action TH-13	
Description of Action	Educate building owners on proper hail damage mitigation techniques. This may include installing structural bracing, shutters, and laminated glass in windowpanes, and including hail-resistant roof coverings or flashing in the building design to minimize damage.
Applicable Goal(s)	Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 9: Use public information and education programs to support community members’ decision-making on how to protect themselves and their property from natural hazard events.
Relevant Hazard	Severe Winter Storm
HMCAP Priority	Low

Action TH-14	
Description of Action	Require retrofitting/hardening any reused county- or city-owned buildings that will house critical facilities.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Low

Action TH-15	
Description of Action	Promote the acquisition of floodway land (current or future repetitive loss properties) as green space.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood
HMCAP Priority	Low

Action TH-16	
Description of Action	Implement a flood mitigation project to address the flooding issues along the west side of Emmitsburg Road. This may include constructing two stormwater basins and increasing the size of the nearby culverts.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Flood

Action TH-16	
HMCAP Priority	High
Responsible Organizations	Town of Thurmont Planning & Zoning
Estimated Costs	TBD
Possible Funding Sources	Bond, American Recovery Plan Act funds, state grants, HMGP, BRIC
Timeline for implementation	1-3 years

Town of Walkersville

Action WK-1	
Description of Action	Review and update Town Design Manual.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 6: Advance hazard mitigation and climate adaptation-related training, development, and technical assistance. Objective 7: Enhance codes and ordinances to better encourage hazard-resistant infrastructure.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Medium
Status since 2016	In progress.

Action WK-2	
Description of Action	Amend the study to assess flooding on Biggs Ford Road from Glade Creek to Kenneth Drive to include updated effects from Rock Creek School. Develop alternatives to reduce flooding impacts, if necessary.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick County to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Support data collection, studies, plans, and mapping efforts to improve the County's ability to respond to and prepare for future hazards.

Action WK-2	
Relevant Hazard	Flood
HMCAP Priority	Low
Status since 2016	In progress. Study has been completed, and the construction of Rock Creek School may address some concerns. The lack of rain recently has made it hard to understand the impact of the school, and the Town is waiting to see if alternative development is necessary.

Town of Woodsboro

Action WD-1	
Description of Action	Encourage residents to attend hazard mitigation meetings held by Frederick County.
Applicable Goal(s)	Goal C: Improve the public's awareness of potential hazards, education on resilience planning, and incentives for mitigation actions.
Applicable Objective(s)	Objective 9: Use public information and education programs to support community members' decision-making on how to protect themselves and their property from natural hazard events. Objective 11: Provide the public with more opportunities to actively participate and provide input regarding hazard mitigation and climate adaptation activities.
Relevant Hazard	Multiple Hazards
HMCAP Priority	Low

Action WD-2	
Description of Action	Identify flood or wind mitigation projects that can be implemented and work with the County to get them included in a hazard mitigation grant application.
Applicable Goal(s)	Goal A: Protect public infrastructure, human health, private property, and the environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard	Multiple Hazards

Action WD-2	
HMCAP Priority	Low

CHAPTER 8. IMPLEMENTATION AND MAINTENANCE

This chapter identifies procedures for implementing and maintaining the HMCAP as it is a living document that continuously guides actions within the Frederick County. The Division of Emergency Management and the Hazard Mitigation Planning Committee will submit a 5-year written update to the State and FEMA Region III, unless a disaster or other circumstances lead to a different time frame.

Implementation

After the HMCAP undergoes an update, the focus shifts to implementation. This involves monitoring the progress of the mitigation actions outlined in Chapter 7, as well as collecting new and changing information to inform the next update.

Monitoring

HMCAP maintenance requires an ongoing effort to monitor the progress of mitigation actions and projects. The Division of Emergency Management will be responsible for monitoring the HMCAP, and the Hazard Mitigation Planning Committee will play an advisory role for oversight and expert input. The team should accomplish the following:

- The Division of Emergency Management will review the HMCAP yearly, specifically the mitigation action plan and responsible organization designation in each project.
- As high-priority projects are marked complete, the Hazard Mitigation Planning Committee will re-prioritize the mitigation actions in coordination with the local planning teams, as needed.
- If extra funding becomes available, the Division of Emergency Management will re-visit the low priority mitigation actions for re-prioritization and potential implementation.
- If needed, the Division of Emergency Management will request a meeting with the Hazard Mitigation Planning Committee and the public to do a formal review of the plan.

The timing of the yearly reviews should coincide with either the anniversary of the approval date of the Plan or another date chosen by the committee.

Evaluating

In addition to monitoring and record-keeping, HMCAP maintenance will require ongoing evaluation of the implementation of mitigation actions to identify progress, roadblocks, and changing circumstances. The Division of Emergency Management and primary responsible organizations for each mitigation action listed in Chapter 7 will be responsible for evaluating progress in implementing mitigation projects. The Division of Emergency Management, during its annual review, may also identify corrective actions for projects. In addition, the Division of Emergency Management should review the Hazard Mitigation Planning Committee's organizational composition annually and adjust membership, if needed.

Maintenance

The Division of Emergency Management will determine at its annual meeting if a formal update of the Plan is required. At a minimum, the Plan will be updated every 5 years. Factors to consider when determining if an update is necessary include:

- Decreased vulnerability as a result of implementing recommended actions;
- Increased vulnerability as a result of failed or ineffective mitigation actions;
- Increased vulnerability as a result of new development;
- New state/federal laws, policies, or programs;
- Changes in resource availability; and/or
- Applicability of goals/objectives/strategies.

A major event such as a presidentially declared disaster may trigger a need to review the plan. If such an event affects Frederick County, the Division of Emergency Management will coordinate to determine how best to review and update the plan. Major changes to the Plan will be submitted to the State and to FEMA Region III.

Ongoing Plan Integration

The HMCAP is meant to be integrating into other county plans and documents as applicable. In turn, during the annual and 5-year updates, relevant plans and studies will be integrated into the HMCAP. During the annual meeting, the lead parties for new and updated plans and documents should be invited with the goal of identifying collaboration and integration opportunities, especially within the mitigation and climate adaptation strategy. Special attention should be paid to any resilience- or climate-related plans.

Future Improvements

As the HMCAP is a living document, it should be continuously improved. During the 2021 update, new foundational elements were added to the plan, such as a climate adaptation focus, an analysis of socially vulnerable populations, a broadened future development analysis, and enhanced public outreach opportunities. However, there are opportunities to strengthen these elements in future updates, such as:

- Identifying and integrating new climate adaptation and resilience goals, objectives, and actions that the County has prioritized;
- Incorporate new and updated social vulnerability data that coordinates with the methods used by FEMA's HMA programs;
- Conduct a social vulnerability analysis at a more granular scale than the U.S. Census tract level as currently used by the CDC's SVI data;
- Combine all spatial assessments to identify and create mitigation actions for potential "hot spots" of overlapping hazard risk, social vulnerability, and future development;
- Complete a future development analysis that looks at the potential growth scenarios as identified in the Livable Frederick Plan;
- Create GIS data on building age that also shows the distribution of commercial, industrial, and residential building types;
- Create a more comprehensive public outreach strategy that utilizes already-existing community groups and networks to reach broader and more diverse audience for participation and feedback;
- Improve the pluvial flood model with the future update recommendations outlined in the pluvial flood section; and

- Add in high-priority human-caused hazards into the hazard identification and risk assessment, such as hazardous spill and pandemic/infectious disease.

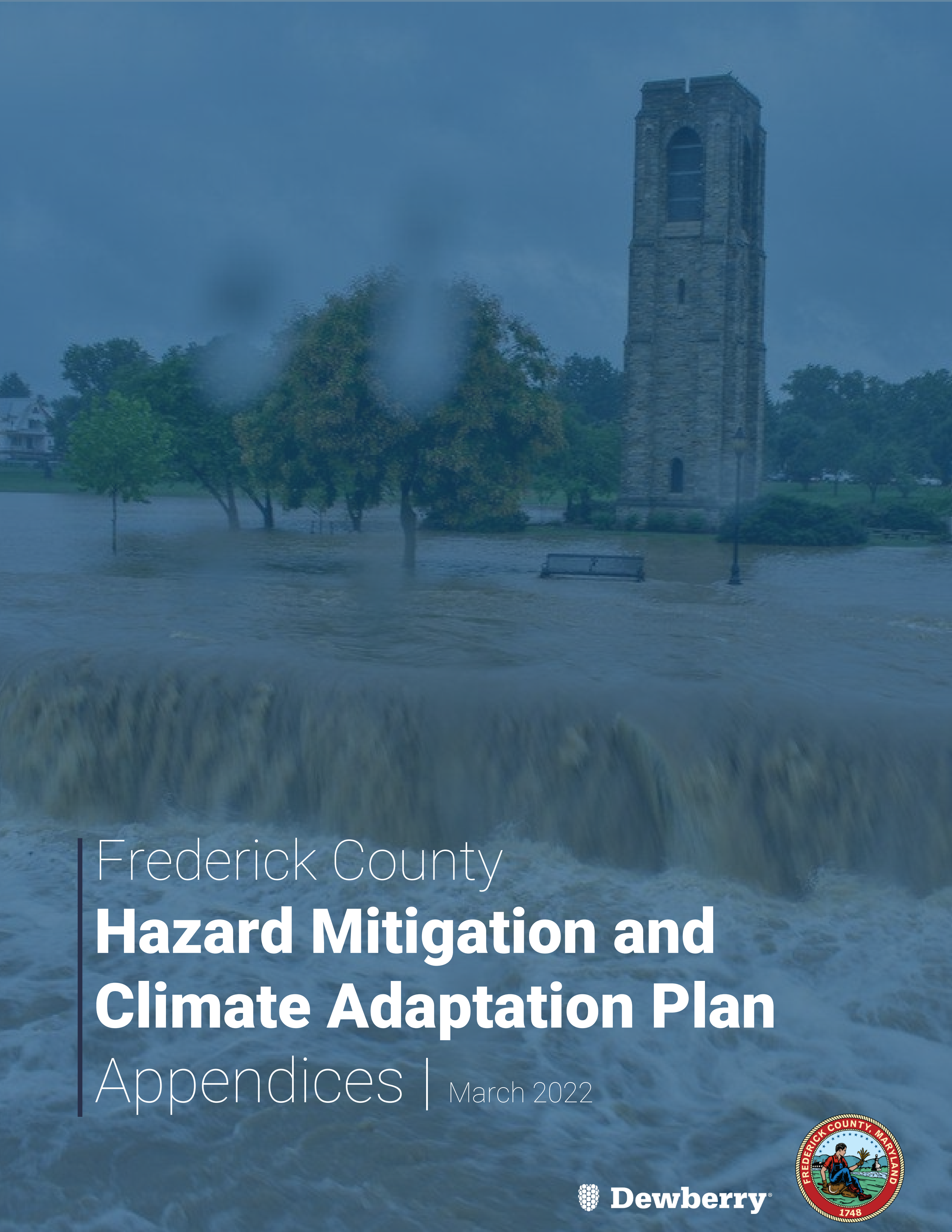
Public and Stakeholder Involvement

Feedback from residents, businesses, and other stakeholders is a critical part of hazard mitigation planning. The input from the Frederick County public was a highly valuable part of the 2021 HMCAP update, and it will continue to be sought as the planning process continues and evolves. Public and stakeholder involvement helps guide mitigation actions and projects through prioritizing what the public values and needs. The HMCAP heavily relies on data, but the numbers don't always capture and reflect the day-to-day experiences and firsthand accounts of the community. Contextualizing the data we have access to helps paint a more complete picture of risk and vulnerability—the foundation of the mitigation and adaptation strategy.

Public notice of the annual review will be given and public participation will be actively invited. At a minimum, notification will be through web postings and press releases to local media outlets, primarily newspapers. In addition, an annual event will be held to publicize progress on implementing the mitigation plan. This event could be timed to coincide with the anniversary of a significant event or annual awareness event (e.g., Hurricane Preparedness Week). The County will also post a link to the mitigation plan on the Division of Emergency Management's website. It is recommended that the County's website serve as a means of communication by providing information about mitigation initiatives and updates to the projects and the HMCAP itself.

As resources become available, social media should be utilized to publicize public hazard mitigation planning meetings and news. Specifically, community Facebook groups and the Frederick County Subreddit can be utilized as they are already-existing community networks that allow for greater exposure to those who do not typically see notices about hazard mitigation planning. Feedback can and should be solicited from these groups as a way to bolster knowledge of hazard issues using local knowledge.

Additionally, as described in the future improvements section, outreach can be conducted to further involve community groups (e.g., church groups, schools, volunteer organizations) in the planning process. Emergency management professionals can also be contacted to determine areas for collaborations and identify specific mitigation projects that can be collaboratively implemented to address hazards that effect both jurisdictions.



Frederick County

Hazard Mitigation and Climate Adaptation Plan

Appendices | March 2022

Dewberry

FREDERICK COUNTY, MARYLAND 1748

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APPENDIX A: PLUVIAL FLOODING ANALYSIS

Motivation

As described in the main report, there are two major types of flood hazard: fluvial and pluvial. The main report presents a flood exposure analysis based in part on FEMA flood maps, which only consider fluvial (riverine) flood risk. It is important to also understand the pluvial (stormwater) flood hazard because it is large and potentially growing, due to climate and urbanization trends. fortunately, recent advances in computing power and topographic data make it faster and easier than before to consider pluvial flood risk in hazard mitigation plans.

Recognizing the opportunity to better understand fluvial flooding, a new pluvial flood analysis was performed for Frederick County. This study provides a new baseline understanding of pluvial flood risk for planning. The analysis employed a large number of assumptions to simplify the development and running of the model across a very large area. Despite its limitations, the model results provide the most complete picture to date of pluvial flooding hot spots and exposure over a range of potential storm events.

Study Scope

The goal of the pluvial flooding analysis was to develop high-level stormwater flood risk products for a limited range of precipitation events for all of Frederick County. The risk products were derived from a 2D hydraulic model using readily available data and simplifying assumptions based on engineering judgement. The model results were not calibrated or validated to any observed flood data, which is sparse and difficult to obtain. The model results were however compared to the FEMA Special Hazard Flood Area (SFHA) and previous flood modeling at Clover Hill to ensure general consistency in areas where the flood map products overlap.

Modeling Approach

The pluvial flood analysis was conducted using a U.S. Army Corps of Engineer HEC-RAS Version 6 2-dimensional (2D) unsteady flow model. The open-source model and documentation were downloaded from https://www.hec.usace.army.mil/software/hec-ras/download.aspx.

Topographic Processing

Existing Digital Elevation Model (DEM) and LiDAR datasets were downloaded for the Frederick County area using the USGS National Map API. The best-available DEMs were stitched together into a single elevation data layer (see Figure 1). The DEM used across most of Frederick County was collected in 2012 with a resolution of 1/9 arc-second (3.4 m).

Development of Major Watersheds

The USGS Watershed Boundary Dataset was used to help delineate Frederick County into two major watersheds: Catoctin watershed and Monocacy watershed. A separate pluvial flood model was developed for each major watershed, which was necessary to reduce model run times. The borders of the major watersheds extend slightly beyond the county boundaries, because rainfall in areas outside the county can still contribute to flooding inside the county, when they are in the same watershed.

Note the major watersheds do not include large upstream portions of the watershed that are outside of Frederick County, such as the upper Monocacy in Pennsylvania and the upper Potomac in West Virginia. Instead of modeling the upper watersheds in detail, which would have significantly increased run times, the contributions from these areas were simulated as river inflows (see section on Boundary Conditions below).

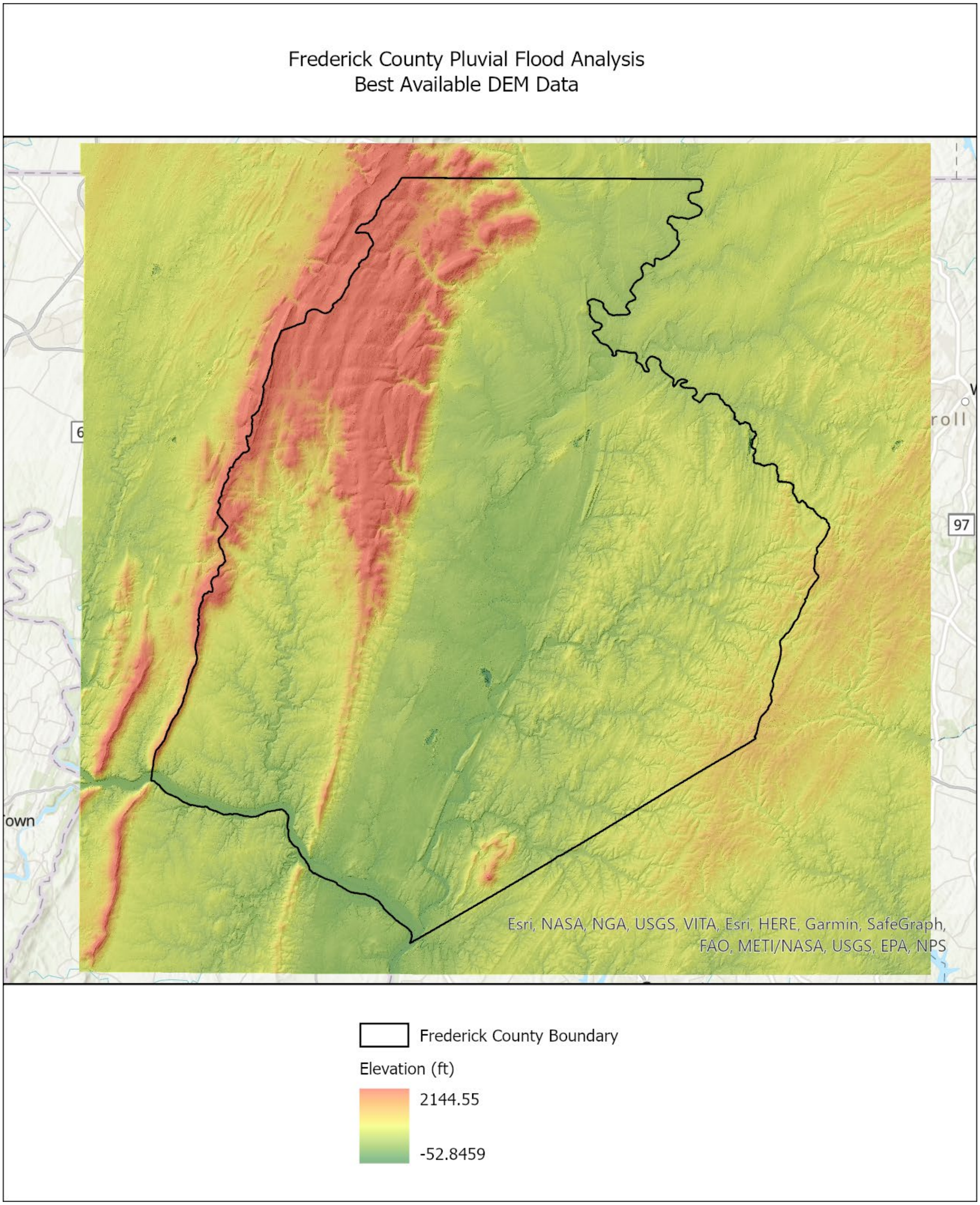


Figure 1. Frederick County DEM Data Used in Pluvial Model

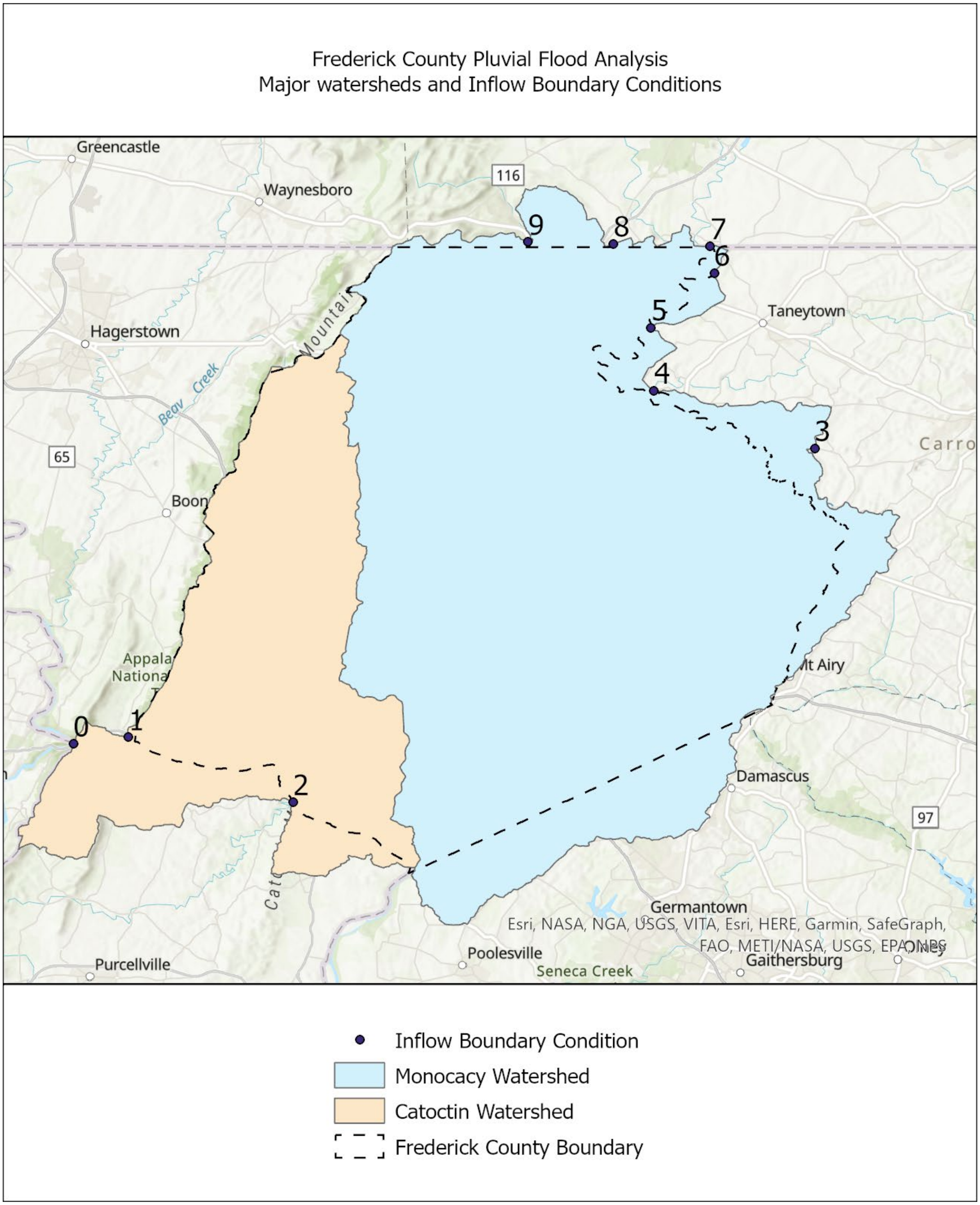


Figure 2. Location of Monocacy and Catoctin watersheds with inflow boundary conditions used in pluvial model. Each inflow is labeled with ID and described in Table 2.

Development of Model Mesh

For each of the two major watersheds, a model mesh (also called a model grid) was created using HEC-RAS automated mesh generation tools and minor manual adjustments. The model mesh represents the land surface being modeled. The average model mesh resolution was set to 100 m, so the average grid size is 100 m by 100 m, or 10,000 m^2.

Development of Rainfall Inputs

The pluvial flood model simulates stormwater flooding with a "rain-on-grid" modeling approach. The rain-on-grid approach adds or "rains" the appropriate amount of rainfall onto the surface of each grid cell at each model time step. During the model simulation, rainfall ponds and/or moves from model grid cell to grid cell based on the governing hydraulic equations which account for topography, differences in water surface elevation, and surface roughness. The rainfall timestep was set to six minutes, which was sufficiently short to capture the rise and fall of rainfall during the storm. Note the rain-on-grid approach used here is substantially different than the approach used in traditional FEMA models, which use increases in river flows instead of increases in rainfall to simulate flood events.

The rain-on-grid approach was applied with five different storm events: the 100-year 24-hour event, 100-year 12-hour event, 100-year 6-hour event, 25-year 24-hour event, and 10-year 24-hour event. These scenarios were chosen to represent a range of potential extreme storm events. The NOAA atlas-14 dataset was used to get the cumulate rainfall totals for each event at three points surrounding each major watershed.

The NOAA atlas-14 rainfall totals were multiplied by an areal reduction factor of 0.91 based on equation 2 in.[1] The areal reduction factor is applied to transform the atlas-14 point rainfall into average areal rainfall. The final cumulative rainfall totals are shown in Table 1.

Table 1. Cumulative total rainfall for each scenario averaged over three points surrounding each major watershed

Rainfall Scenario	Average Cumulative Rainfall at Catoctin Watershed (in)	Average Cumulative Rainfall at Monocacy Watershed (in)
100-year 24-hour	6.92	7.24
100-year 12-hour	5.89	6.03
100-year 6-hour	4.67	4.73
25-year 24-hour	5.11	5.28
10-year 24-hour	4.14	4.22

The storm events were assumed to have an SCS Type-II temporal distribution, which is typical for the mid-Atlantic region.[2] The distribution shape is illustrated in Figure 3. The rainfall at grid cells between the three points was spatially interpolated. Note that a large fraction of rain falls during the middle of the storm between the 10th and 14th hours.

Rainfall Infiltration

Rainfall infiltration was modeled within HEC-RAS using the SCS curve number approach. The method is described in detail in the HEC-RAS Version 6 Hydraulic Reference Manual.[3] Briefly, the infiltration model effectively reduces the amount of rainfall falling on each grid cell depending on its SCS curve number, which is derived from the SSURGO hydrologic soil classification and land use from the 2019 National Land Cover Database (NLCD).

[1] Allen, R. J., & DeGaetano, A. T. (2005). Areal Reduction Factors for Two Eastern United States. Journal of Hydrologic Engineering.
[2] USDA-SCS. (1986). Urban Hydrology for Small Watersheds (TR-55).
[3] Brunner, W. B. (2021). HEC-RAS, River Analysis System Hydraulic Reference Manual.

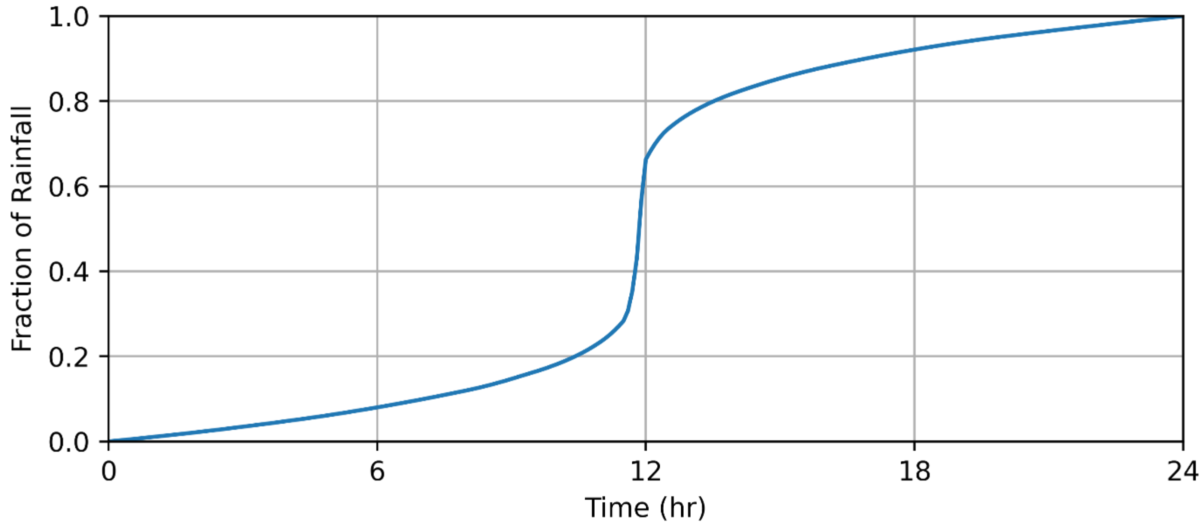


Figure 3. Cumulative rainfall during a 24-hour event used in the pluvial model, based on the SCS Type-II distribution.

Higher SCC curve numbers are associated with less infiltration and greater runoff. More urbanized land uses tend to have higher SCS curve numbers, while less urbanized land uses tend to have lower SCS curve number. The NLCD data is shown in Figure 4, and the final curve numbers used in the infiltration model are shown in Figure 5.

Boundary Conditions

The model boundary conditions determine how water flows at the edges of the model grid. In general, the model edge was assigned a normal flow boundary condition. In addition, as mentioned earlier, the contribution of upstream areas to Frederick County flooding was modeled as a constant river inflow at the model boundary. for example, a constant river inflow was applied at the inflow of the Potomac River from West Virginia and the inflow of the Monocacy from Pennsylvania. The location of the inflow boundary conditions is shown in Figure 2.

The amount of inflow was assumed to be equal to the 100-year event discharge. The discharge for inflows was obtained from the USGS StreamStats tool, which in turn uses regression equations described in.[4] An exception was the Potomac River inflow, which was approximated from information in the effective FEMA Flood Insurance Study. Table 2 has the 10-year, 25-year, and 100-year flow for each.

Manning's n

Manning's n values were assigned to each grid cell in the model mesh based on its land use class from the 2019 NLCD. The correspondence between land use codes and the Manning's n values are provided in Table 3. In addition, the Manning's n along stream beds was set to 0.03. The stream bed area was roughly delineated using Google Earth imagery and a stream map downloaded from the Frederick County GIS website.

[4] Thomas, J. W., & Moglen, G. (2010). An Update of Regional Regression Equations for Maryland, Appendix 3 in Application of Hydrologic Methods in Maryland, Third Edition, September 2010: Maryland State Highway Administration and Maryland Department of the Environment.

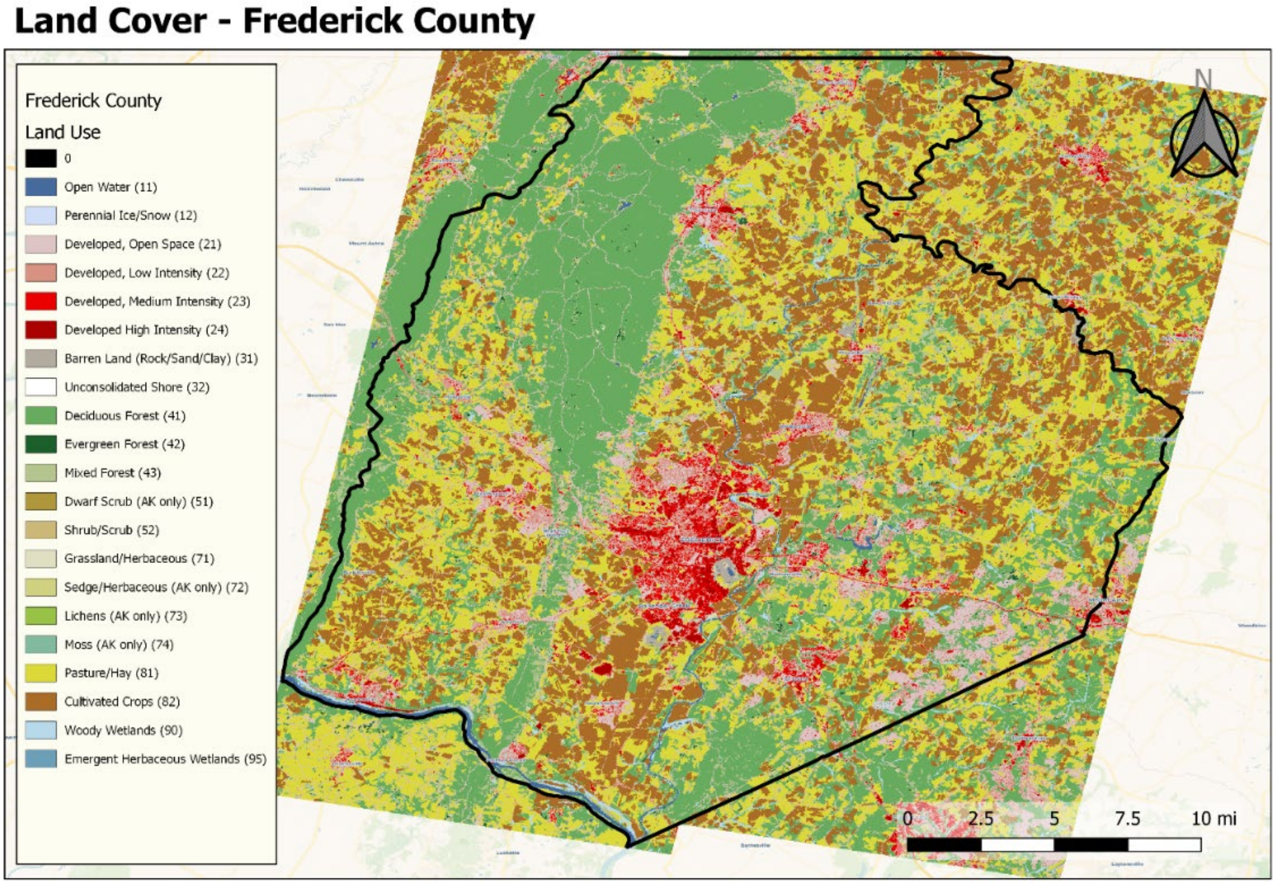


Figure 4. Frederick County used to calculate infiltration and Manning's n, from the 2019 NLCD dataset.

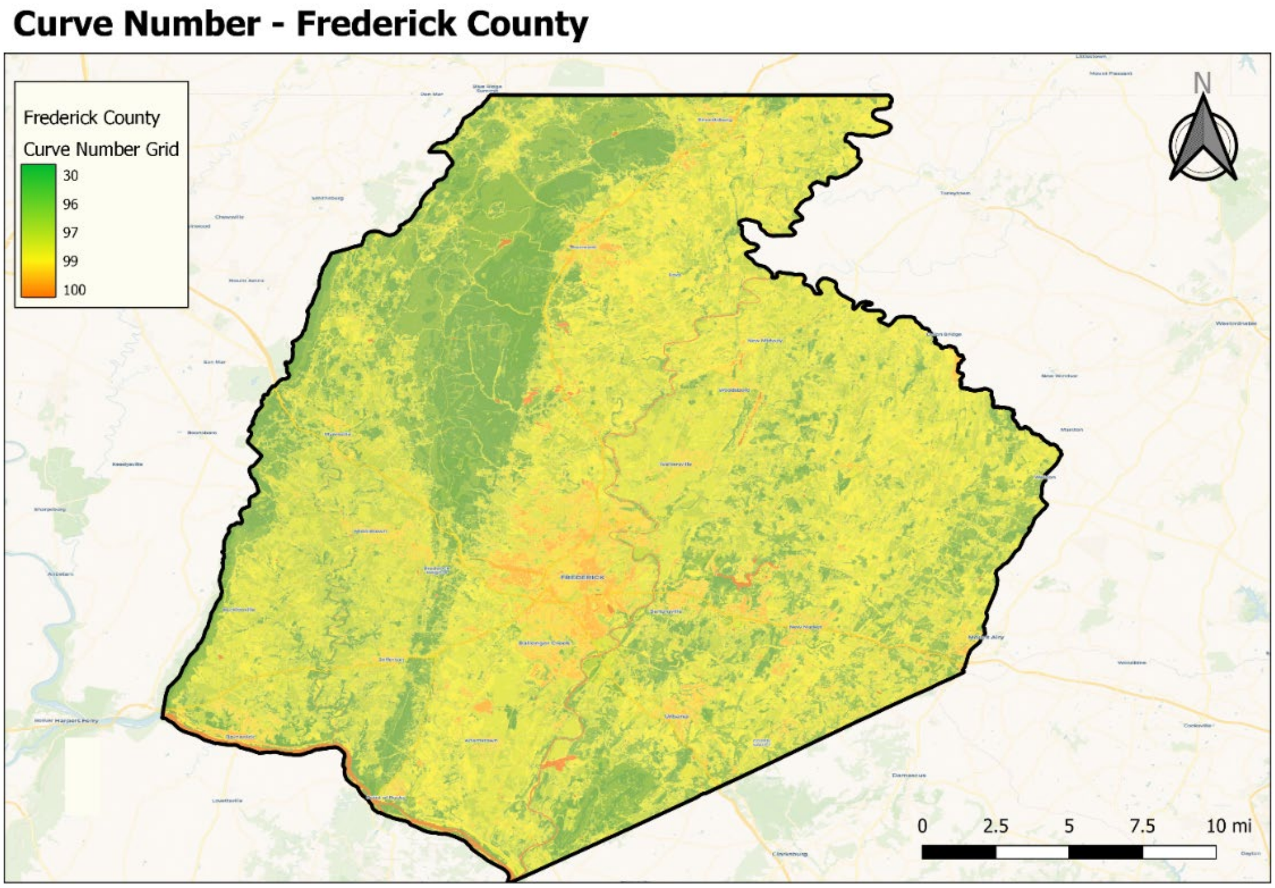


Figure 5. Distribution of curve number values for Frederick County used to calculate infiltration.

Table 2. List of inflow boundary conditions including 100-year flow used in model. The location of each Inflow ID is labeled in Figure 2.

Inflow ID	Stream Name	100-year Flow (cfs)	Contributing Area (sq mi)
0	Potomac River	474800	5041
1	Israel Creek	5970	13
2	Catoctin Creek	21000	94
3	Little Pipe Creek	13000	34
4	Big Pipe Creek	20400	109
5	Piney Creek	9510	35
6	Alloway Creek	6800	25
7	Rock Creek	17000	64
8	Middle Creek	5400	24
9	Toms Creek	6110	23

Table 3. Manning's n value assigned to each land use in the pluvial model.

Land Use Code	Land Use Description	Manning's n
11	Open Water	0.04
21	Developed, Open Space	0.04
22	Developed, Low Intensity	0.1
23	Developed, Medium Intensity	0.08
24	Developed, High Intensity	0.15
31	Barren Land Rock/Sand/Clay	0.025
41	Deciduous forest	0.16
42	Evergreen forest	0.16
43	Mixed forest	0.16
52	Shrub/Scrub	0.1
71	Grassland/Herbaceous	0.035
81	Pasture/Hay	0.03
82	Cultivated Crops	0.035

Bridges and other Hydraulic Structures

The model mesh was manually adjusted to ensure that flows can pass through large bridges and major culverts. for many bridges, no adjustment was needed because the bridge deck was already removed or "burned out" of the DEM. for other bridges with intact decks, the mesh near bridges was adjusted to ensure that water could pass. While this method prevents unrealistic ponding upstream of structures, it may not realistically simulate local hydraulic conditions that affect flooding such as flow constriction, expansion, and backwater (see section on Limitations below). In addition, several no-flow barriers or "breaklines" were added along mountain ridges and other high-elevation barriers that were too small to be represented by the 100 m grid cells.

Stormwater Infrastructure

The pluvial model did not explicitly simulate the effect of stormwater management infrastructure including stormwater catch basins, subsurface storm pipes, and outfalls. The influence of stormwater infrastructure was indirectly captured by the infiltration model, which assumes a "typical" amount of stormwater runoff from areas based on the density of development. This approach does not account for the specific stormwater infrastructure and best management practices at any given site. It is worth noting however that most stormwater infrastructure is designed to handle small to moderate size storm events (e.g., up to 10-year events) and may not be effective at reducing flooding during more extreme events (e.g., 100-year events).

Flood Map Post-Processing

The HEC-RAS model simulation produced maps of the maximum flooding extent and the maximum flood depth across Frederick County for the five rainfall scenarios. The maximum extent and depth was determined using the outputs of all model timesteps during the entire event. Therefore, the maximum extent and flood depth in one region of the model might not occur at exactly the same time as in another region of the model.

The flood maps were post-processed in ArcGIS Pro software to remove minor “nuisance” flooding from the maps. The post-processing removed flooded areas from the maps that were (1) less than 6 inches deep or (2) less than 0.5 acres in extent and not connected to the stream network. The final flood map for the 100-year 24-hour event is shown in Figure 3.

Model Evaluation

The model results were compared with existing flood model results and found to be generally consistent.

- FEMA Modeling: Figure 7 shows a side-by-side comparison of the 100-year 24-hour event flooding with the FEMA 100-year floodplain (i.e., the Special Hazard Flood Area) in a typical area. As anticipated, the pluvial model shows roughly the same flooded area as the FEMA model near FEMA-modeled streams, while also capturing additional pluvial flooding in areas far from the stream.
- Clover Hill Modeling: Figure 8 shows a side-by-side comparison of the 100-year 24-hour event flooding and results from another pluvial flood model developed for the Clover Hill neighborhood just outside of Frederick City. The Clover Hill model, which was developed for a separate drainage and capacity study, includes a detailed representation of the neighborhood’s stormwater management system including roadside drainage ditches, catchment basins, and stormwater pipes. The overall consistency in the modeling results suggests that the stormwater management system has a limited effect on pluvial flooding during extreme rainfall events.

Exposure Analysis

An exposure analysis was conducted to understand the potential pluvial flood hazard for buildings, critical infrastructure, and major educational institutions. The results from the three types of exposure analysis are summarized below.

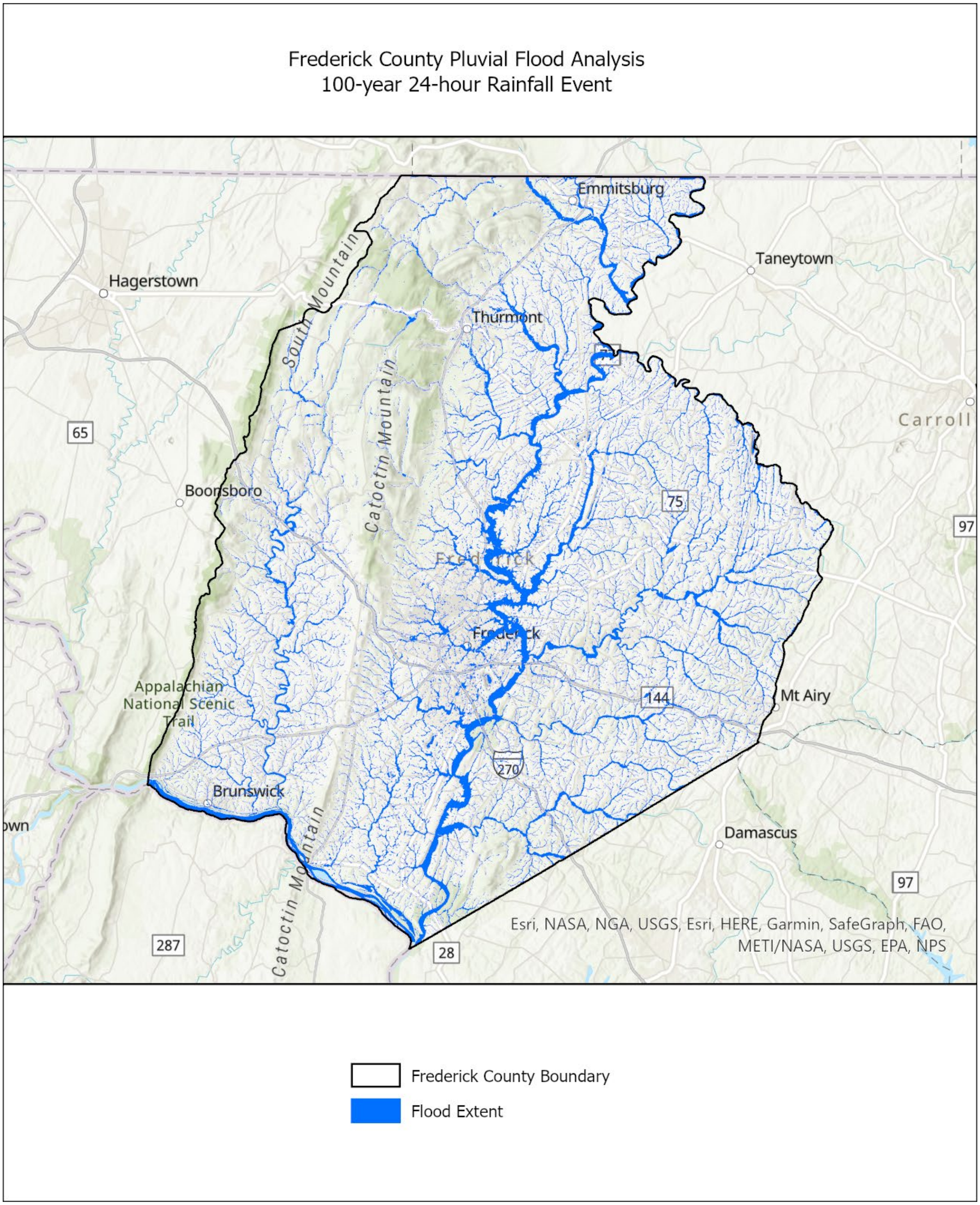


Figure 6. Modeled flood extent for the 100-year 24-hour rainfall event across Frederick County.

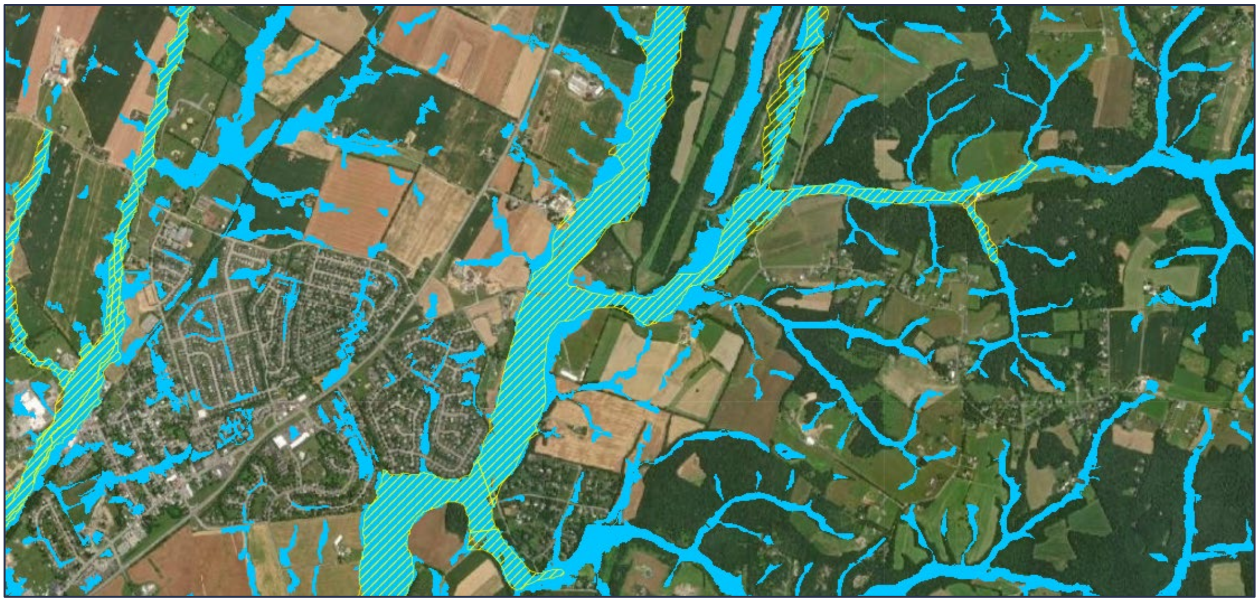


Figure 7. Overlay comparison between the pluvial flood model results for the 100-year 24-hour event (blue fill) and the FEMA 100-year floodplain (yellow hatch).

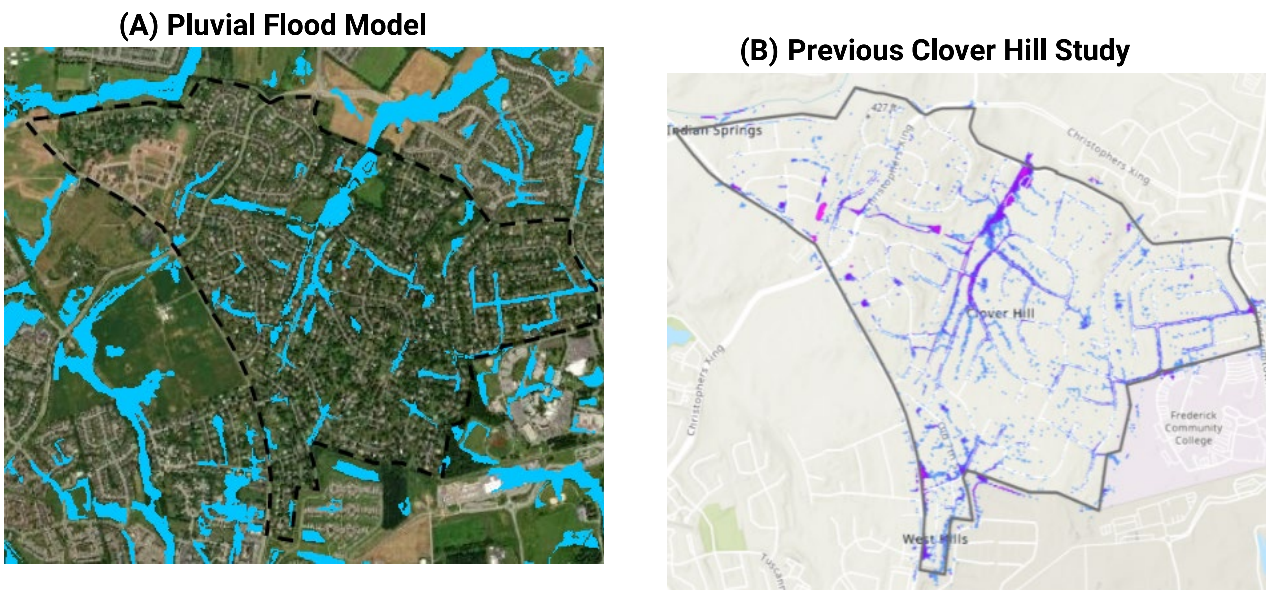


Figure 8. Comparison between the pluvial flood model results for the 100-year 24-hour event (left panel A) and the previous Clover Hill flood model for the 100-year 24-hour event (right panel B, from www.frederickcountymd.gov/8097/Clover-Hill-Drainage-and-Capaci

Building Exposure

The estimated exposure of buildings to pluvial flooding is presented for the 100-year 24-hour event (Table 4), the 100-year 12-hour event (Table 5), the 100-year, 6-hour event (Table 6), the 25-year 24-hour event (Table 7), and the 10-year 24-hour event (Table 8). A building is counted as exposed if any portion overlaps with the flood extent.

The total number of buildings exposed across Frederick County ranges from 7,566 (4.2% of total) for the 10-year 24-hour event to 12,560 (6.9% of total) for the 100-year 24-hour event. The highest number and percent of buildings affected are in Frederick City and Burkittsville. The number of buildings exposed based on our pluvial modeling is generally higher than the number of buildings exposed to the FEMA floodplain, which only considers fluvial (riverine) flooding.

Table 4. Building exposure to pluvial flooding for 100-year 24-hour event.

Jurisdiction	Number of Buildings	Number of Buildings Flooded	Percent of Buildings Flooded (%)	Value of Buildings ($M)	Value of Buildings Flooded ($M)	Percent of Value Flooded (%)
UA	128,662	6,822	5.3	15,665.9	915.7	5.8
Walkersville	3,790	397	10.5	578.2	36.3	6.3
New Market	914	47	5.1	163.7	3.5	2.1
Myersville	1,043	18	1.7	148.3	3.4	2.3
Frederick City	31,252	4,126	13.2	7,547.7	840.9	11.1
Mount Airy	2,151	82	3.8	334.9	6.2	1.9
Rosemont	326	8	2.5	18.6	1.0	5.4
Brunswick	4,414	265	6.0	596.5	22.8	3.8
Emmitsburg	1,451	123	8.5	175.6	6.6	3.8
Woodsboro	883	97	11.0	94.7	4.0	4.3
Burkittsville	207	28	13.5	11.7	1.9	16.6
Middletown	2,502	149	6.0	510.7	13.9	2.7
Thurmont	4,514	398	8.8	465.6	26.9	5.8
Frederick County (Total)	**182,109**	**12,560**	**6.9**	**26,312**	**1,883**	**7.2**

Table 5. Building exposure to pluvial flooding for 100-year 12-hour event.

Jurisdiction	Number of Buildings	Number of Buildings Flooded	Percent of Buildings Flooded (%)	Value of Buildings ($M)	Value of Buildings Flooded ($M)	Percent of Value Flooded (%)
UA	128,662	6,360	4.9	15,665.9	883.0	5.6
Walkersville	3,790	373	9.8	578.2	35.4	6.1
New Market	914	47	5.1	163.7	3.5	2.1
Myersville	1,043	17	1.6	148.3	3.4	2.3
Frederick City	31,252	3,812	12.2	7,547.7	789.1	10.5
Mount Airy	2,151	86	4.0	334.9	6.2	1.9
Rosemont	326	8	2.5	18.6	0.9	4.9

Brunswick	4,414	263	6.0	596.5	22.1	3.7
Emmitsburg	1,451	99	6.8	175.6	5.8	3.3
Woodsboro	883	95	10.8	94.7	3.4	3.6
Burkittsville	207	26	12.6	11.7	1.8	15.7
Middletown	2,502	143	5.7	510.7	13.5	2.6
Thurmont	4,514	373	8.3	465.6	24.5	5.3
Frederick County (Total)	**182,109**	**11,702**	**6.4**	**26,312**	**1,793**	**6.8**

Table 6. Building exposure to pluvial flooding for 100-year 6-hour event.

Jurisdiction	Number of Buildings	Number of Buildings Flooded	Percent of Buildings Flooded (%)	Value of Buildings ($M)	Value of Buildings Flooded ($M)	Percent of Value Flooded (%)
UA	128,662	5,518	4.3	15,665.9	813.1	5.2
Walkersville	3,790	320	8.4	578.2	32.3	5.6
New Market	914	45	4.9	163.7	3.5	2.1
Myersville	1,043	16	1.5	148.3	3.0	2.0
Frederick City	31,252	3,223	10.3	7,547.7	710.6	9.4
Mount Airy	2,151	78	3.6	334.9	4.9	1.5
Rosemont	326	9	2.8	18.6	0.9	4.9
Brunswick	4,414	241	5.5	596.5	20.8	3.5
Emmitsburg	1,451	69	4.8	175.6	4.3	2.4
Woodsboro	883	88	10.0	94.7	3.0	3.2
Burkittsville	207	26	12.6	11.7	1.3	11.0
Middletown	2,502	132	5.3	510.7	12.0	2.3
Thurmont	4,514	306	6.8	465.6	18.0	3.9
Frederick County (Total)	**182,109**	**10,071**	**5.5**	**26,312**	**1,627**	**6.2**

Table 7. Building exposure to pluvial flooding for 25-year 24-hour event.

Jurisdiction	Number of Buildings	Number of Buildings Flooded	Percent of Buildings Flooded (%)	Value of Buildings ($M)	Value of Buildings Flooded ($M)	Percent of Value Flooded (%)
UA	128,662	5,251	4.1	15,665.9	795.8	5.1

Walkersville	3,790	282	7.4	578.2	30.3	5.2
New Market	914	41	4.5	163.7	3.5	2.1
Myersville	1,043	15	1.4	148.3	3.0	2.0
Frederick City	31,252	2,969	9.5	7,547.7	658.3	8.7
Mount Airy	2,151	74	3.4	334.9	4.3	1.3
Rosemont	326	8	2.5	18.6	0.9	4.9
Brunswick	4,414	232	5.3	596.5	20.2	3.4
Emmitsburg	1,451	56	3.9	175.6	3.8	2.1
Woodsboro	883	73	8.3	94.7	2.7	2.9
Burkittsville	207	24	11.6	11.7	1.3	11.0
Middletown	2,502	128	5.1	510.7	12.2	2.4
Thurmont	4,514	246	5.4	465.6	16.3	3.5
Frederick County (Total)	**182,109**	**9,399**	**5.2**	**26,312**	**1,553**	**5.9**

Table 8. Building exposure to pluvial flooding for 10-year 24-hour event.

Jurisdiction	Number of Buildings	Number of Buildings Flooded	Percent of Buildings Flooded (%)	Value of Buildings ($M)	Value of Buildings Flooded ($M)	Percent of Value Flooded (%)
UA	128,662	4,271	3.3	15,665.9	698.6	4.5
Walkersville	3,790	221	5.8	578.2	27.0	4.7
New Market	914	33	3.6	163.7	2.9	1.8
Myersville	1,043	14	1.3	148.3	2.9	2.0
Frederick City	31,252	2,358	7.5	7,547.7	502.1	6.7
Mount Airy	2,151	64	3.0	334.9	3.0	0.9
Rosemont	326	9	2.8	18.6	0.8	4.5
Brunswick	4,414	218	4.9	596.5	17.7	3.0
Emmitsburg	1,451	27	1.9	175.6	2.5	1.4
Woodsboro	883	45	5.1	94.7	2.0	2.1
Burkittsville	207	22	10.6	11.7	0.9	7.8
Middletown	2,502	105	4.2	510.7	10.6	2.1
Thurmont	4,514	179	4.0	465.6	14.8	3.2
Frederick County (Total)	**182,109**	**7,566**	**4.2**	**26,312**	**1,286**	**4.9**

Critical Infrastructure Exposure

The estimated exposure of critical infrastructure to pluvial flooding for different rainfall events is presented in Table 9. The modeling suggest that 53 critical sites will flood during at least one of the simulated events.

Educational Institution Exposure

The exposure of buildings at select institutions of higher education is shows in Figure 9. The pluvial analysis suggests that several buildings are at risk of pluvial flooding. As previously stated, these modeling results do not consider the flood reduction benefit of specific stormwater infrastructure and best management practices at these sites.

Electronic Materials

The final flood extent and depth maps were saved as a set of shapefiles and TIFs, respectively, and included in the electronic supplementary materials.

Limitations and Future Work

The pluvial flood analysis was performed using a state-of-practice pluvial model with readily available topography and other data. Although the modeling results should constitute the best-available estimates of pluvial flooding across the region, it was necessary to make several assumptions that contribute to the overall uncertainty of the results including:

- The best-available DEM used in the model was too expansive to ground-truth and was assumed to represent actual ground conditions;
- Bridges, culverts, and other structures were modeled as generic flow passages that don't necessarily capture actual local hydraulic features such as flow contraction and backwater; and
- Stormwater infrastructure was implicitly modeled in the HEC-RAS infiltration model, which assumes that the infrastructure performance is "typical" or average, which may be different than actual site conditions.

To reduce model uncertainty and produce a better picture of the overall pluvial flood hazard, future work should consider making the following improvements:

- Improve the model mesh resolution from 100 m to 30 m or less, which may require breaking up the major watersheds into smaller watersheds to maintain reasonable model run times;
- Add additional detail to bridges and other hydraulic structures including invert elevations and structure dimensions;
- Simulate the effect of stormwater management infrastructure, which can reduce accumulation of water in some areas while delivering it more rapidly to others; and

Add additional rainfall scenarios to simulate the effect of different antecedent moisture conditions, which controls soil infiltration, as well as potential future changes in climate and land use.

Table 9. Critical facility exposure to five pluvial flooding scenarios.

Jurisdiction	Facility Type	Facility Name	Site Address	Flooding 100yr 24hr	Flooding 100yr 12hr	Flooding 100yr 6hr	Flooding 25yr 24hr	Flooding 10yr 24hr
Emmitsburg	Fire/EMS	FREDERICK COUNTY VOLUNTEER FIRE AND RESCUE ASSOCIATION STATION 26 - EMMITSBURG AMBULANCE COMPANY INCORPORATED	17701 CREAMERY ROAD	Yes	Yes	Yes	Yes	Yes
Emmitsburg	Library	TOWN OF EMMITSBURG		Yes	Yes			
Emmitsburg	Post office	Emmitsburg Post office	305 South Seton Avenue	Yes	Yes			
Emmitsburg	WWTP	Emmitsburg Public Library		Yes	Yes	Yes	Yes	Yes
Frederick City	Fire/EMS	UNITED STEAM FIRE COMPANY 3	79 SOUTH MARKET STREET	Yes	Yes	Yes	Yes	Yes
Frederick City	Fire/EMS	FREDERICK COUNTY VOLUNTEER FIRE AND RESCUE ASSOCIATION STATION 1 - INDEPENDENT	310 BAUGHMANS LANE	Yes	Yes	Yes	Yes	

Jurisdiction	Facility Type	Facility Name	Site Address	Flooding 100yr 24hr	Flooding 100yr 12hr	Flooding 100yr 6hr	Flooding 25yr 24hr	Flooding 10yr 24hr
		HOSE COMPANY						
Frederick City	Fire/EMS	Independent Fire Company No. 1	310 Baughmans Ln	Yes	Yes	Yes	Yes	
Frederick City	Fire/EMS	United Steam Fire Engine Co. No. 3	79 S Market St	Yes	Yes	Yes		
Frederick City	Government Facilities	FREDERICK CITY WWTP		Yes				
Frederick City	Government Facilities	Lincoln Elementary	200 Madison Street	Yes	Yes	Yes	Yes	
Frederick City	Government Facilities	FREDERICK COUNTY DEPARTMENT OF PUBLIC WORKS	118 N MARKET ST	Yes	Yes	Yes		
Frederick City	Interchange	FREDERICK COUNTY WINCHESTER HALL	12 E CHURCH ST	Yes	Yes	Yes	Yes	Yes
Frederick City	Interchange	FREDERICK CITY OFFICES (ANNEXED)	140 W PATRICK ST	Yes	Yes	Yes	Yes	Yes
Frederick City	Interchange	Downtown Frederick	22 S. Market St., Suite 2A	Yes	Yes	Yes	Yes	Yes
Frederick City	Library	Frederick towne Mall	1301 W. Patrick St.	Yes	Yes			

Jurisdiction	Facility Type	Facility Name	Site Address	Flooding 100yr 24hr	Flooding 100yr 12hr	Flooding 100yr 6hr	Flooding 25yr 24hr	Flooding 10yr 24hr
Frederick City	School	Rosehill Plaza	1564 Opossumtown Pike	Yes	Yes	Yes	Yes	Yes
Frederick City	Shopping Center	Creekside Plaza	50 Citizens Way	Yes	Yes	Yes	Yes	Yes
Frederick City	Shopping Center	South Market Center	50 Carroll Creek Way	Yes	Yes	Yes	Yes	Yes
Frederick City	Shopping Center	Prospect Plaza Shopping Center	429 S Jefferson St	Yes	Yes	Yes	Yes	
Frederick City	Shopping Center	Riverside Center	1811 Monocacy Blvd	Yes	Yes	Yes	Yes	Yes
Frederick City	Shopping Center	Interchange		Yes	Yes	Yes	Yes	Yes
Frederick City	Shopping Center	Interchange		Yes	Yes	Yes	Yes	
Frederick City	Shopping Center	Interchange		Yes				
Frederick City	Transit Station	Frederick Transit Station		Yes	Yes	Yes	Yes	Yes
Frederick City	WWTP	C. Burr Artz Public Library		Yes	Yes	Yes	Yes	Yes
Middletown	Fire/EMS	Middletown Volunteer Fire Company	135 S Church St	Yes	Yes	Yes	Yes	Yes
New Market	Dry Hydrant	Dry Hydrant - Emory Alley		Yes	Yes	Yes	Yes	Yes

Jurisdiction	Facility Type	Facility Name	Site Address	Flooding 100yr 24hr	Flooding 100yr 12hr	Flooding 100yr 6hr	Flooding 25yr 24hr	Flooding 10yr 24hr
UA	Dry Hydrant	BALLENGER CREEK WWTP		Yes	Yes	Yes	Yes	Yes
UA	Dry Hydrant	Tuscarora Elementary	6321 Lambert Drive	Yes	Yes	Yes	Yes	Yes
UA	Dry Hydrant	Sugarloaf Elementary	3400 Stone Barn Drive	Yes	Yes	Yes	Yes	Yes
UA	Dry Hydrant	Ballenger Creek Plaza	5840 Ballenger Creek Pike	Yes	Yes			
UA	Dry Hydrant	Pointe Plaza	5801 Buckeystown Pike	Yes				
UA	Dry Hydrant	Dry Hydrant - On bridge at Covell Rd, near Thurston Rd		Yes	Yes	Yes	Yes	
UA	Dry Hydrant	Dry Hydrant - 12500 blk of Simpsons Mill Road	12500 Simpsons Mill Rd	Yes	Yes	Yes	Yes	Yes
UA	Dry Hydrant	Dry Hydrant - 14109 Pleasant Valley Road	14109 Pleasant Valley Rd	Yes	Yes			
UA	Dry Hydrant	Dry Hydrant - 10940 Hessong Bridge Rd,(across from)	10940 Hessong Bridge Rd	Yes				

Jurisdiction	Facility Type	Facility Name	Site Address	Flooding 100yr 24hr	Flooding 100yr 12hr	Flooding 100yr 6hr	Flooding 25yr 24hr	Flooding 10yr 24hr
UA	Dry Hydrant	Dry Hydrant - On Poffenberger Rd., at bridge over Catoctin Creek		Yes	Yes	Yes	Yes	Yes
UA	Dry Hydrant	Dry Hydrant - 7705 Utica Road, near Utica Covered Bridge	7705 Utica Rd	Yes	Yes	Yes	Yes	
UA	Dry Hydrant	Dry Hydrant - 5509 Mount Zion Rd.	5509 Mount Zion Rd.	Yes	Yes	Yes	Yes	Yes
UA	Dry Hydrant	Dry Hydrant - 8316 Rocky Ridge Rd	8316 Rocky Ridge Rd	Yes	Yes	Yes	Yes	Yes
UA	Interchange	Dry Hydrant - 13000 blk of Woodsboro Pike	13000 Woodsboro Pike	Yes	Yes	Yes	Yes	Yes
UA	Interchange	Dry Hydrant - Intersection of Mud College & Orndorff Roads		Yes				
UA	Interchange	Dry Hydrant - 16000 blk of Foxville-Deerfield Rd	16000 Foxville-Deerfield Rd	Yes	Yes			
UA	Interchange	Dry Hydrant - Old Frederick Rd, near Loys		Yes	Yes	Yes	Yes	

Jurisdiction	Facility Type	Facility Name	Site Address	Flooding 100yr 24hr	Flooding 100yr 12hr	Flooding 100yr 6hr	Flooding 25yr 24hr	Flooding 10yr 24hr
		Station covered bridge						
UA	Interchange	Dry Hydrant - Life in Jesus Church 9002 Clemsonville Road	9002 Clemsonville Rd	Yes	Yes	Yes	Yes	Yes
UA	Interchange	Interchange		Yes	Yes	Yes	Yes	Yes
UA	School	Interchange		Yes	Yes	Yes	Yes	
UA	School	Interchange		Yes	Yes	Yes		
UA	Shopping Center	Interchange		Yes	Yes	Yes	Yes	Yes
UA	Shopping Center	Interchange		Yes	Yes	Yes	Yes	Yes
UA	WWTP	Interchange		Yes	Yes	Yes	Yes	Yes
Walkersville	Medical Center	GLADE VALLEY CENTER	56 WEST FREDERICK STREET	Yes				
Walkersville	Shopping Center	Walkers Village Shopping Center	Woodsboro Pike & Glade Blvd	Yes	Yes	Yes	Yes	Yes

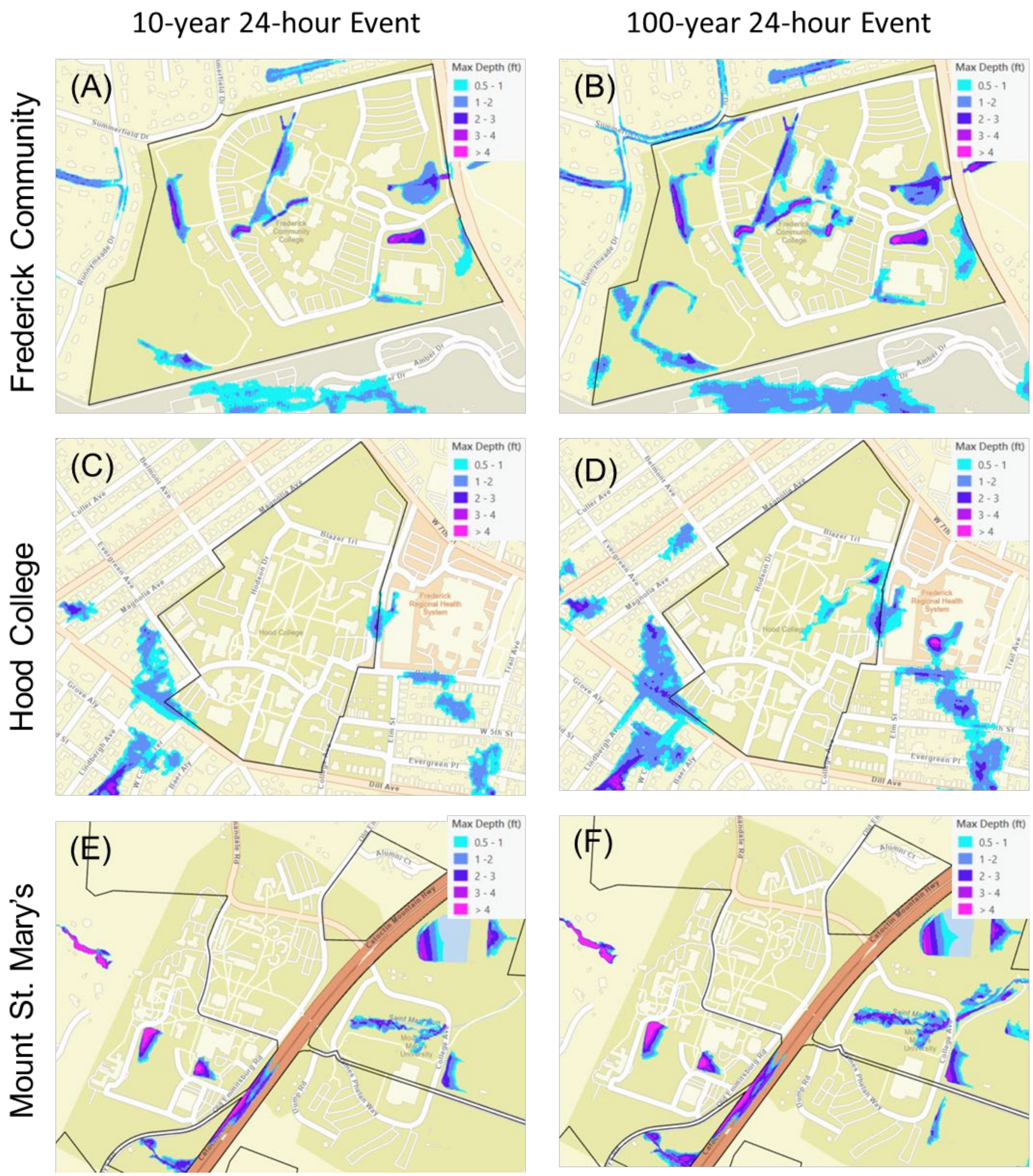


Figure 9. Pluvial flooding exposure at Frederick Community College (top row), Hood College (middle row), and Mount St. Mary's University (bottom row) for the 10-year (left column) and 100-year (right column) 24-hour event.

APPENDIX B: 2016 MITIGATION ACTIONS UPDATE

This Appendix contains an update on the status of actions from the 2016 Hazard Mitigation Plan. The list below contains only those actions that Hazard Mitigation Planning Committee members decided *not* to carry over into the 2022 plan. 2016 actions that were carried over as 2022 actions are found in Chapter 7 of the HMCAP.

Public Awareness (PA) Actions

Action	PA-1
Description of Action	Fund the purchase and delivery of all-hazards public outreach materials, i.e., website, brochures, advertisements, public service announcements, etc., that instruct citizens and businesses on what to do before, during, and after an emergency to prepare, mitigate, respond, and recover.
Applicable Goal	Goal A: Promote public understanding of, support for, and involvement in hazard mitigation activities.
Objective	Use countywide public information and education programs to advise citizens on how to protect themselves and their property from natural hazard events.
Priority:	High
Responsible Organizations	Division of Emergency Management
Estimated Costs	Staff time
Possible Funding Sources	HMGP
Timeline for implementation	Ongoing
Status since 2016:	Complete—this is now considered a capability. Website and public outreach materials kept up to date and are available to citizens. Division of Emergency Management averages about 35 public awareness/outreach events per year pre-COVID-19 pandemic. During the pandemic, there has been a lack of in-person community events.

Action	PA-2
Description of Action	Provide mitigation information in all branches of the County library system and the Book Mobile. Interested property owners can read or check out handbooks or other publications that cover their particular situation. The public library will also archive FEMA publications that address various flood-

	and other-hazard-related topics. In addition to the community library, the County will provide publications for public use and distribution at Fredrick County buildings and municipalities.
Applicable Goal	Goal A: Promote public understanding of, support for, and involvement in hazard mitigation activities.
Objective	Develop a countywide public information and education program to advise citizens on how to protect themselves and their property from natural hazard events.
Priority:	High
Responsible Organizations	Division of Emergency Management, Frederick County Public Library System.
Estimated Costs	No cost incurred
Possible Funding Sources	No funding required
Timeline for implementation	Annually
Status since 2016:	Complete—FEMA documents addressing flooding have been added to the Frederick County Public Library as a result of the prerequisites for the CRS.

Action	**PA-3**
Description of Action	Develop a clear, concise, and consistent community-specific threat-based public preparedness message that can be delivered in each municipality using previously-established media sources and public outreach mechanisms.
Applicable Goal	Goal A: Promote public understanding, support, and involvement in hazard mitigation activities.
Objective	Develop a countywide public information and education program to advise citizens on how to protect themselves and their property from natural hazard events.
Priority:	Medium
Responsible Organizations	Division of Emergency Management, municipal leaders.
Estimated Costs	$3,000 per year
Possible Funding Sources	HMGP
Timeline for implementation	2 to 3 years
Status since 2016:	Complete

Plans and Ordinances (PO) Actions

Action	PO-2
Description of Action	Ensure natural hazards are included in the Comprehensive Plan
Applicable Goal	Goal B: Reduce exposure to natural hazards through local planning and ordinances
Objective	Review and recommend changes to the County Comprehensive Plan, sub-area plans, municipal plans, and existing ordinances (zoning, subdivision, and floodplain) as appropriate
Priority:	Medium
Responsible Organizations	Division of Emergency Management, Planning Division
Estimated Costs	None
Possible Funding Sources	None
Timeline for implementation	Two years
Status since 2016:	Complete—the Livable Frederick Master Plan was adopted in 2019, and it includes considerations for natural hazards and hazard mitigation.

Karst/Land Subsidence (KLS) Actions

Action	
Description of Action	Fund the purchase and delivery of public outreach materials, i.e., website, brochures, advertisements, public service announcements, etc., that educate citizens and businesses on karsts, how they are formed, and how to identify early indicators and mitigate or respond to karsts.
Applicable Goal	Goal C: Reduce Frederick County's vulnerability to sinkholes
Objective	Continue to educate Frederick County residents on karst
Priority:	Low
Responsible Organizations	Division of Emergency Management
Estimated Costs	$3,000 per year
Possible Funding Sources	HMGP
Timeline for implementation	6 months from receipt of secured funding

Status since 2016:	Complete—this is now considered a capability. Karst is one of the hazards Frederick County focuses on during public education and outreach events.

Flooding (F) Actions

Action	F-1
Description of Action	Ensure that all County-owned bridges and culverts are maintained on a yearly basis
Applicable Goal	Goal D: Investigate structural solutions to flooding problems
Objective	Investigate the feasibility of enhancing and/or improving drainage of flood-prone lands
Priority:	High
Responsible Organizations	Division of Public Works and Department of Highway and Facility Maintenance
Estimated Costs	$550,000 per year
Possible Funding Sources	Division of Public Works Operating and Capital budgets
Timeline for implementation	Ongoing
Status since 2016:	Complete—this is now considered a capability. DPW maintains bridges and culverts on a regular basis before and after severe weather events.

Action	F-3
Description of Action	To maintain county-owned storm water management facilities
Applicable Goal	Goal D: Investigate structural solutions to flooding problems
Objective	Investigate the feasibility of enhancing and/or improving drainage of flood-prone lands
Priority:	High
Responsible Organizations	Division of Parks and Recreation
Estimated Costs	$50,000/year for preventative maintenance and the occasional rehabilitation project
Possible Funding Sources	General fund
Timeline for implementation	As funding is provided

Status since 2016:	Complete—this is now considered a capability. Frederick County regularly maintains county-owned stormwater management facilities.

Evacuation (E) Actions

Action	**E-1**
Description of Action	Develop a GIS data layer of priority roadways that may be used to evacuate citizens, and ensure that the Evacuation Annex is kept current
Applicable Goal	Goal G: Ensure safe and efficient evacuation routes within, to, and from Frederick County
Objective	Coordinate with local, state, and regional partners to provide safe and efficient evacuation routes
Priority:	High
Responsible Organizations	Division of Emergency Management, Planning Division, Sheriff's office, Division of Public Works
Estimated Costs	None
Possible Funding Sources	None
Timeline for implementation	Ongoing
Status since 2016:	Complete—the Priority Roads GIS data layer is linked to the County street centerline data layer and maintained as updates are received from Division of Public Works. The ongoing maintenance of this GIS layer is considered a capability.

Communication (C) Actions

Action	**C-1**
Description of Action	Evaluate and enhance Frederick County's local warning system notifications through multiple mechanisms. The Division of Emergency Management should consider introducing a Reverse 9-1-1 system that would enhance quality of service. Reverse 9-1-1 is an interactive community notification system that enables a recorded telephone message to be sent out to selected areas, blocks, or neighborhoods in the event of an emergency. The system is a quick and efficient way of contacting and notifying residents of a potentially serious problem near their homes or businesses. It allows the police department to quickly send out time-critical messages rather than going door-to-door. Messages can be sent to a select jurisdiction or the entire county and includes a convenient TTY/TDD feature capable of sending information to

	the hearing impaired. The system is sophisticated enough to indicate whether a call was received or whether a message was left on an answering machine. It also can be programmed to keep trying until a call has been successfully received. Develop a countywide audible alert system. Evaluative alternatives such as e-911, etc. Identify major developments, municipalities, and other populated centers for the installation of these early warning devices. Develop a booklet to educate the public on meanings of warnings and appropriate actions to take before, during, and after a disaster or emergency.
Applicable Goal	Goal I: Improve severe weather notification in the community
Objective	Improve access in the County to severe weather and emergency notifications
Priority:	High
Responsible Organizations	Division of Emergency Management, Emergency Communications
Estimated Costs	As funding becomes available
Possible Funding Sources	HMGP, DHS’s Emergency Management Performance Grant (EMPG)
Timeline for implementation	2 to 5 years
Status since 2016:	Complete—Frederick county purchased a notification system and sends out warnings for severe weather. The county has also partnered with some of the municipalities that are also using the system. A study of outdoor warning sirens was completed and it was determined that it was not feasible to install at least 28 sirens countywide. The County did automate severe weather alerting for the 3 municipalities that have sirens. Frederick County is no longer interested in Reverse 9-1-1 due to a lack of landlines within the County. Focus has shifted to gaining access to widespread cell phone notifications (Next Generation 9-1-1) since about 80% of 9-1-1 calls are from cell phones.

Community-Specific Actions

City of Brunswick

Action	**Brunswick-2**
Description of Action	Consider providing battery-operated radios, flashlights, etc., to residents, free-of-charge
Applicable Goal	Goal J: Identify community-specific needs to reduce risks to various hazards

Objective	The Division of Emergency Management will continue to work with all the municipalities in the County to identify needs, abilities, and resources to implement appropriate mitigation efforts.
Priority:	Low
Responsible Organizations	City of Brunswick, Division of Emergency Management
Estimated Costs	Regular employee pay
Possible Funding Sources	General fund
Timeline for implementation	None
Status since 2016:	Not Complete—removed from the 2022 HMCAP as cell phone technology has covered this need.

Action	**Brunswick-4**
Description of Action	To ensure that wind damage is minimal to city-owned facilities; continue tree-trimming program and tree maintenance in City of Brunswick
Applicable Goal	Goal B: Reduce exposure of structures, infrastructure, and contents to hazards
Objective	Create an awareness of building to safe standards
Priority:	Medium
Responsible Organizations	City of Brunswick Department of Public Works
Estimated Costs	$3,000 per year
Possible Funding Sources	General Fund or HMGP
Timeline for implementation	1 year
Status since 2016:	Complete—this is now a capability. DPW does this regularly on an as-needed basis. Utility has a forestry plan on a four-year cycle, and there is a line item in the budget to address clean-up and tree removal.

City of Frederick

Action	**Frederick-3**
Description of Action	Complete the Carroll Creek Levee. The completion of the project will protect an additional 48 properties. Obtain approval for final construction of Carroll Creek Levee from USACE.

Applicable Goal	Goal E: Develop measures to protect all buildings (commercial, residential, institutional, and industrial) that are in floodplain
Objective	Develop flood mitigation strategies for flood-prone structures
Priority:	High
Responsible Organizations	City of Frederick – Planning, Engineering, Public Works, Maryland Department of the Environment, Maryland Historical Trust, Federal agencies
Estimated Costs	Staff time
Possible Funding Sources	HMGP, FMA
Timeline for implementation	Short-term
Status since 2016:	Complete—Carroll Creek Levee has been constructed. The City obtained approval of final construction from USACE. The City is currently working with FEMA to incorporate them into flood maps.

Action	**Frederick-6**
Description of Action	Middletown, Walkersville, and the City of Frederick should get together and urge the county to adopt a sinkhole ordinance.
Applicable Goal	Goal B: Reduce exposure to natural hazards through local planning and ordinances
Objective	Review and recommend revisions to the County Comprehensive Plan, sub-area plans, municipal plans, and existing ordinances (zoning, subdivision, and floodplain) as appropriate
Priority:	Medium
Responsible Organizations	Town of Middletown, Town of Walkersville, City of Frederick – Engineering, Public Works, Legal, Mayor's office
Estimated Costs	Regular employee pay
Possible Funding Sources	No funding required
Timeline for implementation	6 to 10 years
Status since 2016:	Not complete – remove as not applicable

Action	**Frederick-7**

Description of Action	Establish a regular maintenance inspection and preventive program for sinkholes on/near city streets
Applicable Goal	Goal B: Reduce exposure to natural hazards through local planning and ordinances
Objective	Review and recommend revisions to the County Comprehensive Plan, sub-area plans, municipal plans, and existing ordinances (zoning, subdivision, and floodplain) as appropriate
Priority:	Medium
Responsible Organizations	City of Frederick – Streets and Grounds
Estimated Costs	Regular employee pay
Possible Funding Sources	N/A
Timeline for implementation	1 year
Status since 2016:	Not Complete – not a priority

Town of Burkittsville

Action	**Burkittsville-1**
Description of Action	Replacement of failing CMP storm drain along East Main St. and replacement of 3 box culverts
Applicable Goal	Goal J: Identify community-specific needs to reduce risks to various hazards
Objective	Improve safety regarding traffic, pedestrian, lighting, and stormwater management while bringing everything up to today's standards
Priority:	High
Responsible Organizations	Town of Burkittsville
Estimated Costs	$227,000
Possible Funding Sources	TBD; FEMA PDM; HMGP
Timeline for implementation	12 to 19 months
Status since 2016:	Complete—storm drains and box culverts have been replaced.

Town of Emmitsburg

Action	

Description of Action	Adoption of an updated Comprehensive Plan to encourage sustainable growth practices and reduce exposure to natural hazards
Applicable Goal	Goal B: Reduce exposure to natural hazards through local planning and ordinances
Objective	Review and recommend revisions to the County Comprehensive Plan, sub-area plans, municipal plans, and existing ordinances (zoning, subdivision, and floodplain) as appropriate
Priority:	High
Responsible Organizations	Planning
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	2015
Status since 2016:	Complete—the updated comprehensive plan was adopted in 2015.

Action	**Emmitsburg-3**
Description of Action	Coordinate with the State Highway Administration (SHA) to assist in the rebuilding of the bridge over Flat Run to reduce potential flooding on East Main Street.
Applicable Goal	Goal G: Ensure safe and efficient evacuation routes within, to, and from Frederick County
Objective	Coordinate with local, state, and regional partners to provide safe and efficient evacuation routes
Priority:	Medium
Responsible Organizations	SHA, Town staff
Estimated Costs	$1.2 million
Possible Funding Sources	State of Maryland
Timeline for implementation	2017
Status since 2016:	Complete—the bridge has been rebuilt as of late 2020.

Action	**Emmitsburg-4**

Description of Action	Purchase a GIS system and create a complete infrastructure monitoring system. Then, add an early warning notification system to subscribers for emergency notices.
Applicable Goal	Goal I: Improve severe weather notification in the County
Objective	Improve access in the County to severe weather and emergency notifications
Priority:	Low
Responsible Organizations	Town staff
Estimated Costs	TBD
Possible Funding Sources	State of Maryland
Timeline for implementation	2018
Status since 2016:	Complete

Town of Middletown

None

Town of Mount Airy

Action	**Mount Airy-3**
Description of Action	Install a SCADA system to monitor all critical public works facilities. This is a type of computer monitoring system for water and wastewater system operations. From a desktop and/or laptop computer, all pumps, flows, chemical feeds, power usage, security door contacts, fire detectors, etc., could be monitored.
Applicable Goal	Goal J: Identify community-specific needs to reduce risks to various hazards
Objective	The Division of Emergency Management will continue to work with all the municipalities in the County to identify needs, abilities, and resources to implement appropriate mitigation efforts.
Priority:	Medium
Responsible Organizations	Town of Mount Airy Communications & Technology Committee, Division of Public Works, Department of Water and Sewer
Estimated Costs	Unknown
Possible Funding Sources	DHS Emergency Management Performance Grant (EMPG)
Timeline for implementation	1 year

Status since 2016:	Complete—the SCADA system has been installed. It is currently offline.

Town of Myersville

Action	Myserville-1
Description of Action	Conduct stream restoration of Catoctin Creek in Doubs Meadow Park to protect the pedestrian trail and fields.
Applicable Goal	Goal D: Investigate structural solutions to flooding problems
Objective	Investigate the feasibility of enhancing and/or improving drainage of flood-prone lands
Priority:	Medium
Responsible Organizations	Town of Myersville, NWFS
Estimated Costs	$40,000
Possible Funding Sources	Myersville, USFW, NRCS, USACE, FEMA
Timeline for implementation	Within the 6-year CIP
Status since 2016:	Complete

Action	Myersville-2
Description of Action	Repair utility line exposed by storm-related events in Grindstone Run
Applicable Goal	Goal J: Identify community-specific needs to reduce risks to various hazards
Objective	The Frederick County Division of Emergency Management will continue to work with all municipalities in the County to identify needs, abilities, and resources to implement appropriate mitigation efforts.
Priority:	Medium
Responsible Organizations	Myersville
Estimated Costs	$250,000
Possible Funding Sources	Myersville
Timeline for implementation	Within the 6-year CIP
Status since 2016:	Complete

Action	Myersville-3
Description of Action	Install approximately 2,000 linear feet force main 8-inch waterline and hydrant connection for fire flow suppression on Milt Summers Road to serve significant commercial and gas utility company facilities.
Applicable Goal	Goal J: Identify community-specific needs to reduce risks to various hazards
Objective	Eliminate use and drainage of potential contaminated water source in karst area, limit exposure of potential flammable property uses to wildland burning.
Priority:	High
Responsible Organizations	Town of Myersville, private development partners, TBD
Estimated Costs	$220,000
Possible Funding Sources	Private investment
Timeline for implementation	End of calendar year 2016
Status since 2016:	Complete

Town of New Market

Action	New Market-1
Description of Action	Implementation of a recently signed developer agreement to design and construct a new parkway. This will create an alternate east-west route through town and create new town evacuation route options, thereby mitigating problems that could occur in town during an emergency with a blockage of Main Street/Maryland Route 144.
Applicable Goal	Goal J: Identify community-specific needs to reduce risks to various hazards
Objective	Increase evacuation options
Priority:	High
Responsible Organizations	Town of New Market; private developer
Estimated Costs	TBD
Possible Funding Sources	Private developer
Timeline for implementation	Short-term
Status since 2016:	Complete

Town of Thurmont

Action	Thurmont-4
Description of Action	Coordinate with local fire and rescue services to develop a community emergency response plan.
Applicable Goal	Goal J: Identify community-specific needs to reduce risks to various hazards
Objective	The Division of Emergency Management will continue to work with all the municipalities in the County to identify needs, abilities, and resources to implement appropriate mitigation efforts.
Priority:	Medium
Responsible Organizations	Town of Thurmont, Division of Emergency Management
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	2 to 5 years
Status since 2016:	Not complete—it has been determined that the town is small enough to not need a specific plan, as current coordination efforts and strategies are working well. GIS information has been shared with local fire and rescue services to supplement efforts.

Town of Walkersville

Action	Walkersville-2
Description of Action	Build new water plant with micro-filtration and ion exchange to replace aging plant. Due to karst geology, the town's water supply (groundwater) is vulnerable to contamination.
Applicable Goal	Goal C: Reduce Frederick County's vulnerability to sinkholes
Objective	N/A
Priority:	Medium
Responsible Organizations	Town of Walkersville
Estimated Costs	TBD
Possible Funding Sources	Town funds, state grants and loans
Timeline for implementation	Medium-term
Status since 2016:	Complete—operational as of July 2020

Action	Walkersville-4
Description of Action	Develop a plan and procedure for inspecting and cleaning out storm drains before storm events.
Applicable Goal	Goal D: Investigate structural solutions to flooding problems
Objective	Investigate the feasibility of enhancing and/or improving drainage of flood-prone lands
Priority:	High
Responsible Organizations	Town of Walkersville
Estimated Costs	TBD
Possible Funding Sources	Town funds
Timeline for implementation	Short-term
Status since 2016:	Complete—this is now a capability of the Town of Walkersville.

Town of Woodsboro

Action	Woodsboro-1
Description of Action	Replace a damaged well for the residents of Woodsboro
Applicable Goal	Goal J: Identify community-specific needs to reduce risks to various hazards
Objective	To reduce risk of drought impacts and wildfire/urban interface fire impacts through ensuring water supply
Priority:	Medium
Responsible Organizations	Town of Woodsboro
Estimated Costs	TBD
Possible Funding Sources	Town budget
Timeline for implementation	Short-term
Status since 2016:	Complete

Village of Rosemont

Action	Rosemont-1

Description of Action	Post hazard mitigation information on village website and send out emails to the Rosemont resident listserv
Applicable Goal	Goal A: Promote public understanding, support, and involvement in hazard mitigation activities
Objective	Use countywide public information and education programs to advise citizens on how to protect themselves and their property from natural hazard events
Priority:	High
Responsible Organizations	Village of Rosemont
Estimated Costs	Staff time
Possible Funding Sources	N/A
Timeline for implementation	Ongoing
Status since 2016:	Complete

College and University Actions

Hood College is not included in this section as they did not participate in the 2016 Hazard Mitigation Plan.

Frederick Community College

Action	**FCC-1**
Description of Action	Utilize Frederick Community College's emergency management program to develop a 15- to 20-minute briefing for instructors to deliver to students at the beginning of every semester on emergency preparedness.
Applicable Goal	A
Objective	Use public information and education programs to advise students on how to protect themselves from hazard events.
Priority:	High
Responsible Organizations	Director of Public Safety and Security
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	Summer 2016 – FY 17
Status since 2016:	Complete—this is ongoing and is now a capability of FCC.

Action	**FCC-2**
Description of Action	Develop and/or disseminate awareness information on natural hazards preparedness and mitigation for students, employees and their families. Reinforce need to review and update annually personal emergency evacuation plans.
Applicable Goal	A
Objective	Use public information and education programs to advise students on how to protect themselves from hazard events.
Priority:	High
Responsible Organizations	Director of Public Safety and Security
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	FY 17
Status since 2016:	Complete—this is now a capability. The evacuation plan has been updated, updated evacuation maps are in every room, emergency trainings are offered monthly, and ongoing preparedness messaging is sent out. More hazard mitigation aspects will be added to all messaging.

Action	**FCC-3**
Description of Action	Purchase radios to enable better, more reliable communications among college departments and with county/city emergency services.
Applicable Goal	I
Objective	Increase college's ability to quickly respond, recover and mitigate against hazard events.
Priority:	Medium
Responsible Organizations	Director of Public Safety and Security
Estimated Costs	$35,000
Possible Funding Sources	Operations Budget
Timeline for implementation	FY 17

Status since 2016:	Complete—a new 2-way radio system was purchased from ProComm in 2017.

Action	**FCC-4**
Description of Action	Convert lockdown presentation to web-based product for broad dissemination
Applicable Goal	A
Objective	Use public information and education programs to advise students on how to protect themselves from hazard events
Priority:	High
Responsible Organizations	Director of Public Safety and Security
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	Summer 16 - FY 17
Status since 2016:	Complete—YouTube video link is available on the FCC website.

Action	**FCC-8**
Description of Action	Cap existing wet fire suppression system in Primary Server Room (G) and maintain dry fire suppression system
Applicable Goal	J
Objective	Ensure continuity of information technology systems
Priority:	High
Responsible Organizations	Director of Network Services
Estimated Costs	$15,000
Possible Funding Sources	Capital Projects
Timeline for implementation	FY 17
Status since 2016:	Not complete—it was determined that the Fire Marshall does not allow dry systems.

Action	**FCC-9**
Description of Action	Cap existing wet fire suppression system in Primary Hub Room (L-207) and install dry fire suppression system
Applicable Goal	J
Objective	Ensure continuity of information technology systems
Priority:	High
Responsible Organizations	Director of Network Services
Estimated Costs	$15,000
Possible Funding Sources	Capital Projects
Timeline for implementation	FY 17
Status since 2016:	Not complete—it was determined that the Fire Marshall does not allow dry systems.

Action	**FCC-11**
Description of Action	Evaluate options to improve drainage (i.e., install French drains, retrofit entrances to improve waterproofing) for minor flood issue affecting Knuckle A/B
Applicable Goal	J
Objective	Minimize flood hazard
Priority:	Medium
Responsible Organizations	Director of Facilities and Planning
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	FY 17
Status since 2016:	Complete—a new threshold was installed and additional sealing was put on the base of storefronts.

Action	**FCC-13**

Description of Action	Purchase materials to flag fire hydrants in case of snow events. Assign responsible party to do the flagging
Applicable Goal	J
Objective	Enhance the college's resilience to future hazard events
Priority:	High
Responsible Organizations	Plant Operations
Estimated Costs	Approximately $10 for each flag/Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	FY 17
Status since 2016:	Complete

Action	**FCC-17**
Description of Action	Conduct a structural inspection (10-year cycle) of the older buildings on campus
Applicable Goal	J
Objective	Enhance the college's resilience to future hazard events
Priority:	Low
Responsible Organizations	Facilities and Planning
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	FY 2021
Status since 2016:	Complete—this was completed with the creation of the Facilities Master Plan.

Mount St. Mary's University

Action	**MSM-3**
Description of Action	Consider developing an MOU with the American Red Cross to address sheltering
Applicable Goal	H

Objective	Enhance capability of university to shelter students on-site
Priority:	High
Responsible Organizations	Director of Public Safety
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	60 days
Status since 2016:	Not complete—MSM has decided to not pursue this action anymore.

Action	**MSM-7**
Description of Action	Implement active shooter policy, conduct awareness training for staff and students and conduct tabletop exercise
Applicable Goal	J
Objective	Protect life safety
Priority:	High
Responsible Organizations	Director of Public Safety
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	30 days
Status since 2016:	Complete—this is done at least annually and is considered a capability.

Action	**MSM-8**
Description of Action	Include information on hazards preparedness and mitigation in annual student/parent orientation presentation
Applicable Goal	A
Objective	Use public information and education programs to advise students on how to protect themselves from hazard events
Priority:	Medium
Responsible Organizations	Director of Public Safety

Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	90 days
Status since 2016:	Complete—this is done annually and is considered a capability.

Action	**MSM-11**
Description of Action	Conduct annual evaluation of trees on campus to ensure they are not at risk and implement trimming as needed
Applicable Goal	J
Objective	Reduce likelihood trees could create secondary hazard (e.g., debris creation, fall hazard)
Priority:	Medium
Responsible Organizations	Facilities Services and Project Management
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	Annually
Status since 2016:	Complete—this is done at least annually and is considered a capability.

APPENDIX C: HAZARD HISTORIES

The information contained in Appendix C is data from the 2004, 2009, and 2016 Frederick County Mitigation Plans, organized by hazard category. The information shown has not been changed or updated. Hazards are only listed if they had historical data included in the plan. for hazard history after 2016, please refer to Chapter 5 of the HMCAP.

Primary Climate Change Interaction: Changes in Precipitation

Flood

- On June 27, 2006, waves of low pressure rode along a stationary front parked just to the west of the region. Clusters of strong thunderstorms trained over the county in a tropical air mass. Reports of 4 to 7 inches of rain in a short amount of time turned normally small streams into raging torrents of water. Three people died from drowning in the bed of a pickup truck driving through flooded roads east of Myersville along Middle Creek. Two teenagers died near Little Pipe Creek. It is believed the teenagers were swept away while swimming in the raging creek. MARC Commuter Rail experienced numerous disruptions with underground tunnels being filled up with water. Numerous roads were closed across the county due to high water or mud slides. Damage from the flash flooding was estimated at $500,000.
- On September 20, 2003, 2 to 4 inches of rain, a result of Hurricane Isabel, fell across central and western Maryland. This was not enough to cause flash flooding but added to previous rains. Three homes sustained moderate to major damage from flooding and 2 homes experienced minor to moderate damage. The flood waters also closed down a section of the C&O canal. The Monocacy River remained well below flood stage in Frederick. A state trooper was injured when a tree fell on his car in the storm and another was injured when a tree fell on him. Two homes had some damage and there were 40 road closures from trees falling on them. Approximately 28,892 customers lost power in the County. Damages were estimated over $100,000.
- On June 14, 1972, Hurricane Agnes began as a tropical disturbance off the coast of Mexico; by June 19, Agnes had become a hurricane. The storm made initial landfall along the Florida panhandle and made her way up the Atlantic Coast. The most impressive aspect of the hurricane was the widespread nature of its floods, resulting in extremely rare floods on major rivers and streams. The flood recurrence frequency in many locations exceeded 100 years, most notably on the Susquehanna River downstream of Waverly, New York, and on the Potomac River, downstream from Point of Rocks, Maryland. The Monocacy River in Frederick rose from a height of 30 feet to 35.9 feet after Agnes. Hurricane Agnes was the costliest natural disaster in the United States at that time. Damage was estimated at $3.1 billion and 117 deaths were reported. In Maryland, the damage was estimated at $110 million and 19 deaths were reported.
- On January 19, 1996, snowmelt combined with 1 to 3 inches of rain to produce heavy river flooding in Allegany, Montgomery, Washington, and Frederick Counties. The flooding was the worst in the region since 1985. Almost all dwellings in the town of Point of Rocks were damaged by floodwaters in some way. There were several water and sewage plant failures. Water line breaks in La Vale and failures at Sharpsburg and Hagerstown forced residents to boil water for 3 to 5 days (thousands of others were without water for 1 to 2 days). The plant in Brunswick was shut down for 1 to 3 days due to flood waters and high turbidity. Three counties, Washington, Allegany, and Frederick in central Maryland were declared under a federal disaster declaration. Total property damage in the area was estimated at $60 million. No fatalities or injuries were reported.

- On June 19, 1996, the northern part of the County experienced a major flood. There was one fatality and approximately $5 million of property damage.
- On September 6, 1996, flooding was experienced throughout the County. No casualties or injuries were reported. Property damage was $75,000 and crop damage was $10,000.
- On August 1, 2000, scattered thunderstorms produced very heavy rainfall, gusty winds, and frequent lightning. In Frederick County, the chimney of a two-story home in Jefferson was struck by lightning. A fire resulted that heavily damaged the structure. A heavy downpour sent Martin's Creek out of its banks in Brunswick. Rushing water from the creek inundated nearby buildings. A Brunswick City building made of cinder blocks had the rear and part of a side wall washed away. Cars, trucks, and other equipment stored inside were also damaged. Some culvert pipes were washed out and a foot bridge and a fence were washed away. A home across the street from the creek also reported flood damage to appliances. Property damage to the County was approximately $100,000. No fatalities or injuries were reported.
- On September 18, 2003, Hurricane Isabel made landfall on the North Carolina Coast. The high wind gusts up to 70 mph came with bands of showers down to the surface, causing streaks of damage that sometimes appeared as though a tornado had moved through instead of a strong narrow ribbon of wind. Wind damage to structures was limited but wind damage to trees in the area was extensive and widespread. Soil moisture was high from previous rains, making it easier for trees to uproot. The trees were also still in full canopy, which acted like a sail to catch the wind. Trees fell on electrical and utility wires, taking out power and phone lines. Trees fell on roads, cars, and homes. In Frederick County, a state trooper was injured when a tree fell on his car in the storm and another was injured when a tree fell on him. Two homes had some damage and there were 40 road closures from fallen trees. Approximately 29,000 customers lost power in Frederick County due to this flooding event. The region incurred property damage of approximately $130,000. No fatalities were reported.

Karst/Sinkholes

- In June 2008, a large sinkhole formed on Interstate 70 near Patrick Street and Market Street, closing the highway, and another formed near South Street on Interstate 70. One particular sinkhole that appeared in this area was so large that the depth of the hole was never actually determined. The Maryland State Highway Administration placed 60 feet of rope down the hole to determine its depth but was unable to identify solid rock bed at that depth.
- A sinkhole closed the westbound side of Interstate 70 just to the east of Frederick on April 24, 2008. The sinkhole was 20 feet across and 35 feet deep. It was found by a Maryland State Trooper traveling westbound on Interstate 70 who reported it to the Maryland State Highway Administration. There were no injuries.
- In September 2003, heavy rains that followed Hurricane Isabel caused a 110-foot-long, 35-foot-deep sinkhole along Interstate 70 at the interchange with South Street. This caused temporary closure of South Street and the MARC rail line, knocking out power and putting backpressure on sewage treatment plants.
- One of the largest sinkholes in Frederick County occurred on New Design Road in June 2003. The sinkhole, 12 feet deep and 30 feet in diameter, opened across both northbound lanes and cost nearly $2 million to repair. DPW is currently developing a sinkhole inspection program to map areas of sinkhole incidence and to establish a regular review program.
- Another sinkhole formed in a local farmer’s field in March 2003. Others appeared at the East Gate Shopping Center and in Sagner Park in April and September 2003, respectively. In general, they were 7 to 8 feet deep and 4 to 5 feet in diameter.
- In September 2002, 12 sinkholes formed after Tropical Storm Hanna dropped several inches of rain on the county. The sinkholes were found near Maryland Route 85 in the southern portion of the county; the largest was 20 feet in diameter.

- On February 15, 2015, a large sinkhole formed on Inspiration Drive near a pressure sewer system. As a result, the sewer system was closed for two weeks during repair/reconstruction. Total costs associated with the repair of the facility and roadway was $175,758. [i]
- On June 6, 2012, the Maryland State Highway Administration (SHA) closed the ramp from South Street to eastbound Interstate 70, as well as the left lane along Interstate 70 to repair a sinkhole that developed in the median. The sinkhole was about 20 feet deep by 10 feet wide and 10 feet long.

Drought

- Much of 2007 was extremely dry across Maryland as well as in Frederick County. In early October 2007, rainfall deficits across the County reached nearly 10 inches for the year. A strong ridge of high pressure was anchored over the Eastern Seaboard throughout much of the year, resulting in little moisture from cold fronts. Most of the County was classified under extreme drought conditions by the United States Drought Monitor. Many towns, cities, and counties across Maryland enacted mandatory and voluntary water restrictions. Area streams and rivers experienced all-time record low water levels, especially in the late summer and early fall due to the extreme hydrological drought. Many farmers in the county had very poor yields in crop production due to the extreme dryness.
- The period between September of 2001 and August of 2002 was the second driest 12 months in Maryland history. By August of 2002, groundwater levels had reached record lows. Along with several other eastern states, Maryland was in a state of “extreme drought” as defined by the United States Drought Monitor, characterized by major crop/pasture losses, extreme fire danger, and widespread water shortages. Above normal rainfall in October of 2002 helped alleviate drought conditions and reduced drought conditions to abnormally dry. By February of 2003, water restrictions were lifted in most of the state, including Frederick County (umd.edu).
- July 1997 was a very dry month with a 7-day heat wave that exacerbated drought-like conditions across much of the fertile farmland of Maryland. The weather in July proved disastrous for many crop yields, including corn, hay, alfalfa, and soybeans. Agricultural states of emergency were declared in many areas west of the Chesapeake Bay. Hardest-hit counties included Carroll, Frederick, Howard, Montgomery, and Washington. Some of the more impressive damage estimates included: in Frederick County nearly $9 million in corn, an approximate 90 percent loss; an additional $5.5 million in corn for silage and soybeans, a 60 percent loss. The total crop damage to the 12-county region in Maryland was estimated at $43.7 million.
- November 1998 was the fifth month in a row that drought conditions were seen across central and northern Maryland. Only 1.13 inches of rain fell at the Baltimore/Washington International Airport in Anne Arundel County during the month of November, 2.07 inches below normal. Other monthly rainfall totals from affected counties included 0.6 inches in Washington, 0.7 in Howard, 0.9 in Frederick, 1.0 in Charles, 1.1 in Carroll and Anne Arundel, and 1.2 in Montgomery and Prince George’s. Water levels and reserves were greatly affected by the persistent drought. The total crop damage incurred by 13 counties in Maryland, including Frederick County, was approximately $20 million.
- Between September 1998 and August 1999, precipitation was a staggering 12 to 16 inches below average. In August, 6.14 inches of rain fell at Baltimore/Washington International Airport, 2.22 inches above normal. Additional August rainfall totals included Allegany County at 2.5 inches, Washington County at 2.3 inches, Frederick County at 3.1 inches, Prince George’s County at 5.3 inches, Carroll County at 4.7 inches, Anne Arundel at 6.6 inches, Northern Baltimore County at 5.4 inches, Howard County at 4.3 inches, Montgomery County at 4.6 inches, Charles and Calvert Counties at 5.5 inches, and St. Mary's County at 5.8 inches. The lack of rainfall through the third week of August continued to affect water levels along the Potomac River and the Chesapeake Bay. Nineteen Maryland counties were declared federal drought disaster areas. The worst agricultural drought in Maryland continued to devastate farmers. Approximately 55 percent of pastureland, 45 percent of corn, 39 percent of sorghum, 29 percent of tobacco, and 34 percent of soybeans across the state were reported in poor or very poor

condition; 42 percent of topsoil and 84 percent of subsoil were reported as short or very short of moisture. Frederick County lost 90 percent of the corn and soybean crop, losing $9 million revenues. Crop damage for several Maryland counties totaled to $30 million.

- During the summer of 2002, drought gripped the State of Maryland. The ground and reservoir water supply in Frederick County was low. By September 2002, the area was being strangled by the worst drought in more than 30 years. The first nine months of 2002 were dangerously dry, with 25 inches of rain recorded at Dulles International Airport during that time (average for that time period is 32 inches).

Primary Climate Change Interaction: Rising Temperatures

Extreme Heat

- On July 17 and 18, 2006, a hot and very humid air mass seeped into the mid-Atlantic. The heat index value climbed to 105 degrees both afternoons. Emergency response officials reported sporadic incidents of heat-related illness, such as shortness of breath and heat exhaustion, throughout the Washington/Baltimore Metropolitan region. Three deaths were attributed directly to this heat wave.
- Between August 1 and 3, 2006, excessive heat conditions occurred across much of Maryland. Afternoon heat index values ranged between 105 to as high as 115 degrees. Six people died in central Maryland due to the excessive heat conditions during this heat wave. Five people, including one player, were rushed to the hospital during a baseball game due to heat-related illnesses.
- On August 27, 2008, a hot and humid air mass developed over the mid-Atlantic ahead of a strong cold front on August 25. Temperatures climbed into the mid-90s by noon. These temperatures combined with high humidity created heat index values of 105.
- On August 22, 2002, high temperatures rose into the mid-90s and heat index values soared to near 105 degrees during the afternoon. Three people in Frederick County died as a result of the excessive heat. No damage to property or crops was reported.
- High pressure sitting off the Atlantic coastline pumped hot and humid air into the region between August 12 and 19, 2002. Temperatures soared well into the 90s during the afternoon each day and heat index values approached 100 degrees in Frederick County and neighboring areas. Four Marylanders died during the 8-day heat wave. No property or crop damage was reported.
- High pressure off the Atlantic Coast pumped hot and humid air into the mid-Atlantic region, causing high temperatures to reach between 92 and 100 degrees between August 1 and August 5, 2002; heat indices soared to between 98 and 110 degrees. In Frederick County, 11 people participating in an outdoor activity in Ijamsville were treated for heat illnesses. The heat was also blamed for buckling pavement on Interstate 70 near the Maryland Route 355 exit. Several regional power companies noted record energy consumption during this heat wave, the hottest in 5 years.
- A large area of high pressure sat off the mid-Atlantic coast during the last week of July 2002. This caused a warm and moist south wind to blow into the region for several days, resulting in another heat wave in the Frederick County region. The hottest days were the 28th and 29th of July, when temperatures rose into the 90s and heat index values reached 100 to 110 degrees. Power companies reported record electricity use on the 29th. Three fatalities were recorded in Maryland.
- High pressure remained stationary off the Delmarva coastline during the first week of July 2002. This resulted in a prolonged period of hot and humid weather across the mid-Atlantic region. Between July 2 and 4, high temperatures rose into the lower to middle 90s and dew points reached into the lower 70s. This resulted in heat index values reaching 100 to 110 degrees during the afternoon. Twenty other people were treated at hospitals for heat illnesses countywide between July 2nd and 4th. Twenty-one fatalities were recorded in Maryland. There was no damage to crops or property.

Primary Climate Change Interaction: Extreme Weather

Severe Winter Storms

- From December 18 to 19, 2009, a strong area of low pressure tracked slowly over the mid-Atlantic, bringing 19 to 23 inches of snow across Frederick County.
- On January 17, 2008, a snowstorm passed through Maryland, resulting in an accumulation of nearly 6 inches of snow and sleet in Frederick County.
- On February 11 and 12, 2006, an historic snowstorm occurred across the mid-Atlantic. Storm total snowfall in Maryland ranged between 8 and 14 inches. A period of thundersnow occurred overnight and early in the morning of February 12 throughout areas of the northern Washington, DC, suburbs and the Baltimore suburbs, where localized snowfall ranged from 14 to 22 inches. There were also numerous reports of downed trees and power lines, causing significant power outages. Local utility companies reported total power outages of around 300,000 customers in the Washington/Baltimore region. Amtrak reported major delays and cancellations along the northeast rail corridor, which passes through both Baltimore and Washington, DC. Damages were estimated at $230,000.
- On March 26, 1997, a strong surface high pressure area over New England pushed a shallow layer of subfreezing air into the northern tier of Maryland, causing a severe winter storm. Carroll, Frederick, northern Baltimore, and Washington Counties were affected. Total property damage to these counties was estimated at $150,000.
- On January 14, 1999, a strong arctic cold front moved slowly southeast across the mid-Atlantic region. This front brought a thick layer of sub-freezing air to the lowest levels of the atmosphere, but just off the surface, warmer air moved in. This created ice accumulations of 1.25 to 1.5 inches north and west of a line from Montgomery County to Harford County, including Frederick County. The total damage to Maryland counties was estimated at $3.2 million. No fatalities or casualties were reported.
- On February 14, 2003, a complex storm system produced copious amounts of wintry precipitation across Maryland west of the Chesapeake Bay. Nicknamed the President's Weekend Snowstorm of 2003, this storm will go down in history as the heaviest snowstorm in the Baltimore region since records began in 1870. A total of 28.2 inches of snow was recorded at Baltimore-Washington International Airport. This massive storm took a heavy toll on residents, structures, transportation systems, emergency responders, businesses, livestock, and travelers. A state of emergency was declared by the Governor and people across the state were ordered to stay off the roads during the height of the storm between the morning of the 16th and the morning of the 17th. Roads were covered by deep snow and sleet and were nearly impassable. Main highways were partially cleared by the 18th but it took up to 5 days to reach some secondary and residential roads. In Frederick County, 5 sheds or barns caved-in. Portable classrooms at 4 County schools collapsed. A meeting hall and a tennis court bubble were crushed. A 42-year-old man died from a heart attack after shoveling snow in New Market. A 12-year-old boy died from carbon monoxide poisoning in a snowbound car in Mount Airy. Property damage incurred by the Maryland counties was approximately $5.2 million. There were 2 fatalities and 10 injuries.
- On December 5, 2003, a winter storm produced 5 to 6 inches of snow across North and Central Maryland. A medical condition rendered a Frederick woman unconscious after she walked outside to check her mailbox and she eventually died of hypothermia. No property or crop damage was reported during this event.
- On February 4 to 5, 2014, a low-pressure system brought ice accumulations of a quarter inch to Point of Rocks.
- Three major winter storms hit the County during the winter of 2009/2010. The first major storm occurred on December 19, 2009, the second on February 5 and 6, 2010, and the third on February 10, 2010. All three storms dumped upwards of two feet of snow on parts of the County. The February 5 and 6 storm brought snowfall totals of 29.5 inches 2 miles northeast of Jefferson, and 29.0 inches near

Frederick. Much of remainder of the winter was spent recovering from the blizzards. Expenditures from the 2009/2010 winter season, as provided by DPW, totaled $2.1 million.

Thunderstorms

- On June 4, 2008, a local newspaper reported several roofs blown off barns on Brentland Road. A stalled front resided across the mid-Atlantic during the afternoon and evening of June 4, allowing moisture and instability to pool along the boundary. This combined with several strong upper level disturbances resulted in numerous thunderstorms during the afternoon and evening. Many of these thunderstorms became severe. Damages were reported at $50,000.
- On March 5, 2008, Frederick County Emergency Management reported a barn roof and garage collapse. Three telephone poles were downed in the unincorporated city of Adamstown. Several lines of thunderstorms crossed the region from the evening of March 4 through the early morning of March 5. Heavy rain led to several road closures due to flooding and also caused several basements to flood. Wind gusts in excess of 50 mph were measured at several locations statewide. There were numerous reports of trees and power lines down across northern and central Maryland.
- On February 4, 2006, a newspaper report indicated significant damage to a log house near Libertytown in Frederick County. A large old oak tree was downed, as well as a few other smaller trees. Trees and power lines also were downed near Ridgeville and Westminster. Damages were reported to approach $100,000.
- On July 10, 2001, a 69-mph wind gust was recorded in Emmitsburg where 2 inches of rain fell. Southeast of Emmitsburg, a 100-by-300-foot barn under construction on Dry Bridge Road collapsed. Three workers inside the structure were injured. Trees were downed near Rocky Ridge south of Thurmont.
- On May 5, 1991, winds were reported gusting at 70 mph in the northwestern portion of the County. officials estimated damages to be at least $100,000. Many trees were uprooted and power lines down. One woman was injured by a falling tree. Water supply was interrupted for a day after a tree, whose roots were wrapped around an 8-inch line, was toppled.
- On February 4, 1998, a powerful nor'easter, carrying copious amounts of moisture from the Gulf of Mexico and Caribbean region, dumped between 2 and 4 inches of rain across much of Maryland between the foothills and the Chesapeake Bay. Several counties in Maryland, including Frederick County, were affected. Minor sewage backups were reported farther north in Frederick County. A tractor-trailer flipped over along Interstate 70 in western Frederick County near the Myersville exit (Maryland Route 17). The total property damage incurred across the State totaled $145,000 and crop damage was $200,000.
- On July 19, 1996, a supercell that was producing weak to moderate tornadoes across southern Washington and Frederick Counties had an associated rear-flank downburst that struck immediately west of the tornado track. Numerous trees were uprooted or snapped over a wide area from just west of Rosemont to the banks of the Potomac River. Wind speeds maximized along the shoreline, likely a result of a channeling effect through the mountain gap just east of Harpers Ferry, West Virginia. Power outages were substantial in these areas; 10,000 customers in Loudoun County, Virginia, and Frederick County, Maryland, were briefly without electricity. The total crop damage incurred was $50,000 and property damage was $25,000.
- On July 21, 1998, a small but potent line of severe thunderstorms raced from western Maryland through the Washington, DC, metropolitan region, producing wind gusts between 60 and 70 mph along the leading edge. The storm gained strength as it plowed southeast into Frederick and Montgomery Counties. In Frederick County, damage included felled scattered trees and power lines in the Middletown/Braddock Heights area. More substantial damage occurred in the southern portion of the City of Frederick, where two roofs partially collapsed at a shopping center near the intersection of Maryland Route 85 and Interstate 270. An unfastened trailer was flipped off cinder block supports and

fell onto an automobile, pinning the car against a curb. Homes at a nearby neighborhood sustained minor damage, including one whose garage was partially destroyed. The total property damage was approximately $90,000.

- On August 3, 2012, damaging winds caused several trees to be knocked down. Damaging winds also caused a barn roof to come off. Damages estimated at $15,000.
- On June 29, 2012, a strong upper-level disturbance triggered a line of thunderstorms that caused widespread tree damage and brought down transformers throughout the county. Storm damages totaled $50,000.
- The roof of a large dairy barn was destroyed on June 22, 2012 by a thunderstorm downburst with estimated winds of around 80 mph. Many trees in the area were uprooted or destroyed by this thunderstorm, and property damages totaled about $25,000.
- Strong thunderstorms moved through the county on August 12, 2010, bringing structural damage to a drag racing facility near Green Valley.

Extreme Wind Events

- On December 16, 2007, wind gusts over 60 mph knocked out power, and Frederick County Emergency Management reported nearly 30 reports of trees down across the county. Damages were intensified in areas that had significant ice accumulations. Property damages approached $10,000.
- Large trees were knocked down by 55 mph wind gusts from a strong cold front on December 1, 2006. Trees were downed along Gashouse Pike east of the City of Frederick and along Rocky Springs and Yellow Springs Roads to the north of the city. Property damage was estimated to be $30,000. A strong cold front brought very strong winds to the county on February 17, 2006. Wind gusts of over 50 mph were reported with scattered power outages from downed trees and power lines. Property damage exceeded $140,000.
- Tens of thousands of people were without power for an extended period of time on January 14, 2006, as a strengthening low-pressure area moved up the northeast coast. Widespread damages and power outages occurred throughout Maryland with this event. Winds gusted to over 60 mph, and $1.8 million in property damage was reported.
- High winds occurred on March 14, 1993, as the “Blizzard of 1993” moved through the region. Wind gusts over 60 mph created snow drifts up to 10 feet. Nearly $500,000 in property damage occurred.
- On November 11, 1995, a strong cold front ripped through the region creating wind gusts to hurricane force (74 mph). Property damage in the County climbed to $70,000.
- A severe wind event occurred on April 23, 1996, resulting in over 30,000 Baltimore Gas and Electric customers without power. Damages over $100,000 were reported.
- Strong winds in excess of 30 mph knocked down a healthy tree just south of Mount Airy, which just missed a nearby home. A deteriorating and aging silo was also knocked down. Damages were $15,000.
- A strong coastal storm rolled through the state on February 4, 1998, resulting in sustained winds of 35 mph and gusts in excess of 50 mph. Dozens of trees fell across the County and nearly 15,000 people were without power at the height of the storm. A tractor trailer was flipped over by the wind on Interstate 70 near the Myersville exit. Damages were near $350,000 from the storm.
- One person was injured on February 24, 1998, when a wall fell in an unfinished townhome during a severe windstorm. Property damage was $70,000.
- On February 11, 2000, strong cold fronts passed through the region with winds in excess of 55 mph. Trees were reportedly down on area roadways in Emmitsburg, New Market and Middletown. Over 1,000 people were without power in the County and property damage was $22,000.
- A vigorous cold front crossed the County on December 12, 2000, resulting in large tree limbs being knocked down onto U.S. Route 15 near Point of Rocks. A wind gust of 44 mph was reported at Frederick Airport. Property damages were $35,000.

- A severe wind event occurred on February 1, 2002, with a wind gust of 54 mph at Frederick Airport. There were trees and power lines reported down across the County, along with scattered power outages.
- Strong downslope winds from the Appalachian Mountains gusted to over 50 mph on January 9, 2003. Tree limbs were downed near Brunswick and wires were downed in Walkersville and Mount Pleasant.
- High winds occurred on November 13, 2003, as a strong cold front plowed through the region. A truck was blown over on U.S. Route 15. Over 150,000 homes and businesses were without power at the height of the storm in Maryland.
- On February 26, 2010, a wind gust of 63 mph was measured near Ballenger Creek. Dozens of trees were down along U.S. Route 15 between Thurmont and Frederick. This damage resulted from a low-pressure system that moved into the northeast on February 25, 2010, rapidly intensifying into the 26th. The strong pressure gradient that developed caused very gusty winds and damages totaling $6,000.
- On January 25, 2010, a low-pressure system tracked through the Ohio Valley and into the Great Lakes, causing strong gusty winds to develop ahead of a cold front, bringing down numerous trees across the County. Property damages approached $4,000.
- On June 29, 2012, a destructive complex of thunderstorms (derecho) moved through the Washington, DC metro areas with winds of 60-80 mph, resulting in extensive damage and leaving more than 1 million area residents without power.
- Gusts of 66 mph were measured on March 12, 2014, in Thurmont downing multiple trees. This wind resulted from a cold front moving through the mid-Atlantic that caused widespread gusts of 55 mph with localized higher windspeeds in the region.

Hailstorms

- On June 26, 2009, ping-pong-ball-sized hail was reported near Walnut Ridge as a result of a potent cold front combined with plenty of instability that triggered severe thunderstorms.
- On July 16, 2007, penny- and nickel-sized hail was spotted in Brunswick. Numerous showers and thunderstorms developed across the region during the afternoon of July 16. Many of these storms became severe, producing large hail and damaging winds that downed large trees and power lines.
- On July 16, 2000, scattered thunderstorms that produced winds in excess of 55 miles per hour, heavy rainfall, large hail, and frequent lightning moved across Maryland. In Frederick County, quarter-sized hail destroyed a cornfield in Thurmont and a car was hit by lightning, but no one was injured.
- On June 22, 2001, severe storms contained very heavy rainfall, frequent lightning, and occasionally produced high winds and large hail. In Frederick County, nickel-sized hail was reported on Maryland Route 40 west of Frederick. In Frederick, pea-sized hail fell and a wind gust of 50 miles per hour was estimated. Trees were downed by high winds in the Putman Road area 5 miles north-northwest of Frederick. Pea-sized hail was reported in Poolesville. A spotter in Braddock Heights reported 2 inches of rainfall in 20 minutes. at Point of Rocks, the railroad crossing on Maryland Route 28 was flooded. A three-story mansion was struck by lightning and the resulting fire caused $300,000 damage. Another lightning fire in Kemptown caused $20,000 damage. No casualties or fatalities were reported.

Lightning

- On June 7, 2008, a local newspaper reported a lightning-sparked fire on the 2300 block of Ballenger Creek Pike in the unincorporated city of Adamstown. A very warm, humid air mass was entrenched across the mid-Atlantic during the late afternoon and evening hours of June 7. As an upper level disturbance moved across the area, scattered strong to severe thunderstorms developed. Damaging winds brought down some trees and power lines throughout Maryland.
- On June 10, 2008, a local newspaper reported a lightning-sparked basement fire on Kemptown Court in New Market. Cool, drier air behind the front clashed with very warm and moist air ahead of it, resulting in

scattered to numerous strong to severe thunderstorms. Storms that became severe brought down trees and power lines throughout the state.

- On August 21, 1994, lightning struck and burned a historic barn in the City of Frederick at the School for the Deaf. The County incurred a total damage of $500,000.
- On July 28, 1999, a series of thunderstorms swept across north-central Maryland, producing heavy downpours, frequent lightning, and damaging winds in excess of 55 miles per hour. The storms moved through Washington, Frederick, Carroll, and Howard Counties. In Frederick County, trees and power lines were downed onto Maryland Route 180 at the intersection of Mount Zion Road, Main Street in New Market, Maryland Route 75 between Maryland Route 80 and Ed McClain Road, and Maryland Route 144. A concentrated area of tree damage also occurred between Monrovia and Bartholows Road. Monrovia was hit especially hard. One home lost part of its roof when several trees fell onto the structure. A car in the driveway was also damaged by a fallen tree. A nearby 150-year-old log home valued at $130,000 was hit by lightning and burned to the ground. The fire department reported delays reaching the structure because of roads blocked by downed trees. In the City of Frederick, 1 house was damaged and 22 intersections were blocked by fallen trees. Approximately 150,000 customers in and around Frederick County lost power as a direct result of the storm. The total property damage was estimated at $130,000.
- On August 7, 2000, scattered thunderstorms moved across central Maryland during the afternoon and early evening. These storms produced winds in excess of 55 miles per hour, frequent lightning, and hail. In the City of Frederick, an apartment complex was hit by lightning. The total property damage during this lightning event (including Howard, Prince George’s, and Montgomery Counties) was $750,000.
- In August 2002, several thunderstorms with high winds, large hail, and frequent lightning moved through western and central Maryland. In Frederick County, a 52-year-old man was killed by lightning while standing on the back porch of his Frederick home. It was not raining at the time he was struck. A 17-year-old swimming pool lifeguard at fort Detrick was injured when lightning struck nearby. A 36-year-old Frederick County man was also injured by lightning in an unknown location. at least 4 homes across the County were damaged by lightning and 2,000 bales of hay were set on fire near Emmitsburg. Wind damage was reported in Park Mills. Marble- to quarter-sized hail fell just south of Frederick for nearly 10 minutes. No fatalities or casualties were reported and there was no damage to crops or property.
- On August 29, 2003, a home caught fire after being struck by lightning. An afternoon thunderstorm produced a lightning bolt that struck a home in Brunswick. The home on East A Street was heavily damaged from the resulting fire and two families were displaced. The damage was estimated at $50,000.

Tornadoes

- On September 17, 2004, three tornadoes touched down in Frederick County. An F1 tornado produced structural damage to several homes near Brunswick. A few structures and outbuildings were destroyed. Other structures sustained roof damage, and trees were downed or stripped. The tornado continued to cause damage to the north along U.S. Route 17 for approximately three miles before lifting at Burkittsville. A second F1 tornado touched down in south-central Frederick County, just east of Adamstown. The storm traveled north and produced minor structural damage. It blew out windows, tore shingles off several roofs, and caused one chimney collapse. The tornado also uprooted and sheared several large softwood and hardwood trees. Finally, an F2 tornado touched down in far northwest Frederick County, on the northwest edge of Catoctin Mountain Park. A thickly forested stand of hardwoods was snapped off above their bases. Total damage from the tornadoes was $255,000.
- On July 31, 1978, a tornado was visible in Frederick County. The exact location was unknown. Property damage was estimated at $25,000. No fatalities or injuries were reported.
- On July 19, 1996, a supercell thunderstorm produced an F2 tornado in Yarrowsburg (Washington County) and dropped a second tornado in Rosemont. The tornado first touched down in Rosemont,

damaging numerous trees as it crossed Maryland Route 17 and moved into Brunswick. A service station's roof was partially damaged by a fallen tree. Many of the homes in Brunswick were protected by the trees and the steep sloping terrain towards the Potomac. The total property damage was estimated at $80,000 and total crop damage was estimated at $50,000.

- On August 14, 1999, an area of thunderstorms moved across much of Maryland, producing damaging wind, frequent lightning, and brief heavy downpours. The thunderstorm complex intensified rapidly as it moved into Frederick County. The northwest side of the City of Frederick took the brunt of the storm. As the storm reached the Abbington Farms area, a tornado developed. The tornado was F1 strength with winds between 75 and 112 mph and ranged from 50 to 200 yards wide as it traveled east for 3 miles. The twister did extensive damage to trees as it moved through the communities of Eastview, Walnut Springs, Shookstown, and fort Detrick. Some trees fell onto cars and houses, and a few homes under construction were damaged. One home under construction in Walnut Ridge was torn to pieces by the tornado and the debris turned into airborne missiles that heavily damaged two finished homes nearby. Two homes in the Eastview subdivision were condemned after trees fell onto the structures. A chimney was blown off a Willowdale Drive home. Yellow Springs Road had to be closed for several hours until power and telephone poles blocking the road could be cleared. A metal storage building on Rosemont Avenue was crumpled. Part of the roof of the Food Lion grocery store on Rosemont Avenue was torn off and thrown toward the gates of fort Detrick. The store suffered water damage and the loss of frozen foods and perishables from the resulting power outage. Next, the storm moved across fort Detrick, causing $260,000 in damage. The twister moved onto the main post where it uprooted trees, downed power lines, and blew off parts of buildings. The headquarters building and post chapel lost part of their roofs. Nearly 30 cars along Rocky Springs Road and near post housing were damaged by downed trees and debris. In addition, the central portion of Frederick was hit by destructive straight-line winds estimated between 60 and 70 miles per hour. Thirty Bradford pear trees were downed on Heather Ridge Drive. Sixteen city streets were closed by fallen trees. A 1-mile stretch of Maryland Route 40 west of the Golden Mile had to be closed for an hour to clear fallen trees. A glider valued at $11,000 was ripped from its mooring at the airport and totaled. The storm downed a total of 300 trees across Frederick and resulted in outages for 8,000 power customers. High winds also downed trees in Brunswick, leaving 100 customers without power. The total damage to property was $800,000.
- On June 14, 2004, unconfirmed reports of funnel clouds and tornadoes were received by the National Weather Service office in Sterling. Several areas across northern Maryland reported wind damage mainly due to downed trees and powerlines. Areas of damage included the region between Thurmont and Libertytown. The tornado was rated F1 with estimated winds of 75 mph. The initial tornado touchdown occurred 1.5 miles north of Woodsboro along Maryland Route 194 near a cement plant. The tornado tracked southeast mostly across farmland and wooded areas, uprooting and toppling trees along its path.
- On August 12, 2010, thunderstorms developed that produced damaging winds and large hail. Numerous trees were uprooted, and large limbs were snapped. The damage to trees and debris showed a convergent and weakly rotational pattern which suggests there was a weak tornado near and just north of Westvale Court. Total costs associated with the repair of roads and utilities, provided by Frederick County Division of Public Works, Department of Highway and Facility Maintenance, show $13,831 in damages.
- On April 16, 2011, an EF1 tornado developed from a strong low-pressure system causing a detached garage to collapse along New London Road. Shingles and siding were removed from a single-family home and softwood trees were snapped along New London Road. Numerous hardwood trees were uprooted or snapped, and barns were damaged or destroyed. Roofing panels were removed from a detached garage near Detrick Road and Old Annapolis Road. Six or more softwood trees were snapped, and pieces of large limbs and plywood were impaled in adjacent roofs. In addition, substantial tree damage was noted near Talbot Run Road. Pine trees were snapped near Buffalo Road and there was

also a report of siding and trim torn from a home near Buffalo Road. Property damages exceed $125,000.

- On May 17, 2011, an F0 tornado traveled more than a mile causing trees to snap and uproot along a track that began from south-southeast of the intersection of forest School Road and Brandenburg Hollow Road to southwest of the intersection of Garfield Road and John Cline Road. Minor shingle damage was noted to two structures. Siding was partially removed from a single-family home, where a backyard play center that had been bolted to the ground was snapped from its moorings and rolled.
- On June 20, 2015, an F0 tornado caused damage along a 1.5-mile path beginning near the intersection of Tuscarora Road and Buckeystown Pike, then moved northeast to Greenfield Road. Large tree branches were snapped halfway up and trees were nearly pushed over from south to north near the intersection of Tuscarora Road and Buckeystown Pike. Additional tree damage occurred at two residences just north of the intersection. Another small tree was snapped over in a southeast to northwest direction about one half mile north of the residences. A large tree was snapped over at the base in a north to south direction at a residence just off Buckeystown Pike near Greenfield Road. On the backside of the residence and along Greenfield Road, an additional large tree branch was also snapped in a north to south direction.

Tropical Cyclones

- On September 6, 2008, Tropical Storm Hanna entered Maryland resulting in heavy rain and severe winds in Frederick County. Tropical Storm Hanna tracked up the mid-Atlantic coast on the 6th with maximum sustained winds around 50 mph. Hanna originally made landfall near the border of North and South Carolina around 3:20 a.m. on the 6th. Hanna tracked across eastern North Carolina during the early afternoon hours before turning northeast across southeastern Virginia later in the afternoon. Hanna eventually tracked across the Chesapeake Bay and into Delaware during the evening hours. With Hanna's track to the east, the strongest winds were also confined to Frederick County's east; however, Hanna was still responsible for heavy rain along with tropical storm force winds across Maryland. Rainfall amounts totaled 4 to 8 inches in many locations. Numerous roads were closed throughout Maryland due to flash flooding. Tropical storm force winds were responsible for downed trees and power lines across Maryland as well. The worst conditions occurred during the late morning and afternoon hours as the storm passed by just to the east. A large tree was down between U.S. Route 15 (Southbound) and Point of Rocks Road.
- During Agnes in June 1972, two houses in the City of Frederick were flooded by an inadequate drainage ditch. The city spent more than $400,000 to purchase and demolish the structures, and clear asbestos and spilled heating oil from the properties.
- Additional detail on events captured under *Flooding* section.

APPENDIX D: CRITICAL FACILITY HAZARD ANALYSIS RESULTS

Table A.1 in this section lists the critical facilities in the county that fall into one or more hazard zones. The table begins with an explanation of the codes found for each hazard.

Table Key

Flood Zone

- X-unshaded = Facility located in area of minimal flood hazard, which are the areas outside the SFHA and higher than the elevation of the 0.2 percent annual chance flood (500-year flood)
- X-shaded = Facility located in area of moderate flood hazard between the limits of the base flood (100 year) and the 0.2 percent annual chance (500 year) flood
- A = Facility located in area subject to inundation by the 1 percent annual chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown.
- AE = Facility located in area subject to inundation by the 1 percent annual chance flood event determined by detailed methods.

Floodway

- Yes = Facility located in mapped floodway
- No = Facility not located in mapped floodway

Wildfire/Wildland Urban Interface

- Interface = Facility located in developed areas that abut wildland vegetation
- Intermix = Facility located in an area where structures and wildland vegetation intermingle
- Other = Facility not located in wildfire interface or intermix

Karst

- Yes = Facility located in an area that has risk of karst processes
- No = Facility not at risk of karst processes

Landslide

- High = High risk of being impacted by a landslide
- Medium = Medium risk of being impacted by a landslide
- Low = Low risk of being impacted by a landslide

Earthquake

- High = High risk of being impacted by an earthquake
- Medium = Medium risk of being impacted by an earthquake
- Low = Low risk of being impacted by an earthquake

Dam Inundation

- Hunting Creek Dam = Facility located in this dam inundation area
- None = Facility not located in a dam inundation area

Table 10. Critical Facilities Located Within Hazard Zones

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Brunswick									
Fire/EMS	Brunswick Volunteer Fire Company Station 5	1500 Volunteer Dr	X-unshaded	No	Other	No	Low	Low	None
Fire/EMS	Brunswick Vol Ambulance Co Station 19	200 W Potomac St	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Brunswick City Hall	1 W POTOMAC ST	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Brunswick Water Meter Department	600 PETERSVILLE AVE	X-unshaded	No	Other	No	Low	Low	None
Law Enforcement	Brunswick Police Department	20 East A Street	X-unshaded	No	Other	No	Low	Low	None
Library	Brunswick Branch Library	915 N Maple Ave, Brunswick, MD 21716	X-unshaded	No	Other	No	Low	Low	None
Medical Center	Life in the Country	6 FIONA WAY	X-unshaded	No	Other	No	Low	Low	None
Post office	Brunswick Post office	315 Brunswick Street	X-unshaded	No	Other	No	Low	Low	None
School	Brunswick Elementary	400 Central Avenue	X-unshaded	No	Other	No	Low	Low	None
School	Brunswick High	101 Cummings Avenue	X-unshaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
School	Brunswick Middle	301 Cummings Avenue	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Brunswick Shopping Center	52 Souder Rd	X-unshaded	No	Other	No	Low	Low	None
Transit Station	Brunswick Md Marc Transit Station		AE	No	Other	No	Low	Low	None
WWTP	Brunswick WWTP	20 CANAL TOWPATH ROAD EAST, Brunswick, MD 21716	AE	No	Other	No	Low	Low	None
Burkittsville									
Dry Hydrant	Dry Hydrant	Burkittsville Community Pond	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Burkittsville Town Hall	500 E MAIN ST	X-unshaded	No	Other	No	Low	Low	None
Post office	Burkittsville Post office	8 East Main Street	X-unshaded	No	Interface	No	Low	Low	None
Emmitsburg									
Fire/EMS	Vigilant Hose Company Station 6 Town of Emmitsburg	25 W Main St	X-unshaded	No	Interface	No	Low	Low	None
Government Facilities	Emmitsburg Town Hall	300A S SETON AVE	X-unshaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Library	Emmitsburg Public Library	300 S Seton Ave	X-unshaded	No	Interface	No	Low	Low	None
Post office	Emmitsburg Post office	305 South Seton Avenue	X-unshaded	No	Interface	No	Low	Low	None
School	Emmitsburg Elementary	300 S. Seton Avenue	X-unshaded	No	Other	No	Low	Low	None
WWTP	Town of Emmitsburg	16707 Creamery Rd	AE	No	Other	No	Low	Low	None
Frederick City									
Fire/EMS	Junior Fire Co Station 2	535 NORTH MARKET STREET	X-unshaded	No	Other	Yes	Low	Low	None
Fire/EMS	Citizens Truck Company Station 4	9 N Court St	X-unshaded	No	Other	Yes	Low	Low	None
Fire/EMS	United Steam Fire Engine Station 3	79 SOUTH MARKET STREET	X-unshaded	No	Other	Yes	Low	Low	None
Fire/EMS	Independent Hose Co Station 1	310 BAUGHMANS LANE	AE	Yes	Other	No	Low	Low	None
Fire/EMS	Frederick County Department of Fire and Rescue Services	340 Montevue Ln	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Fort Detrick	810 Schreider St, fort Detrick, MD 21702	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Government Facilities	Frederick City Department of Public Works	111AIRPORT DR E	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Frederick County Law Enforcement Center	110 AIRPORT DR E	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Frederick City Government offices	101 N COURT ST	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Frederick County Animal Control	1832 ROSEMONT AVE	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Frederick County Board of Education	191 S EAST ST	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Frederick County Economic Development	118 N MARKET ST	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Frederick County Winchester Hall	12 E CHURCH ST	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Frederick County Community Development Division	30 N MARKET ST	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Frederick County Courthouse	100 W PATRICK ST	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Frederick City offices (Annexed)	140 W PATRICK ST	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Government Facilities	Frederick County Extension Services	330 MONTEVUE LN	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Frederick County Health Services	350 MONTEVUE LN	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Frederick County Emergency Management	340 MONTEVUE LN	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Scott Key Center	1050 ROCKY SPRINGS RD	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Frederick County Transit	1040 ROCKY SPRINGS RD	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Frederick County Highway Operations	331 MONTEVUE LN	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Frederick County Parks and Recreation	355 MONTEVUE LN	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Frederick County Division of Public Works	355 MONTEVUE LN	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Montevue Assisted Living	1910 ROSEMONT AVE	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Frederick County Fleet Services	331 MONTEVUE LN	X-unshaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Government Facilities	Citizens Care and Rehabilitation Center	1920 ROSEMONT AVE	X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	Yes	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	Yes	Low	Low	None
Interchange	Interchange		AE	No	Other	Yes	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	Yes	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	Yes	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	Yes	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	Yes	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Law Enforcement	Frederick County Sheriff's Office	110 Airport Drive East	X-unshaded	No	Other	Yes	Low	Low	None
Law Enforcement	Frederick Police Department	100 West Patrick Street	X-unshaded	No	Other	Yes	Low	Low	None
Library	C. Burr Artz Public Library	110 E Patrick St, Frederick, MD 21701	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Frederick Health Hospital	400 West Seventh Street	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Medical Center	College View Center	700 TOLL HOUSE AVENUE	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Record Street Home - Home for The Aged	115 RECORD STREET	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Sunrise of Frederick	990 WATERFORD DRIVE	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Warm Heart Family Assistance Living Ii	752 DOGWOOD COURT	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Heartfields at Frederick	1820 LATHAM DRIVE	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Homewood at Crumland Farms	7407 WILLOW ROAD	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Frederick Health & Rehabilitation Center	30 NORTH PLACE	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Northampton Manor	200 EAST 16TH STREET	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Montevue Assisted Living	1910 ROSEMONT AVENUE	X-unshaded	No	Other	No	Low	Low	None
Medical Center	Tranquility at Fredericktowne	6441 JEFFERSON PIKE	X-unshaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Medical Center	Ballenger Creek Center	347 BALLENGER CENTER DRIVE	X-unshaded	No	Other	No	Low	Low	None
Medical Center	Citizens Care and Rehabilitation Center of Frederick	1920 ROSEMONT AVENUE	X-unshaded	No	Other	No	Low	Low	None
Medical Center	Somerford Place - Frederick	2100-B WHITTIER DRIVE	X-unshaded	No	Interface	No	Low	Low	None
Medical Center	Somerford House - Frederick	2100-A WHITTIER DRIVE	X-unshaded	No	Interface	No	Low	Low	None
Post office	College Estates Post office	1301 W 7th St	X-unshaded	No	Other	Yes	Low	Low	None
Post office	Frederick Post office	201 East Patrick Street	X-unshaded	No	Other	Yes	Low	Low	None
School	Heather Ridge (High)	1445 Taney Avenue	X-unshaded	No	Other	Yes	Low	Low	None
School	Heather Ridge (Middle)	1445 Taney Avenue	X-unshaded	No	Other	Yes	Low	Low	None
School	Heather Ridge (Twilight)	1445 Taney Avenue	X-unshaded	No	Other	Yes	Low	Low	None
School	Monocacy Elementary	7421 Hayward Road	X-unshaded	No	Other	Yes	Low	Low	None
School	Frederick High	650 Carroll Parkway	X-unshaded	No	Other	Yes	Low	Low	None
School	West Frederick Middle	515 West Patrick Street	X-unshaded	No	Other	Yes	Low	Low	None
School	Parkway Elementary	300 Carroll Parkway	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
School	Monocacy Middle	8009 Opossumtown Pike	X-unshaded	No	Other	Yes	Low	Low	None
School	North Frederick Elementary	1001 Motter Avenue	X-unshaded	No	Other	Yes	Low	Low	None
School	Governor Thomas Johnson Middle	1799 Schifferstadt Blvd.	X-unshaded	No	Other	Yes	Low	Low	None
School	Career & Technology Center	7922 Opossumtown Pike	X-unshaded	No	Other	Yes	Low	Low	None
School	Lincoln Elementary	200 Madison Street	X-unshaded	No	Other	Yes	Low	Low	None
School	Governor Thomas Johnson High	1501 Market Street	X-unshaded	No	Other	Yes	Low	Low	None
School	Butterfly Ridge Elementary	601 Contender Way	X-unshaded	No	Other	No	Low	Low	None
School	Hillcrest Elementary	1285 Hillcrest Drive	X-unshaded	No	Other	No	Low	Low	None
School	Waverley Elementary	201 Waverly Drive	X-unshaded	No	Interface	No	Low	Low	None
School	Whittier Elementary	2400 Whittier Drive	X-unshaded	No	Interface	No	Low	Low	None
Shopping Center	Frederick Shopping Center	1305 W 7th Street	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Rosemont Center	1713 Rosemont Ave	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Shopping Center	Eastgate Shopping Center	1202 E Patrick St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	South Market Center	50 Carroll Creek Way	X-shaded	No	Other	Yes	Low	Low	None
Shopping Center	Downtown Frederick	22 S. Market St., Suite 2A	X-shaded	No	Other	Yes	Low	Low	None
Shopping Center	Creekside Plaza	50 Citizens Way	X-shaded	No	Other	Yes	Low	Low	None
Shopping Center	Frederick Shoppers World	1275 W Patrick St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Frederick County Square	101 West Patrick St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Taskers Chance Village Center	Baughmans Ln & Key Pkwy	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Westridge Square Shopping Center	1053 W Patrick St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Golden Mile Gateway (Proposed)	W Patrick St & Baughmans Lane	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Thomas Johnson Center	181 Thomas Johnson Dr	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Shopping Center	Amber Meadows Shopping Center	Opossumtown Pike & TJ Dr	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Rosehill Plaza	1564 Opossumtown Pike	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	College Park Plaza	901 W 7th St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Riverside Center	1811 Monocacy Blvd	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	East Street Plaza	509 East St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Eveready Square/Shab Row	125 North East St.	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Willowtree Plaza	5 Willowdale Dr	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Vista Shops at Golden Mile	1080 W Patrick St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Rockledge Plaza	1100 W Patrick St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Cellular One Plaza	1170 W Patrick St	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Shopping Center	McCain Center	4 S McCain Dr	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Golden Mile Market Place	1304 W Patrick St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Patrick Street Shopping Center	467 W Patrick St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Fairview Center	1003 W 7th St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Clemson Corner Shopping Center	7820 Wormans Mill Road	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Monocacy Village Center	900 N East St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Monocacy Shopping Center	1700 Kingfisher Dr	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Fairground Center	430 E Patrick St	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Waverly Center	45 Waverly Dr	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Frederick Towne Mall	1301 W. Patrick St.	X-shaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Shopping Center	Stonegate Center	1517 W Patrick St	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Westpointe Plaza	1440 W Patrick St	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Old Farm Station	Yellow Springs Rd & Old Farm Dr	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Festival of Frederick	430 Prospect Blvd	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Prospect Plaza Shopping Center	429 S Jefferson St	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Vienna Plaza	1507 W Patrick St	X-unshaded	No	Interface	No	Low	Low	None
Shopping Center	Whittier Lakefront Center	2401 Whittier Dr.	X-unshaded	No	Interface	No	Low	Low	None
Transit Station	Frederick Transit Station		X-shaded	No	Other	Yes	Low	Low	None
WWTP	Frederick City WWTP	111 Airport Dr E, Frederick, MD 21701	X-unshaded	No	Other	Yes	Low	Low	None
WWTP	fort Detrick WWTP	1780 N Market St, Frederick, MD 21701	X-unshaded	No	Other	Yes	Low	Low	None
Middletown									

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Dry Hydrant	Dry Hydrant	In community pond at Middletown Park	X-unshaded	No	Other	No	Low	Low	None
Fire/EMS	Middletown Volunteer Fire Company Station 7	13 SOUTH CHURCH STREET	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Middletown Town Hall	31 W MAIN ST	X-unshaded	No	Other	No	Low	Low	None
Library	Middletown Public Library	101 Prospect St, Middletown, MD 21769	X-unshaded	No	Other	No	Low	Low	None
School	Middletown Elementary	201 Green Street	X-unshaded	No	Other	No	Low	Low	None
School	Middletown High	200 Schoolhouse Dr	X-unshaded	No	Other	No	Low	Low	None
School	Middletown Middle	100 Schoolhouse Dr	X-unshaded	No	Other	No	Low	Low	None
School	Middletown Primary	403 Franklin Street	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Town Center Plaza	Old National Pike	X-unshaded	No	Other	No	Low	Low	None
Mount Airy									
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Law Enforcement	Mount Airy Police Department	2 Park Avenue	X-unshaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
School	Twin Ridge Elementary	1106 Leafy Hollow Circle	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Mt. Airy Shopping Plaza	1502 S Main St	X-unshaded	No	Other	No	Low	Low	None
WWTP	Mount Airy WWTP	1750 S Andy Griffith Pkwy, Mt Airy, NC 27030	X-unshaded	No	Other	No	Low	Low	None
Myersville									
Fire/EMS	Myersville Volunteer Fire Company Station 8	301 Main St	X-unshaded	No	Interface	No	Low	Low	None
Government Facilities	Myersville Town Hall (Municipal Center)	301 Main St	X-unshaded	No	Interface	No	Low	Low	None
Library	Myersville Community Library	8 Harp Place	X-unshaded	No	Interface	No	Low	Low	None
Interchange	Interchange of I-70 and MD Rt 17	I-70 and MD Rt 17	X-unshaded	No	Other	No	Low	Low	None
Post office	Myersville Post office	1 Wolfsville Road	X-unshaded	No	Interface	No	Low	Low	None
School	Myersville Elementary	429 Main Street	X-unshaded	No	Interface	No	Low	Low	None
WTP	Myersville WTP	Easterday Road	X-unshaded	No	Interface	No	Low	Low	None
WWTP	Myersville WWTP	Milt Summers Road	X-unshaded	No	Interface	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
New Market									
Dry Hydrant	Dry Hydrant	Emory Alley	X-unshaded	No	Other	No	Low	Low	None
Fire/EMS	New Market District Vol Fire Co Station 15	76 WEST MAIN STREET	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	New Market Town Hall	39 W MAIN ST	X-unshaded	No	Other	No	Low	Low	None
Post office	New Market Post office	168 West Main Street	X-unshaded	No	Other	No	Low	Low	None
School	New Market Elementary	93 West Main Street	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	New Market Antique Dealers Association	Old National Pike	X-unshaded	No	Other	No	Low	Low	None
Rosemont									
Dry Hydrant	Dry Hydrant	Rosemont Lions Club on Petersville Road	X-unshaded	No	Other	No	Low	Low	None
Thurmont									
Fire/EMS	Guardian Hose Company Station 10	21 NORTH CHURCH STREET	X-unshaded	No	Interface	No	Low	Low	None
Fire/EMS	Thurmont Ambulance Company Station 30	27 NORTH CHURCH STREET	X-unshaded	No	Interface	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Government Facilities	Thurmont Town Hall	10 FREDERICK RD	X-shaded	No	Interface	No	Low	Low	None
Interchange	Interchange		X-shaded	No	Other	No	Low	Low	Hunting Creek Dam
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Law Enforcement	Thurmont Police Department	800 E Main St	X-unshaded	No	Other	Yes	Low	Low	None
Library	Thurmont Regional Library	76 E Moser Rd, Thurmont, MD 21788	X-unshaded	No	Intermix	Yes	Low	Low	Hunting Creek Dam
Post office	Thurmont Post office	110 Water Street	X-shaded	No	Interface	No	Low	Low	None
School	Thurmont Middle	408 East Main Street	X-unshaded	No	Interface	Yes	Low	Low	None
School	Thurmont Primary	7989 Rocky Ridge Road	X-unshaded	No	Other	No	Low	Low	None
School	Thurmont Elementary	805 East Main Street	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Thurmont Plaza	N Church St & Woodside Ave	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Mountain Gate Plaza	130 Frederick Rd	X-unshaded	No	Interface	No	Low	Low	Hunting Creek Dam
Shopping Center	Historic Cozy Village	103 Frederick Rd.	X-shaded	No	Other	No	Low	Low	Hunting Creek Dam

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Shopping Center	Orchard Village	209 Tippin Dr	X-unshaded	No	Interface	No	Low	Low	None
WWTP	Thurmont WWTP	74 E Moser Rd, Thurmont, MD 21788	X-shaded	No	Intermix	Yes	Low	Low	Hunting Creek Dam
Walkersville									
Fire/EMS	Walkersville Volunteer Fire Company Station 11	79 FREDERICK STREET	X-unshaded	No	Other	Yes	Low	Low	None
Fire/EMS	Walkersville Vol Ambulance Company Station 24	73 FREDERICK STREET	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Walkersville Town Hall	21 W FREDERICK ST	X-unshaded	No	Other	Yes	Low	Low	None
Library	Walkersville Library	2 S. Glade Road	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Glade Valley Center	56 WEST FREDERICK STREET	X-unshaded	No	Other	Yes	Low	Low	None
Post office	Walkersville Post office	7 East Frederick Street	X-unshaded	No	Other	Yes	Low	Low	None
School	Rock Creek School	55 B West Frederick Street	X-unshaded	No	Other	Yes	Low	Low	None
School	Walkersville Middle	55 W Frederick Street	X-unshaded	No	Other	Yes	Low	Low	None
School	Walkersville Elementary	83 W Frederick Street	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
School	Walkersville High	81 W Frederick Street	X-unshaded	No	Other	Yes	Low	Low	None
School	Glade Elementary	9525 Glade Road	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Walkers Village Shopping Center	Woodsboro Pike & Glade Blvd	X-unshaded	No	Other	Yes	Low	Low	None
Woodsboro									
Fire/EMS	Woodsboro Vol Fire Company Station 16	2 SOUTH 3RD STREET	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Woodsboro Town office	2 S THIRD ST	X-unshaded	No	Other	Yes	Low	Low	None
Post office	Woodsboro Post office	602 South Main Street	X-unshaded	No	Other	Yes	Low	Low	None
School	Woodsboro Elementary	101 Liberty Road	X-unshaded	No	Other	Yes	Low	Low	None
Unincorporated									
Dry Hydrant	Dry Hydrant	8349 Reichs ford Rd	X-unshaded	No	Other	Yes	Low	Low	None
Dry Hydrant	Dry Hydrant	7907 Dance Hall Rd	X-unshaded	No	Intermix	Yes	Low	Low	None
Dry Hydrant	Dry Hydrant	1550 New Design Rd	X-unshaded	No	Other	Yes	Low	Low	None
Dry Hydrant	Dry Hydrant	Roddy Road, near Roddy Covered Bridge	X-shaded	No	Other	Yes	Low	Low	None
Dry Hydrant	Dry Hydrant	12027 South St	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Dry Hydrant	Dry Hydrant	500 W. Main St.	AE	No	Intermix	No	Low	Low	Hunting Creek Dam
Dry Hydrant	Dry Hydrant	16000 Foxville-Deerfield Rd	X-shaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	On bridge at Covell Rd, near Thurston Rd	AE	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	Lakeview Drive	AE	No	Interface	No	Low	Low	None
Dry Hydrant	Dry Hydrant	Sugarloaf Mountain Rd/ Comus Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	Mink Farm Rd\Tower Rd	X-unshaded	No	Intermix	No	Low	Low	None
Dry Hydrant	Dry Hydrant	8316 Rocky Ridge Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	Western fire pond on Route 77 in Rocky Ridge	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	Eastern fire pond on Route 77 in Rocky Ridge	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	12606 Creagerstown Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	Intersection of Mud College & Orndorff Roads	X-unshaded	No	Interface	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Dry Hydrant	Dry Hydrant	Next to Boat Ramp on Catoctin Hollow Road	X-shaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	6319 Mountain Church Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	9201 Frostown Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	2085 Old National Pike	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	14109 Pleasant Valley Rd	X-unshaded	No	Intermix	No	Low	Low	None
Dry Hydrant	Dry Hydrant	11441 Weller Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	12000 Beaver Dam Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	9201 Church St	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	9002 Clemsonville Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	12337 Legore Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	On Poffenberger Rd., at bridge over Catoctin Creek	AE	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	13000 Woodsboro Pike	AE	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	7705 Utica Rd	AE	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Dry Hydrant	Dry Hydrant	12045 Woodsboro Pike	AE	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	12500 Simpsons Mill Rd	AE	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	Old Frederick Rd, near Loys Station covered bridge	AE	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	10940 Hessong Bridge Rd	AE	No	Intermix	No	Low	Low	None
Dry Hydrant	Dry Hydrant	1200 Park Mills Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	4701 East Basford Rd	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	Intersection of Hamburg & Fishing Creek Roads	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	5509 Mount Zion Rd.	X-unshaded	No	Other	No	Low	Low	None
Dry Hydrant	Dry Hydrant	10132 Hansonville Rd	X-unshaded	No	Other	No	Low	Low	None
Fire/EMS	Westview Fire Station 31	5525 NEW DESIGN ROAD	X-unshaded	No	Other	Yes	Low	Low	None
Fire/EMS	Adamstown Vol Fire Company Station 14	2795 Adams St	X-unshaded	No	Other	Yes	Low	Low	None
Fire/EMS	Libertytown Vol Fire Co Station 17	12027 SOUTH STREET	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Fire/EMS	Graceham Vol Fire Company Station 18	14026 Graceham Road	X-unshaded	No	Intermix	No	Low	Low	None
Fire/EMS	Rocky Ridge Vol Fire Company Station 13	13516 MOTTERS STATION ROAD	X-unshaded	No	Other	No	Low	Low	None
Fire/EMS	Braddock Heights Vol Fire Co Station 12	6715 JEFFERSON BOULEVARD	X-unshaded	No	Intermix	No	Low	Low	None
Fire/EMS	Jefferson Vol Fire Company Station 20	4603 LANDER ROAD	X-unshaded	No	Interface	No	Low	Low	None
Fire/EMS	Wolfsville Vol Fire Company Station 21	12464 Wolfsville Road	X-unshaded	No	Interface	No	Low	Low	None
Fire/EMS	New Midway Volunteer Fire Company Station 9	12045 WOODSBORO PIKE	X-unshaded	No	Other	No	Low	Low	None
Fire/EMS	Green Valley Fire Station 25	3939 GREEN VALLEY ROAD	X-unshaded	No	Other	No	Low	Low	None
Fire/EMS	Urbana Vol Fire Company Station 23	3602 URBANA PIKE	X-unshaded	No	Other	No	Low	Low	None
Fire/EMS	New Midway Volunteer Fire Company	12012 Woodsboro Pike	X-unshaded	No	Other	No	Low	Low	None
Fire/EMS	Spring Ridge Fire Station 33	6061 Spring Ridge Pkwy	X-unshaded	No	Other	No	Low	Low	None
Fire/EMS	Lewistown District Vol Fire Company Station 22	11101 Hessong Bridge Road	X-unshaded	No	Interface	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Fire/EMS	Point of Rocks Fire Station 28	1809 BALLENGER CREEK PIKE	X-unshaded	No	Interface	No	Low	Low	None
Government Facilities	Naval Support Facility Thurmont (Camp David)	Catoctin Mountain Park, Maryland 21788	X-unshaded	No	Other	No	Low	Low	None
Government Facilities	Frederick County Adult Detention Center	7300 MARCIES CHOICE LN	X-unshaded	No	Other	Yes	Low	Low	None
Government Facilities	Frederick County Public Safety Training Facility	5370 PUBLIC SAFETY PL	X-unshaded	No	Other	Yes	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	Yes	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	Yes	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	Yes	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Interface	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Interchange	Interchange		X-unshaded	No	Other	No	Low	Low	None
Landfill	Frederick County Division of Solid Waste and Recycling Landfill	9031 Reichs ford Rd, Frederick, MD 21704	X-unshaded	No	Intermix	No	Low	Low	None
Law Enforcement	Maryland Natural Resources Police - Western Region Echo Lake office (Area 7)	2011 Monument Road	X-unshaded	No	Other	No	Low	Low	None
Library	Urbana Regional Library	9020 Amelung St, Frederick, MD 21704	X-unshaded	No	Other	No	Low	Low	None
Library	Edward F. Fry Memorial Library at Point of Rocks	1635 Ballenger Creek Pike, Point of Rocks, MD 21777	X-unshaded	No	Other	No	Low	Low	None
Medical Center	Devotion Assisted Living LLC	8531 INSPIRATION AVENUE	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Medical Center	Country Meadows of Frederick	5955 QUINN ORCHARD DRIVE	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Bethany Living Ii	5135 CHARLINGTON COURT	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Buckingham's Choice	3200 BAKER CIRCLE	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Integrace Buckingham's Choice	3200 BAKER CIRCLE	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	Cozy Care	12803 BOXWOOD COURT	X-unshaded	No	Other	Yes	Low	Low	None
Medical Center	St Joseph's Ministries	331 SOUTH SETON AVENUE	X-unshaded	No	Other	No	Low	Low	None
Medical Center	Vindobona Nursing and Rehabilitation Center	6012 JEFFERSON BLVD	X-unshaded	No	Intermix	No	Low	Low	None
Medical Center	Fiddler's Green at Edenton	5911 GENESIS LANE	X-unshaded	No	Other	No	Low	Low	None
Medical Center	Garden House at Edenton	5849 GENESIS LANE	X-unshaded	No	Other	No	Low	Low	None
Medical Center	Orchard Terrace at Edenton	5905 EDENTON COURT	X-unshaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Medical Center	Blossom Place at Edenton	5901 GENESIS LANE	X-unshaded	No	Other	No	Low	Low	None
Medical Center	Sunset Ridge Assisted Living, Inc.	7021 ROCK CREEK DRIVE	X-unshaded	No	Interface	No	Low	Low	None
Post office	Point of Rocks Post office	1597 Bowis Drive	X-unshaded	No	Other	Yes	Low	Low	None
Post office	Buckeystown Post office	4001 Buckeystown Pike	X-unshaded	No	Other	Yes	Low	Low	None
Post office	Adamstown Post office	5337 Mountville Road	X-unshaded	No	Other	Yes	Low	Low	None
Post office	Tuscarora Post office	5709a Tuscarora Road	X-unshaded	No	Other	Yes	Low	Low	None
Post office	Rocky Ridge Post office	13516 Motters Station Road	X-unshaded	No	Other	No	Low	Low	None
Post office	Sabillasville Post office	17235 Sabillasville Road	X-unshaded	No	Interface	No	Low	Low	None
Post office	Braddock Heights Post office	4707 Schley Avenue	X-unshaded	No	Other	No	Low	Low	None
Post office	Middletown Post office	7227 Hollow Road	X-unshaded	No	Other	No	Low	Low	None
Post office	Jefferson Post office	3702 Jefferson Pike	X-unshaded	No	Interface	No	Low	Low	None
Post office	Ladiesburg Post office	12509 Woodsboro Pike	X-unshaded	No	Other	No	Low	Low	None
Post office	Libertytown Post office	11941 Main Street	X-unshaded	No	Other	No	Low	Low	None
Post office	Monrovia Post office	4411 Green Valley Road	X-unshaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Post office	New Midway Post office	12048A Woodsboro Pike	X-unshaded	No	Other	No	Low	Low	None
School	Ballenger Creek Elementary	5250 Kingsbrook Drive	X-unshaded	No	Other	Yes	Low	Low	None
School	Crestwood Middle	7100 Foxcroft Drive	X-unshaded	No	Other	Yes	Low	Low	None
School	Tuscarora Elementary	6321 Lambert Drive	X-unshaded	No	Other	Yes	Low	Low	None
School	Carroll Manor Elementary	5624 Adamstown Road	X-unshaded	No	Other	Yes	Low	Low	None
School	Catoctin High	14745 Sabillasville Road	X-unshaded	No	Other	No	Low	Low	None
School	Sabillasville Elementary	16210-B Sabillasville Road	X-unshaded	No	Interface	No	Low	Low	None
School	Valley Elementary	3519 Jefferson Pike	X-unshaded	No	Other	No	Low	Low	None
School	Wolfsville Elementary	12520 Wolfsville Road	X-unshaded	No	Interface	No	Low	Low	None
School	Oakdale High	5850 Eaglehead Drive	X-unshaded	No	Other	No	Low	Low	None
School	Spring Ridge Elementary	9051 Ridgefield Drive	X-unshaded	No	Other	No	Low	Low	None
School	Centerville Elementary	3601 Carriage Hill Drive	X-unshaded	No	Other	No	Low	Low	None
School	Sugarloaf Elementary	3400 Stone Barn Drive	X-unshaded	No	Other	No	Low	Low	None
School	Urbana Elementary	3554 Urbana Pike	X-unshaded	No	Other	No	Low	Low	None
School	Liberty Elementary	11820 Liberty Road	X-unshaded	No	Intermix	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
School	New Market Middle	125 West Main Street	X-unshaded	No	Other	No	Low	Low	None
School	Linganore High	12013 Old Annapolis Road	X-unshaded	No	Other	No	Low	Low	None
School	Oakdale Elementary	5830 Oakdale School Rd	X-unshaded	No	Other	No	Low	Low	None
School	Oakdale Middle	5810 Oakdale School Rd	X-unshaded	No	Other	No	Low	Low	None
School	Deer Crossing Elementary	10601 Finn Drive	X-unshaded	No	Other	No	Low	Low	None
School	Windsor Knolls Middle	1150 Windsor Road	X-unshaded	No	Other	No	Low	Low	None
School	Green Valley Elementary	11501 Fingerboard Road	X-unshaded	No	Other	No	Low	Low	None
School	Urbana High	3471 Campus Drive	X-unshaded	No	Other	No	Low	Low	None
School	Urbana Middle	3511 Pontius Court	X-unshaded	No	Other	No	Low	Low	None
School	New Midway Elementary	12226 Woodsboro Pike	X-unshaded	No	Other	No	Low	Low	None
School	Kemptown Elementary	3456 Kemptown Church Road	X-unshaded	No	Other	No	Low	Low	None
School	Tuscarora High	5312 Ballenger Creek Pike	X-unshaded	No	Other	No	Low	Low	None
School	Ballenger Creek Middle	5525 Ballenger Creek Pike	X-unshaded	No	Other	No	Low	Low	None
School	Orchard Grove Elementary	5898 Hannover Drive	X-unshaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
School	Yellow Springs Elementary	8717 Yellow Springs Road	X-unshaded	No	Interface	No	Low	Low	None
School	Lewistown Elementary	11119 Hessong Bridge Road	X-unshaded	No	Interface	No	Low	Low	None
Shopping Center	Westview Promanade	5200 Buckeystown Pike	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Riverview Plaza	5473 Urbana Pike	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Discovery Shopping Center	8415 Woodsboro Pike	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Frederick Crossing	7210 Guilford Drive	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Evergreen Square	5732 Buckeystown Pike	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Francis Scott Key Mall	5500 Buckeystown Pike	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Kingsbrook Crossing	5316 New Design Rd	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Crestwood Plaza	New Design Rd & Crestwood Blvd	X-unshaded	No	Other	Yes	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Shopping Center	Pointe Plaza	5801 Buckeystown Pike	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Key Plaza	5600 Urbana Pike	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Gateway Shops	5599 Spectrum Drive	X-unshaded	No	Other	Yes	Low	Low	None
Shopping Center	Jefferson Junction	3880 Roundtree Road	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Braddock Heights Village Center	4707 Schely Ave	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Libertytown Shopping Center	11339 Liberty Rd	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Spring Ridge Shopping Center	6093 Spring Ridge Parkway	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Green Valley Center	11801 Fingerboard Rd	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Urbana Village Center	3335 Worthington Blvd	X-unshaded	No	Other	No	Low	Low	None
Shopping Center	Ballenger Creek Plaza	5840 Ballenger Creek Pike	X-unshaded	No	Other	No	Low	Low	None

Facility Type	Critical Facility Name	Site Address	Flood Zone	Floodway	Wildland Urban Interface	Karst	Landslide	Earthquake	Dam Inundation Zone
Transit Station	Monocacy Transit Station		X-unshaded	No	Other	Yes	Low	Low	None
WWTP	Ballenger Creek WWTP	End of Marcies Choice Lane, Frederick, MD 21704	X-shaded	No	Other	Yes	Low	Low	None

APPENDIX E: MAPS

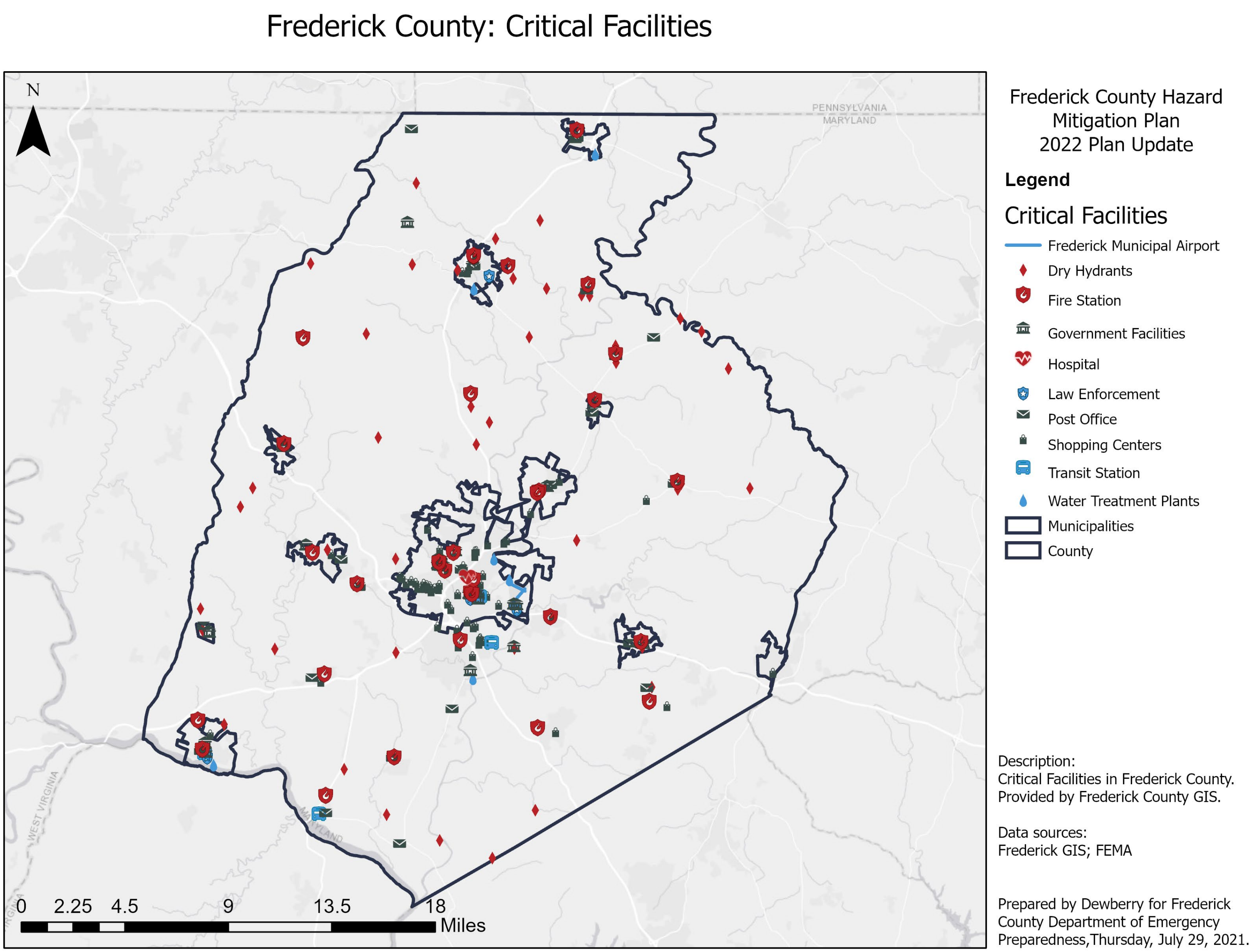
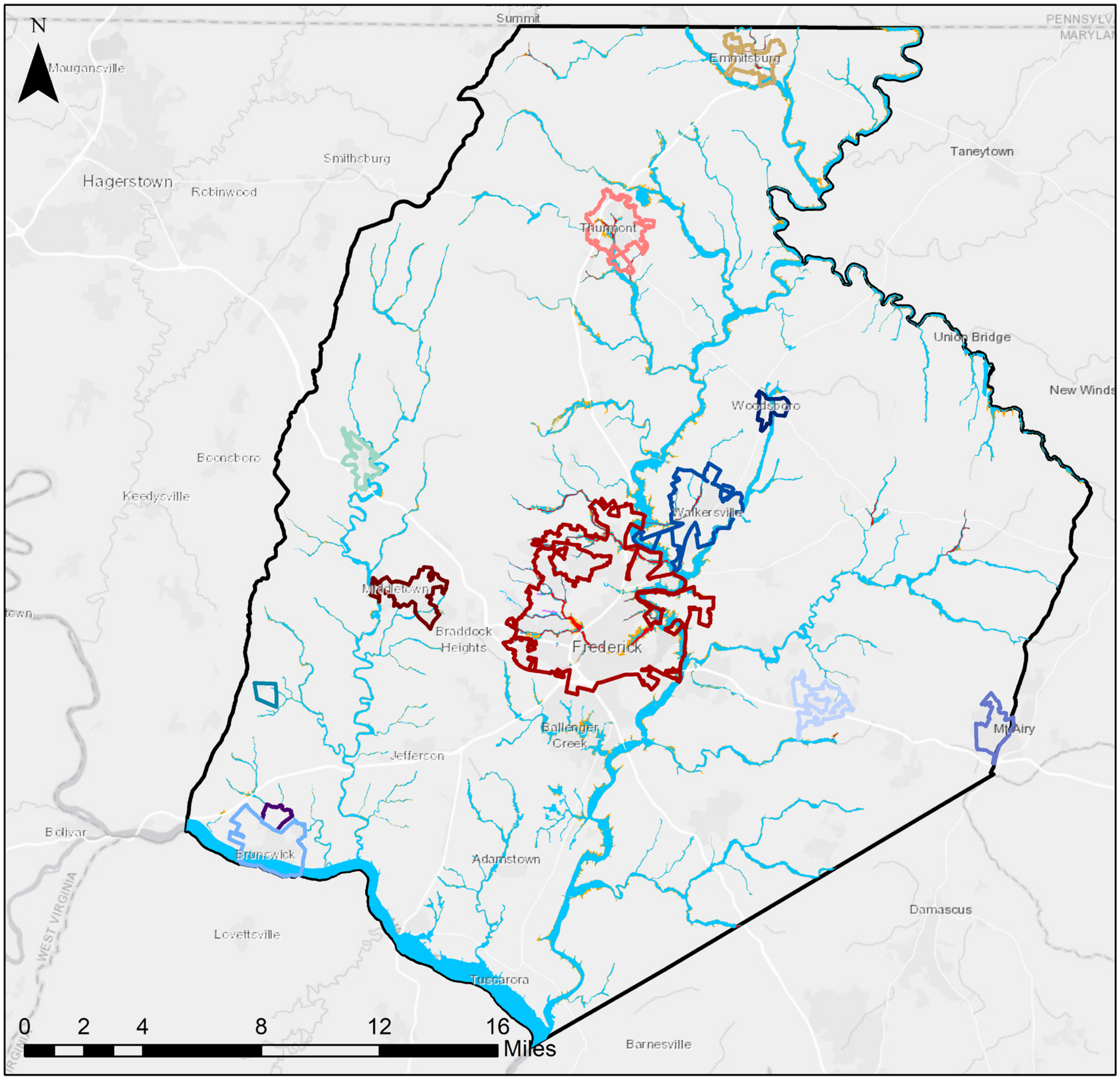


Figure 10 Frederick County Critical Facilities

Frederick County Hazard Mitigation Plan 2022 Plan Update

Frederick County Flood Hazard Areas



Legend

Local Jurisdictions
- City of Brunswick
- City of Frederick
- Town of Burkittsville
- Town of Emmitsburg
- Town of Middletown
- Town of Mount Airy
- Town of Myersville
- Town of New Market
- Town of Thurmont
- Town of Walkersville
- Town of Woodsboro
- Village of Rosemont

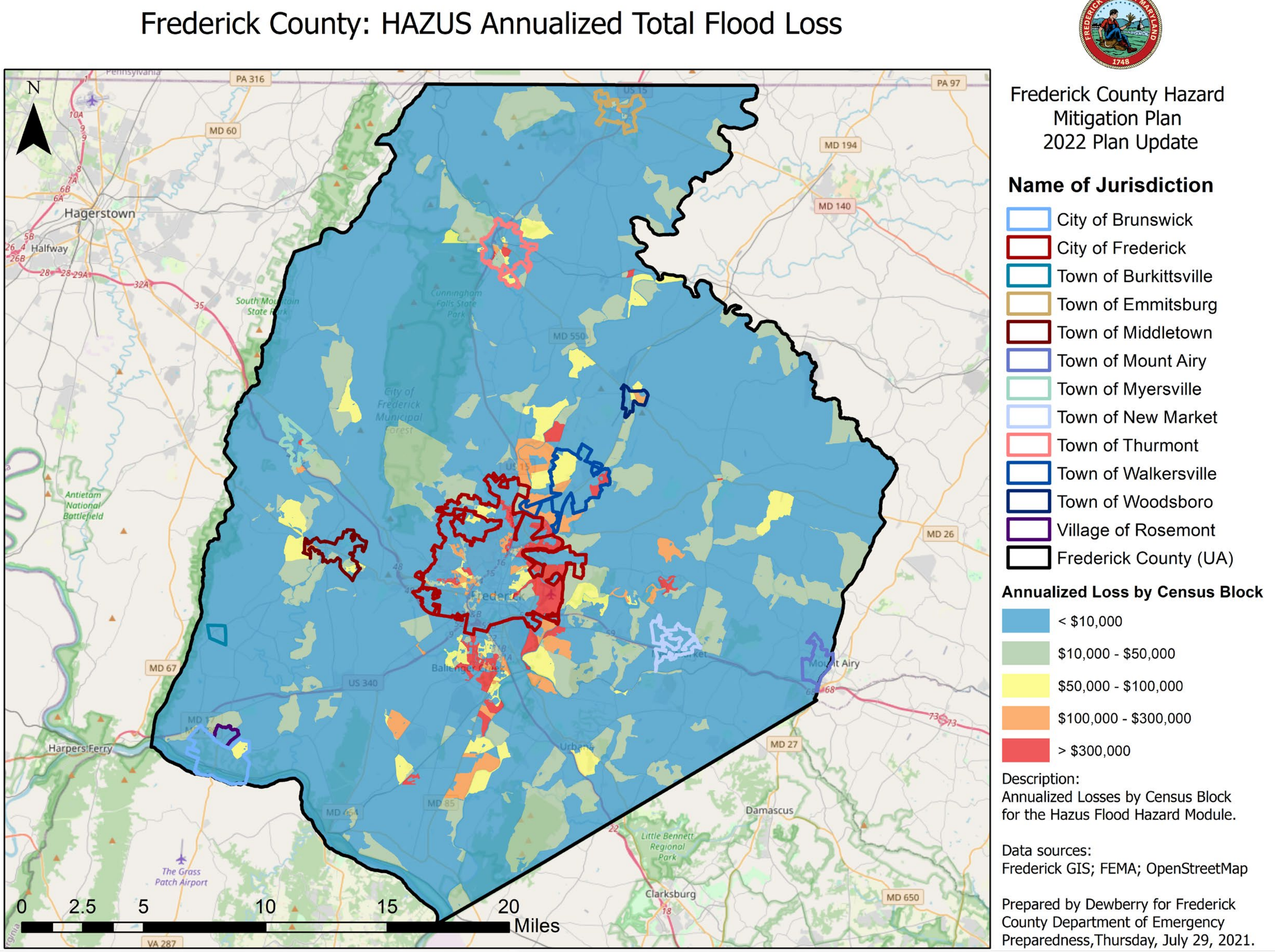
FEMA Flood Zones
- Zone A
- Zone AE
- Zone AO
- Floodway
- Zone X, Shadded
- Frederick County (UA)

Description:
Location of FEMA Flood Zones within Frederick County, Maryland.

Data sources:
FEMA
Frederick County GIS

Prepared by Dewberry for Frederick County Department of Emergency Preparedness, Thursday, July 29, 2021.

Figure 11: Frederick County Special Flood Hazard Area (SFHA)


Frederick County: HAZUS Annualized Total Flood Loss
Frederick County Hazard Mitigation Plan 2022 Plan Update
Name of Jurisdiction
City of Brunswick
City of Frederick
Town of Burkittsville
Town of Emmitsburg
Town of Middletown
Town of Mount Airy
Town of Myersville
Town of New Market
Town of Thurmont
Town of Walkersville
Town of Woodsboro
Village of Rosemont
Frederick County (UA)
Annualized Loss by Census Block
< $10,000
$10,000 - $50,000
$50,000 - $100,000
$100,000 - $300,000
> $300,000
Description:
Annualized Losses by Census Block for the Hazus Flood Hazard Module.
Data sources:
Frederick GIS; FEMA; OpenStreetMap
Prepared by Dewberry for Frederick County Department of Emergency Preparedness,Thursday, July 29, 2021.
0 2.5 5 10 15 20 Miles
N

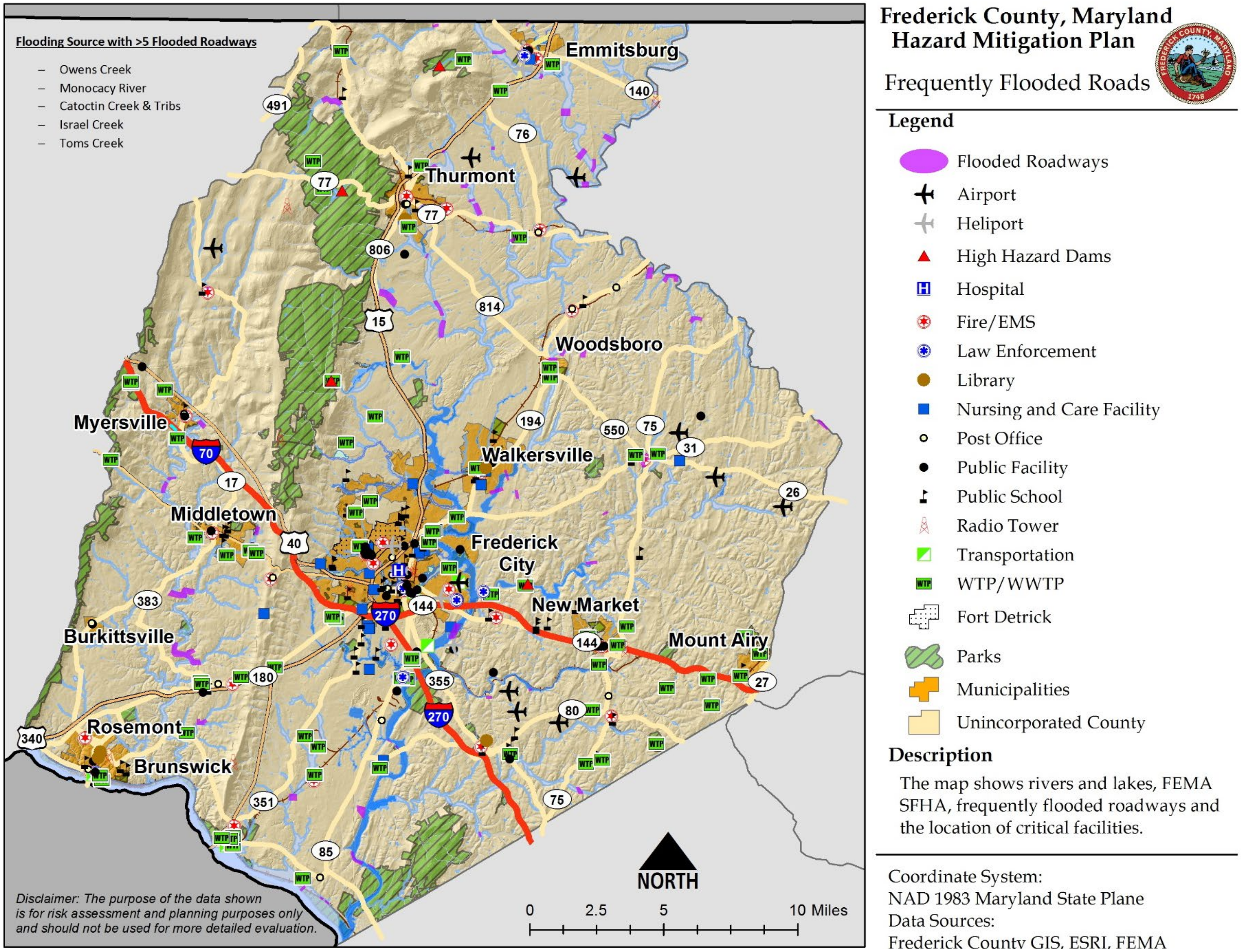
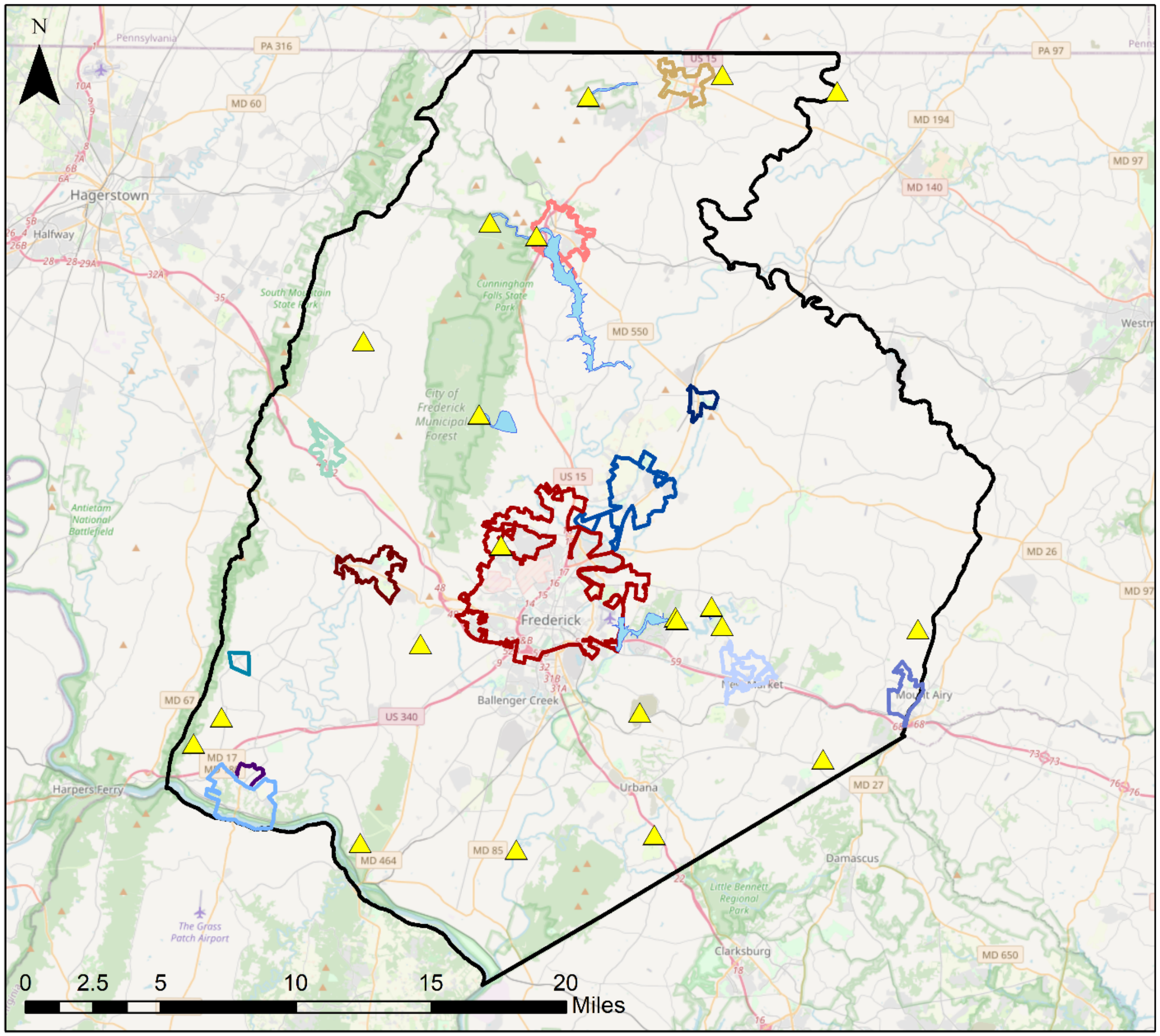


Figure 13 Frederick County Frequently Flooded Roads

Frederick County



Frederick County Hazard Mitigation Plan
2022 Plan Update

Name of Jurisdiction

- Frederick County (UA)
- City of Brunswick
- City of Frederick
- Town of Burkittsville
- Town of Emmitsburg
- Town of Middletown
- Town of Mount Airy
- Town of Myersville
- Town of New Market
- Town of Thurmont
- Town of Walkersville
- Town of Woodsboro
- Village of Rosemont

- Dams
- Dam Inundation Zones

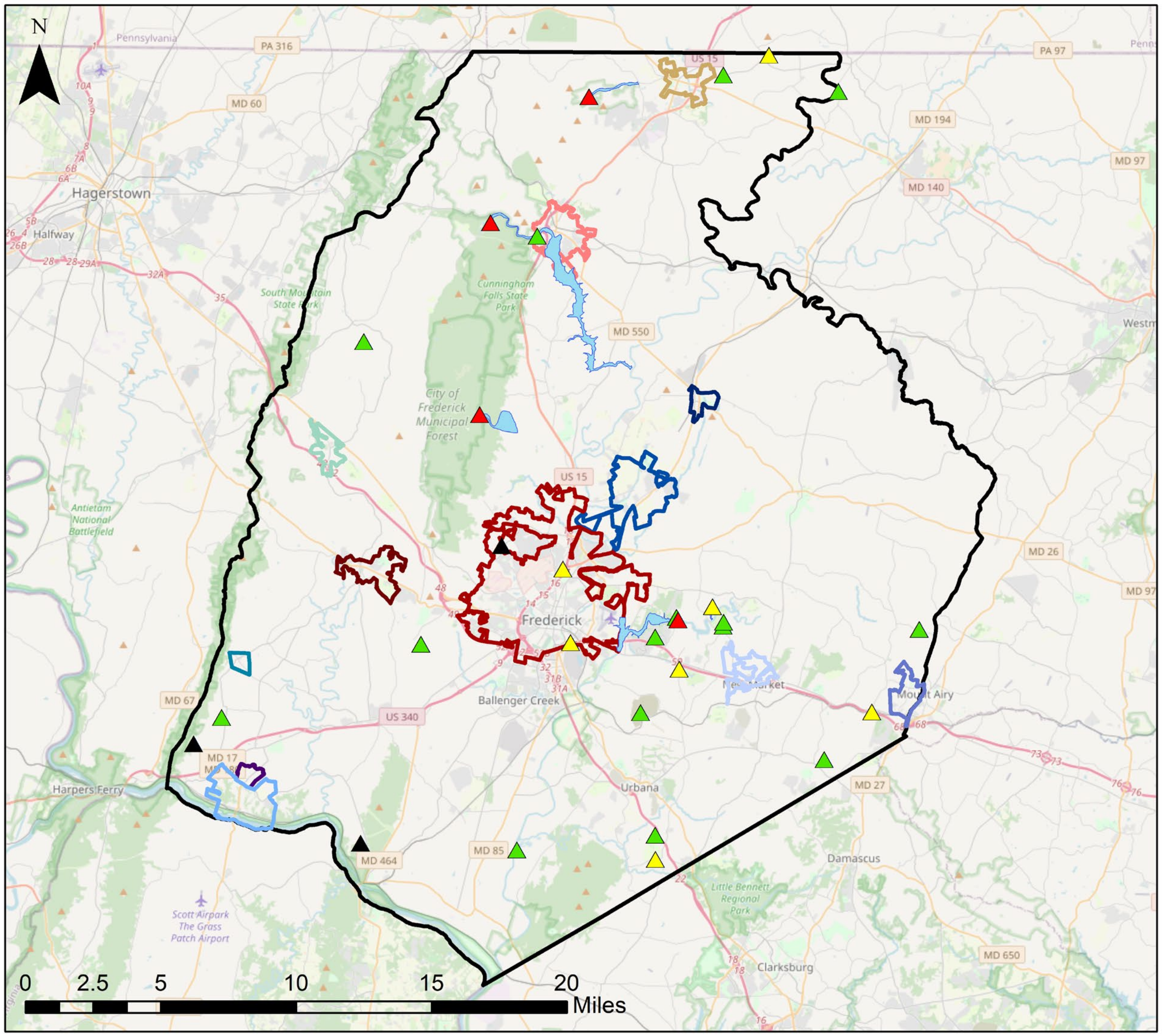
Description:
Location of the 21 dams in Frederick County. Only 5 of these dams have Inundation Zones assocaited with them.

Data Sources:
Frederick County GIS; FEMA; OpenStreetMap

Prepared by Dewberry for Frederick County Department of Emergency Preparedness,Thursday, July 29, 2021.

Figure 14 Frederick County Dam Inundation Zones

Frederick County: Dam Hazard Potential



Frederick County Hazard Mitigation Plan 2022 Plan Update

Name of Jurisdiction

- Frederick County (UA)
- City of Brunswick
- City of Frederick
- Town of Burkittsville
- Town of Emmitsburg
- Town of Middletown
- Town of Mount Airy
- Town of Myersville
- Town of New Market
- Town of Thurmont
- Town of Walkersville
- Town of Woodsboro
- Village of Rosemont

Hazard Potential

- HIGH
- SIGNIFICANT
- LOW
- UNDETERMINED
- Dam Inundation Zones

Description:
Location of the 29 dams in Frederick County. Only 5 of these dams have Inundation Zones assocaited with them.

Data Sources:
Frederick County GIS; FEMA; OpenStreetMap

Prepared by Dewberry for Frederick County Department of Emergency Preparedness,Thursday, July 29, 2021.

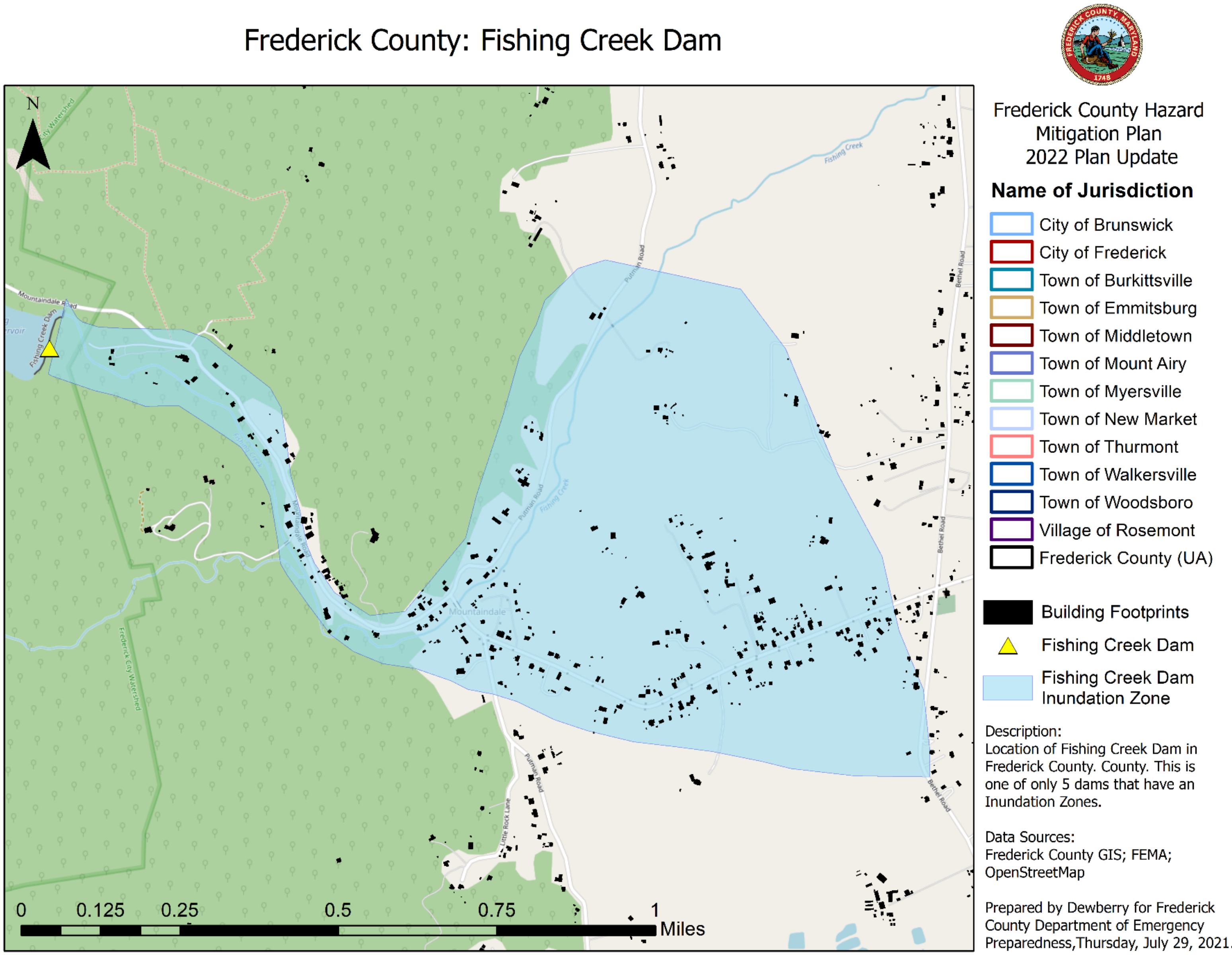
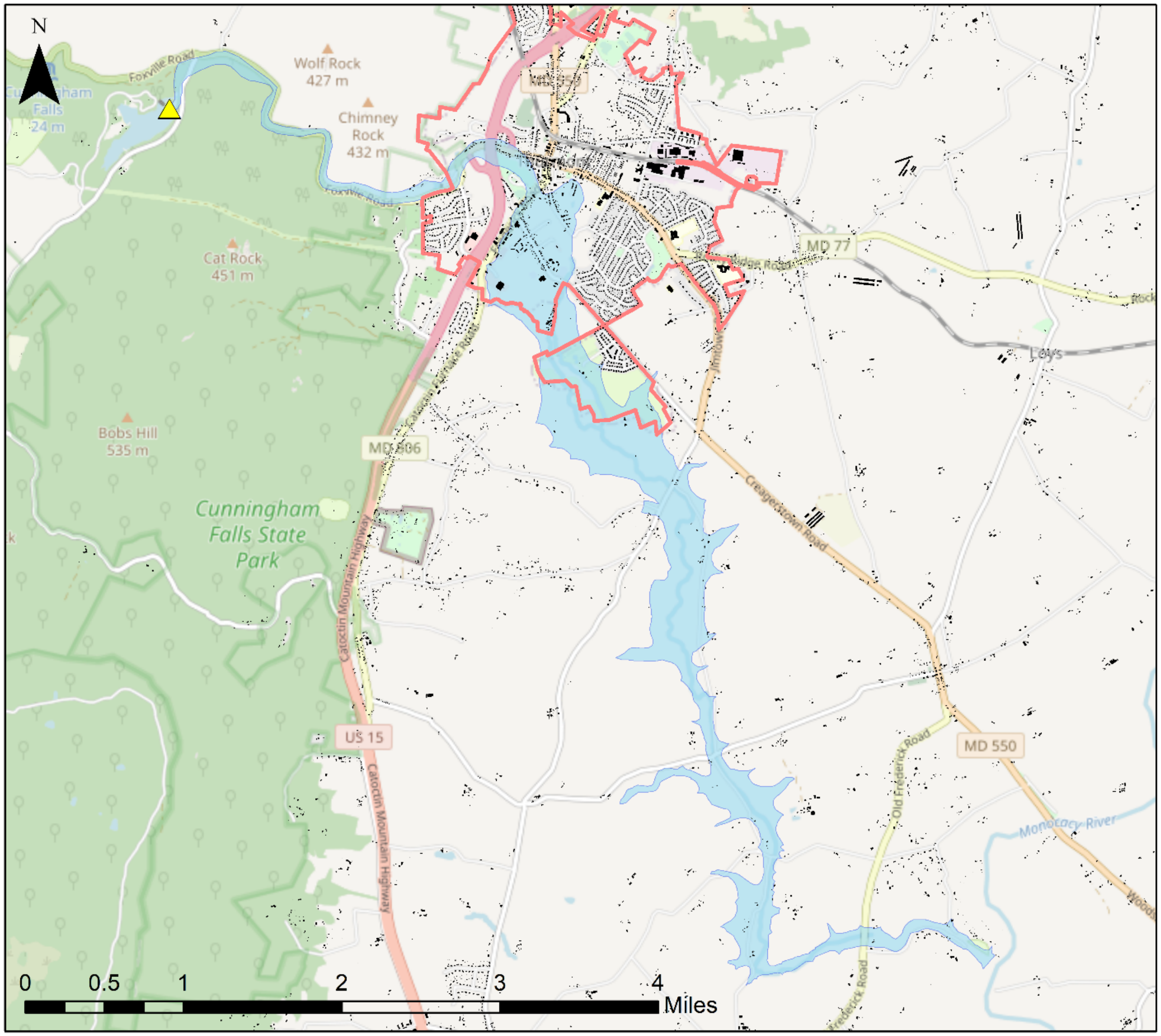


Figure 16 Fishing Creek Dam Inundation Zone

Frederick County: Hunting Creek Dam



Frederick County Hazard Mitigation Plan 2022 Plan Update

Name of Jurisdiction

- City of Brunswick
- City of Frederick
- Town of Burkittsville
- Town of Emmitsburg
- Town of Middletown
- Town of Mount Airy
- Town of Myersville
- Town of New Market
- Town of Thurmont
- Town of Walkersville
- Town of Woodsboro
- Village of Rosemont
- Frederick County (UA)

- Building Footprints
- Hunting Creek Dam
- Hunting Creek Dam Inundation Zone

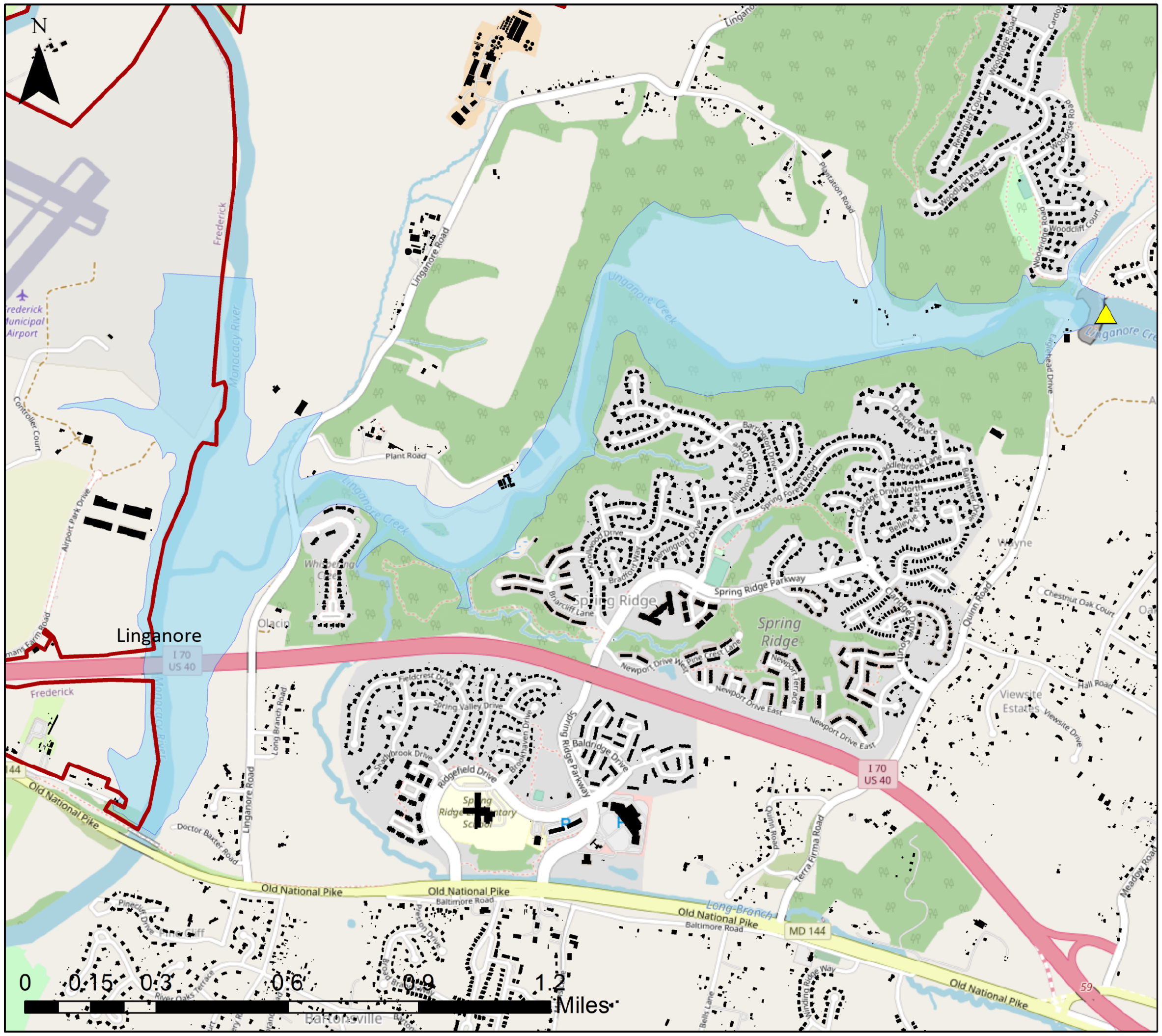
Description:
Location of Hunting Creek Dam in Frederick County. County. This is one of only 5 dams that have an Inundation Zones.

Data Sources:
Frederick County GIS; FEMA; OpenStreetMap

Prepared by Dewberry for Frederick County Department of Emergency Preparedness,Thursday, July 29, 2021.

F

Frederick County: Lake Linganore Dam



Frederick County Hazard Mitigation Plan 2022 Plan Update

Name of Jurisdiction

- City of Brunswick
- City of Frederick
- Town of Burkittsville
- Town of Emmitsburg
- Town of Middletown
- Town of Mount Airy
- Town of Myersville
- Town of New Market
- Town of Thurmont
- Town of Walkersville
- Town of Woodsboro
- Village of Rosemont
- Frederick County (UA)

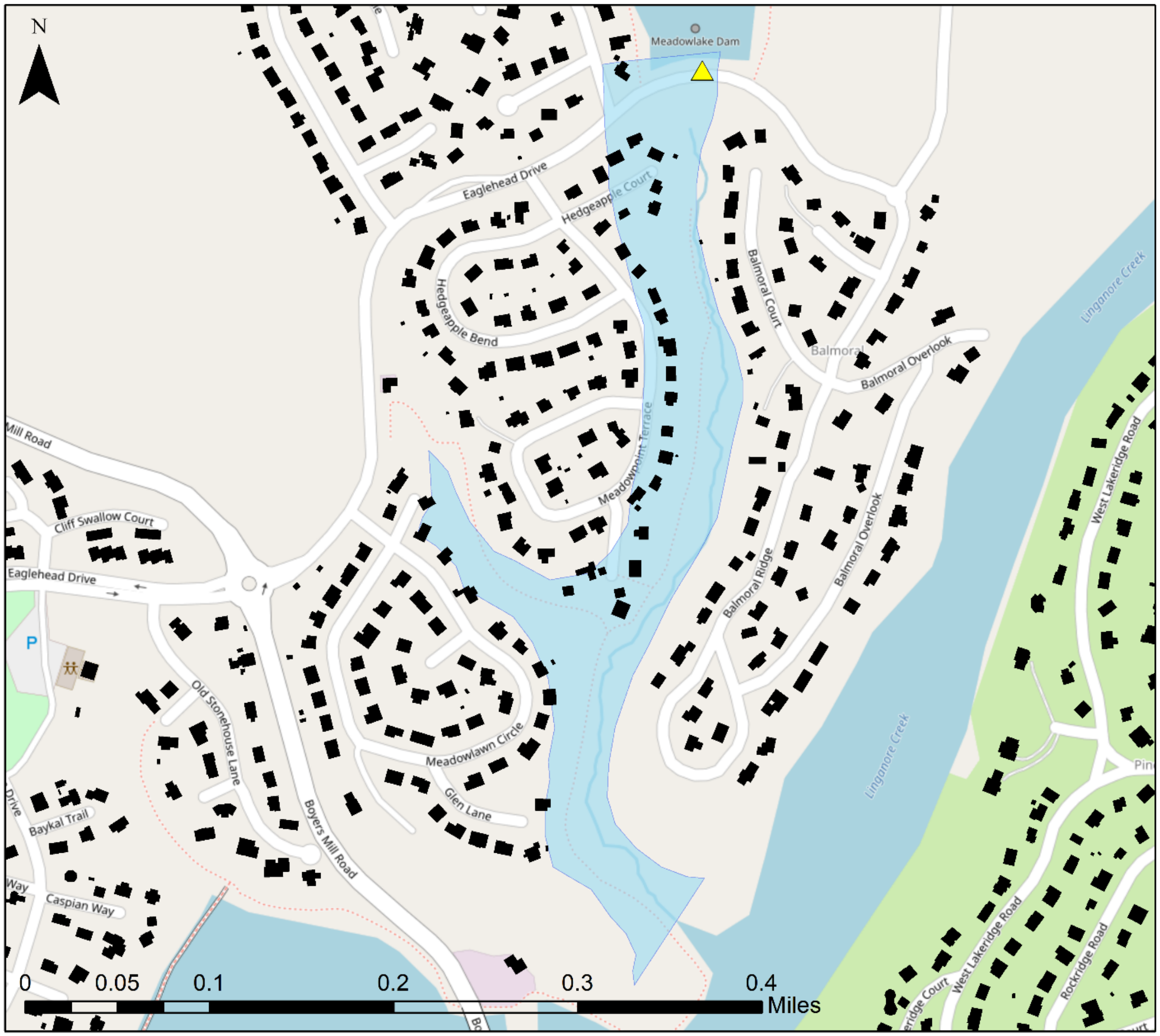
- Building Footprints
- Lake Linganore
- Lake Linganore Dam Inundation Zone

Description:
Location of Lake Linganore Dam in Frederick County. County. This is one of only 5 dams that have an Inundation Zones.

Data Sources:
Frederick County GIS; FEMA; OpenStreetMap

Prepared by Dewberry for Frederick County Department of Emergency Preparedness,Thursday, July 29, 2021.

Frederick County: Lake Merle Dam



Frederick County Hazard Mitigation Plan 2022 Plan Update

Name of Jurisdiction

- City of Brunswick
- City of Frederick
- Town of Burkittsville
- Town of Emmitsburg
- Town of Middletown
- Town of Mount Airy
- Town of Myersville
- Town of New Market
- Town of Thurmont
- Town of Walkersville
- Town of Woodsboro
- Village of Rosemont
- Frederick County (UA)

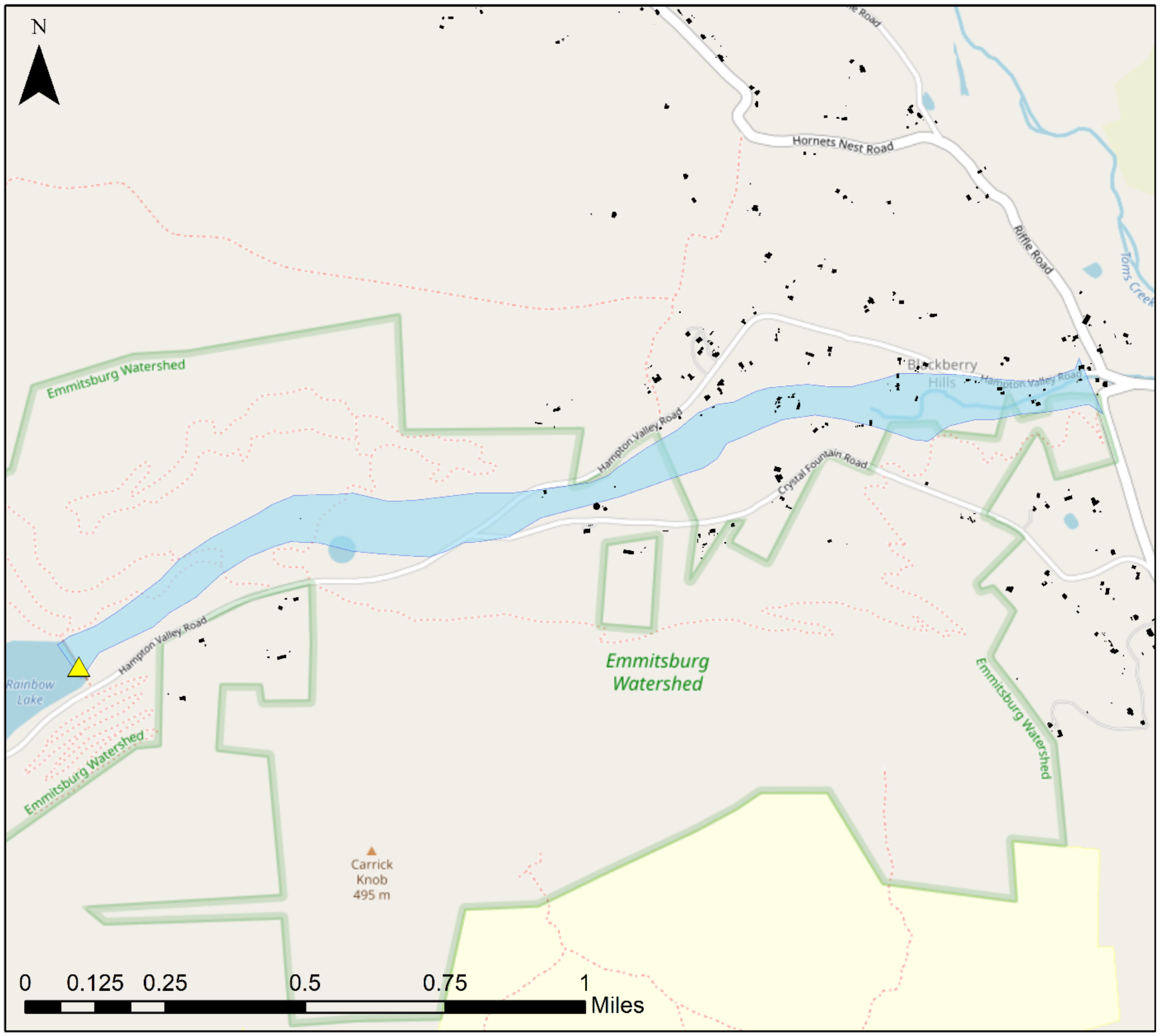
- Building Footprints
- Lake Merle Dam
- Lake Merle Dam Inundation Zone

Description:
Location of Lake Merle Dam in Frederick County. County. This is one of only 5 dams that have an Inundation Zones.

Data Sources:
Frederick County GIS; FEMA; OpenStreetMap

Prepared by Dewberry for Frederick County Department of Emergency Preparedness,Thursday, July 29, 2021.

Frederick County: Rainbow Dam



Frederick County Hazard Mitigation Plan
2022 Plan Update

Name of Jurisdiction

- City of Brunswick
- City of Frederick
- Town of Burkittsville
- Town of Emmitsburg
- Town of Middletown
- Town of Mount Airy
- Town of Myersville
- Town of New Market
- Town of Thurmont
- Town of Walkersville
- Town of Woodsboro
- Village of Rosemont
- Frederick County (UA)

- Building Footprints
- Rainbow Dam
- Rainbow Dam Inundation Zone

Description:
Location of Rainbow Dam in Frederick County. County. This is one of only 5 dams that have an Inundation Zones.

Data Sources:
Frederick County GIS; FEMA; OpenStreetMap

Prepared by Dewberry for Frederick County Department of Emergency Preparedness,Thursday, July 29, 2021.

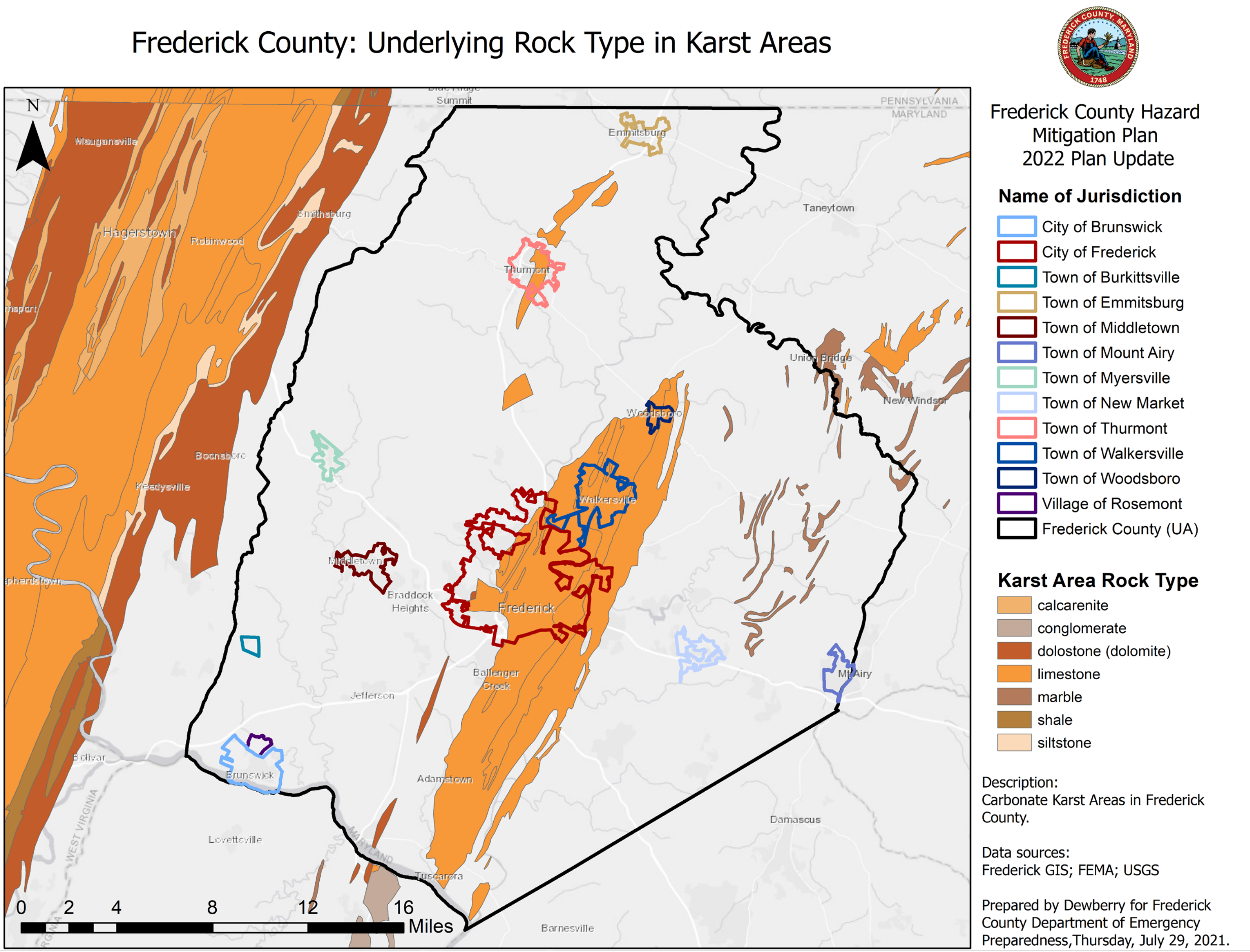


Figure 21 Frederick County Karst Area Rock Types

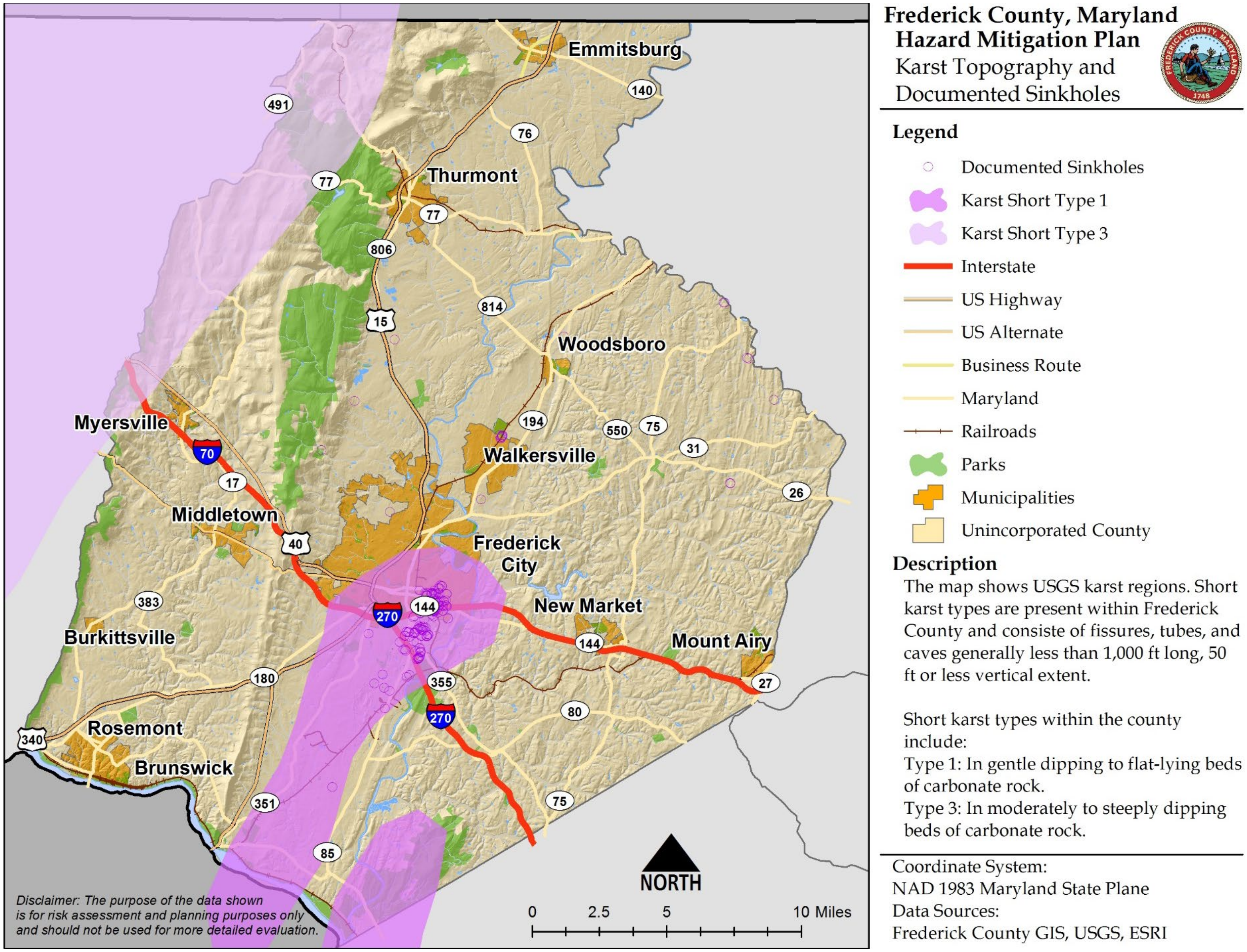
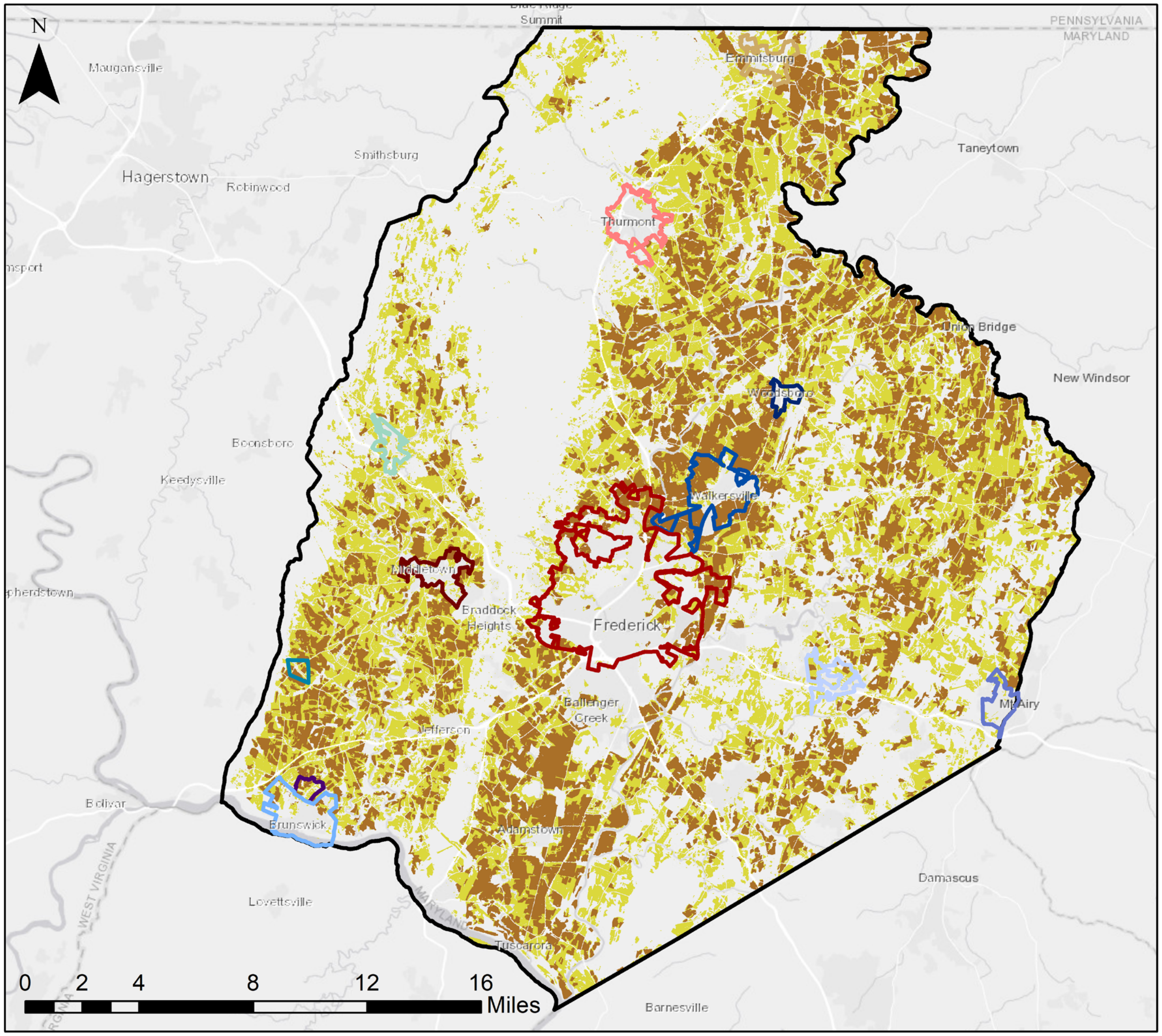


Figure 22 Karst Topography and Documented Sinkholes

Frederick County: National Land Cover Database Agriculture Areas



Frederick County Hazard Mitigation Plan 2022 Plan Update

Name of Jurisdiction

- City of Brunswick
- City of Frederick
- Town of Burkittsville
- Town of Emmitsburg
- Town of Middletown
- Town of Mount Airy
- Town of Myersville
- Town of New Market
- Town of Thurmont
- Town of Walkersville
- Town of Woodsboro
- Village of Rosemont
- Frederick County (UA)

Land Use / Land Cover

- Hay/Pasture
- Cultivated Crops

Description:
2016 National Land Cover Database agricultureal areas. Consist of the Hay/ Pasture and Cultivated Crop classes.

Data sources:
Frederick GIS; FEMA; NLCD 2016

Prepared by Dewberry for Frederick County Department of Emergency Preparedness,Thursday, July 29, 2021.

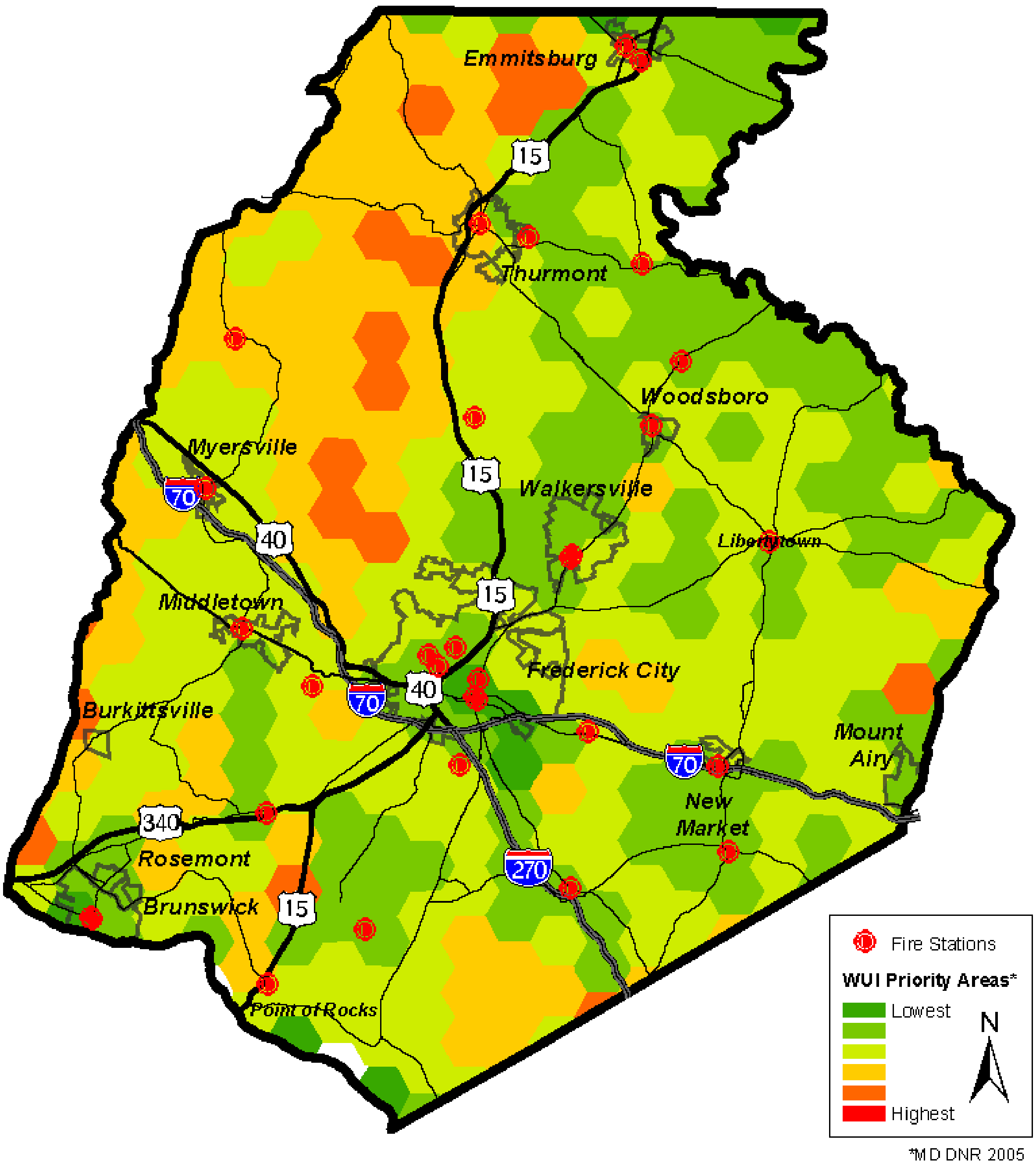


Figure 24 Frederick County Fire Hazard Potential

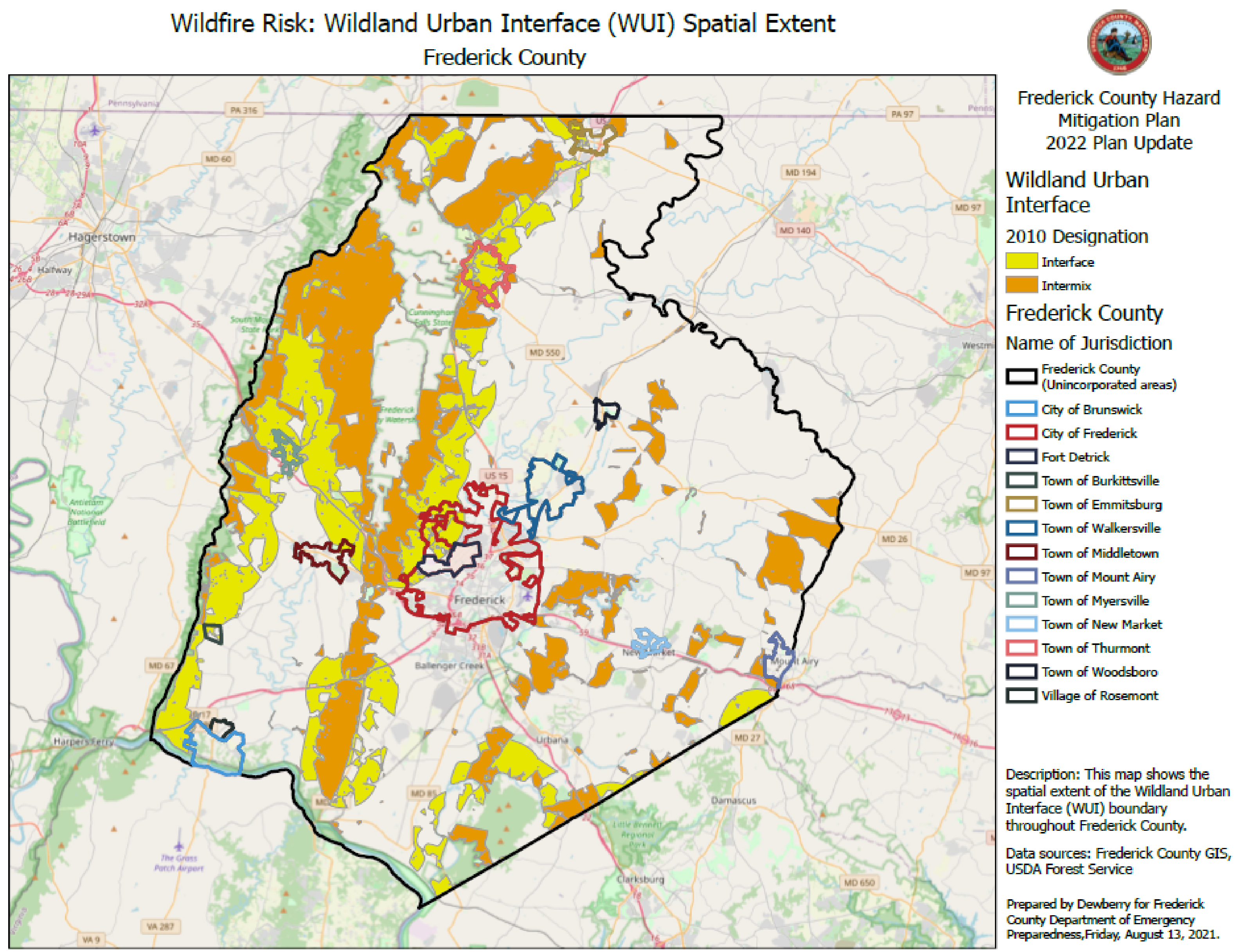


Figure 25 Frederick County Wildland Urban Interface

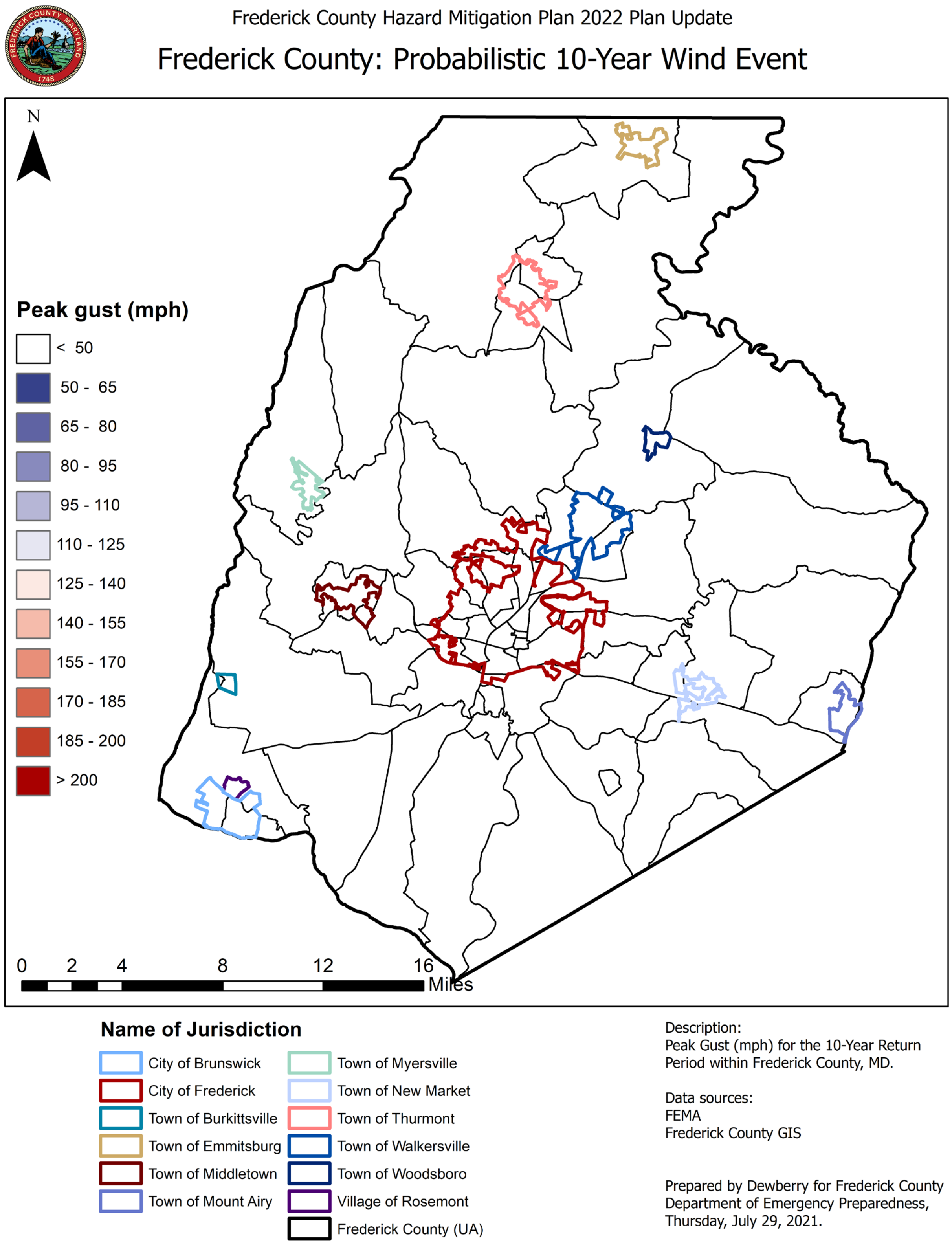


Figure 26 Frederick County 10-Year Wind Event

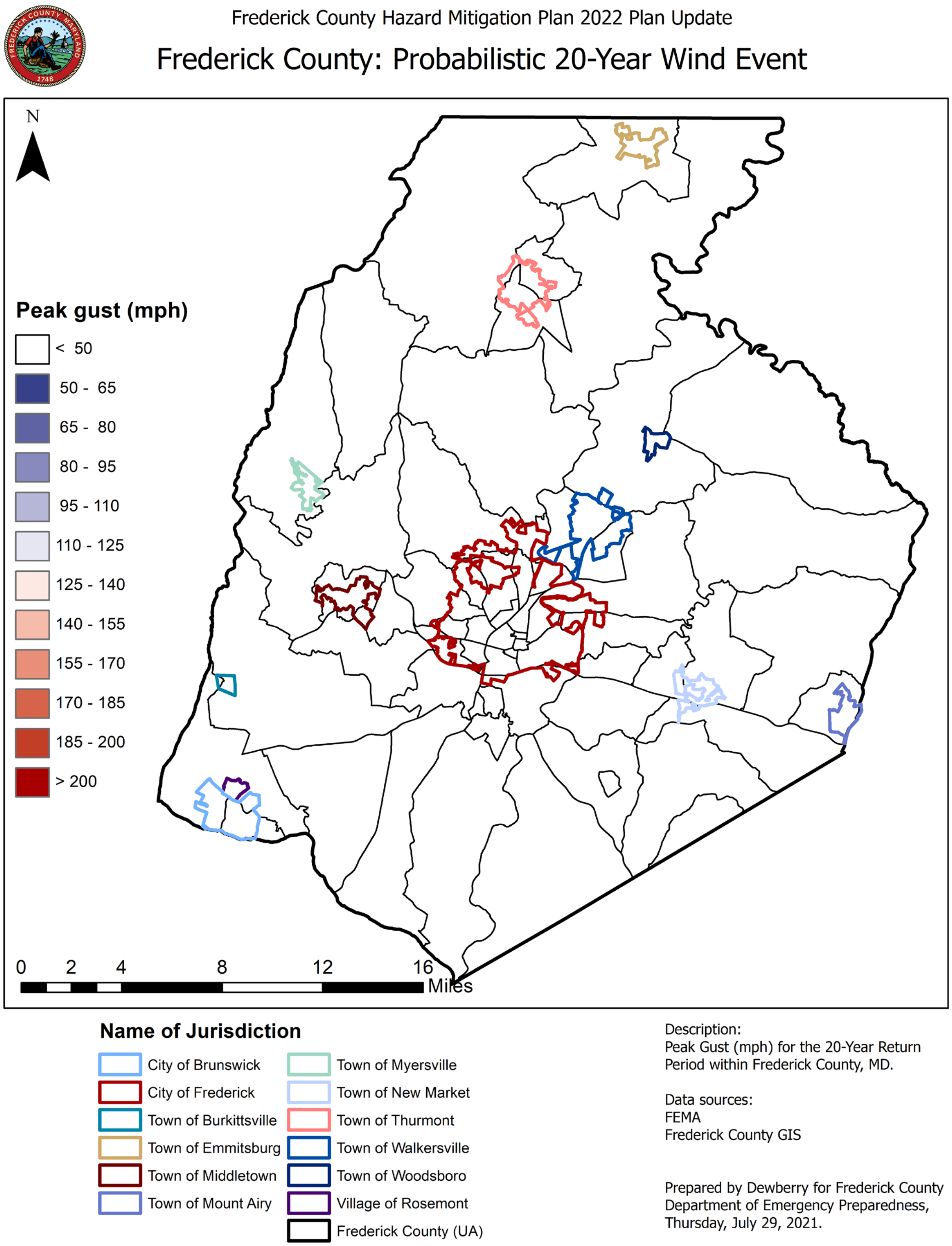


Figure 27 Frederick County 20-Year Wind Event

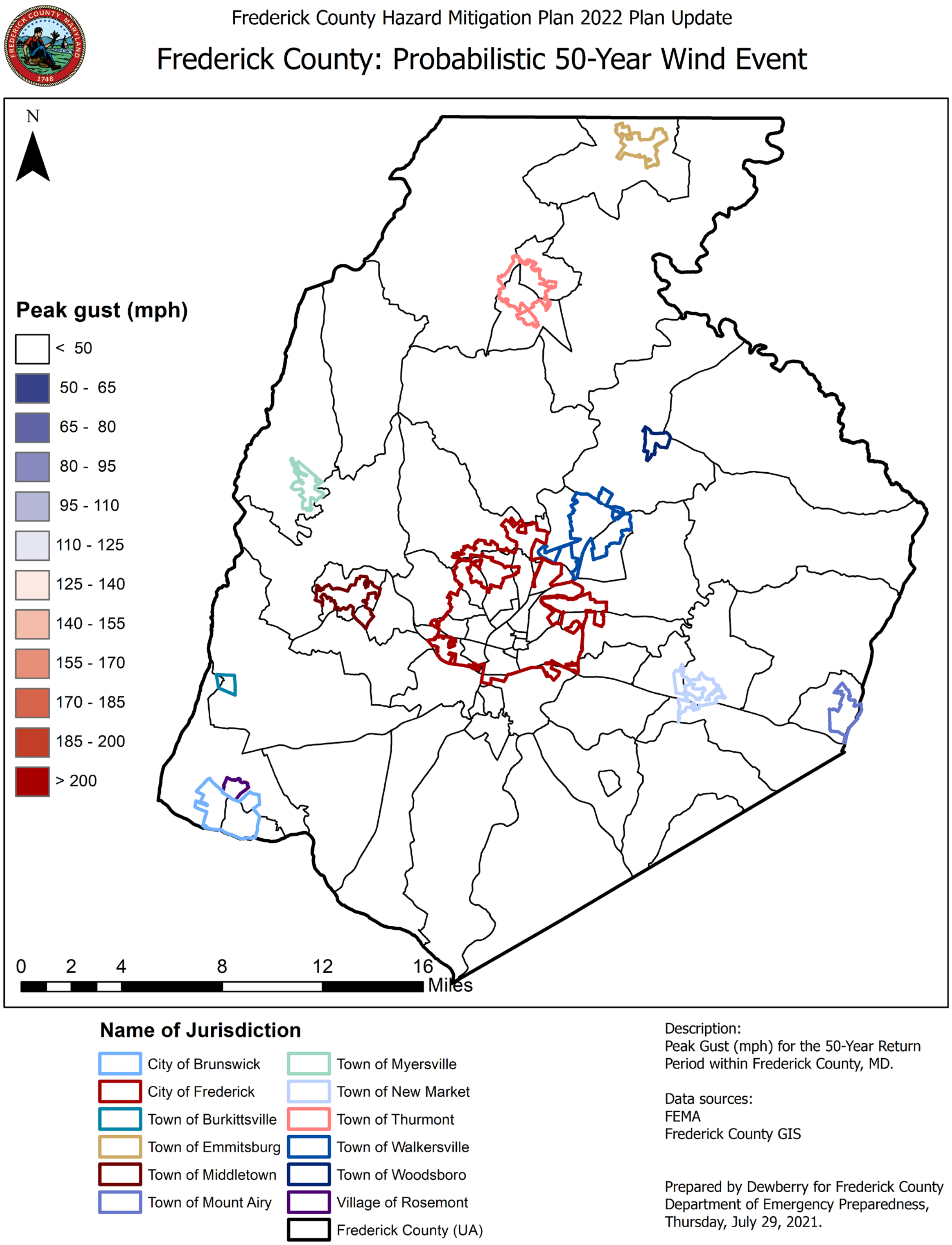


Figure 28 Frederick County 50-Year Wind Event

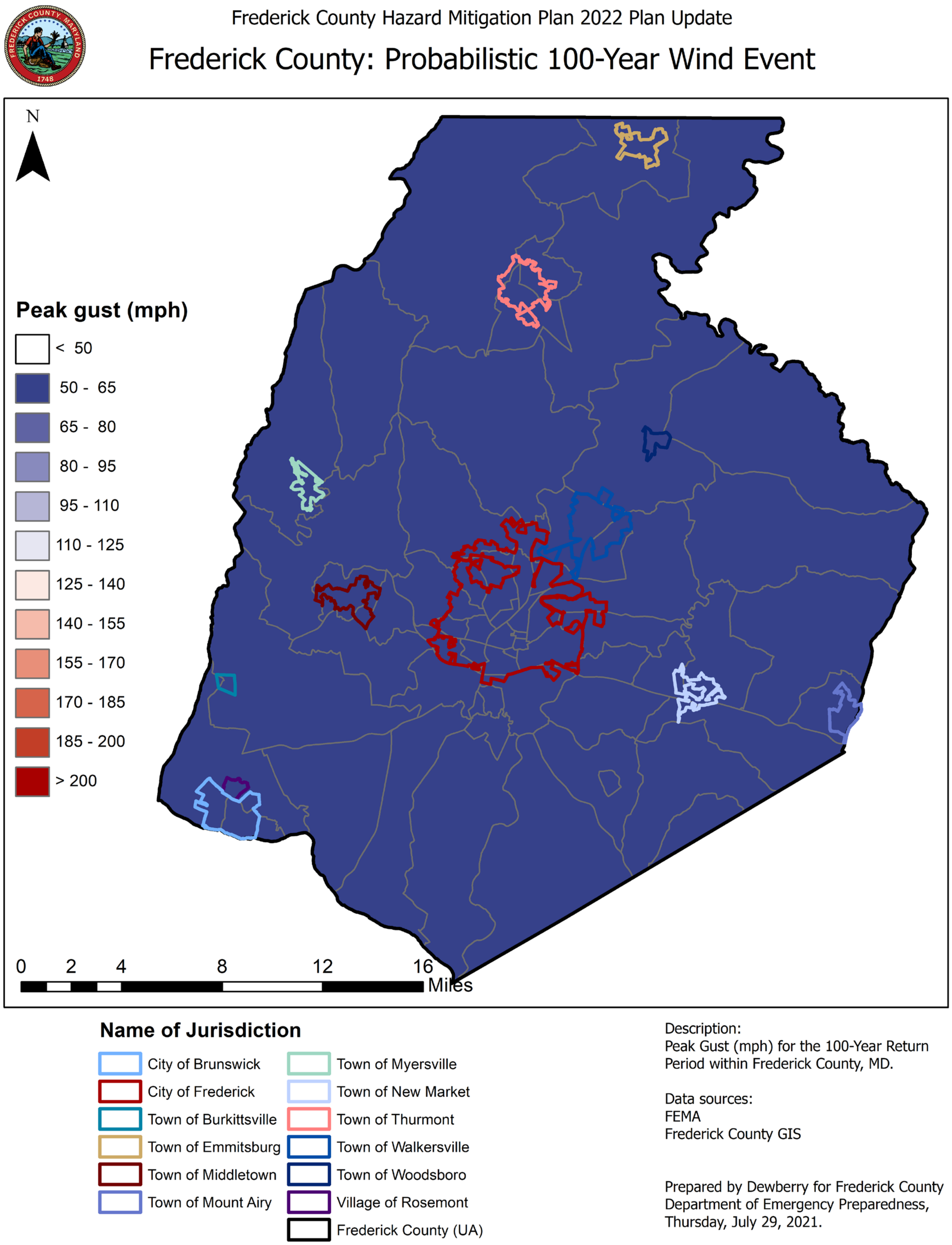


Figure 29 Frederick County 100-Year Wind Event

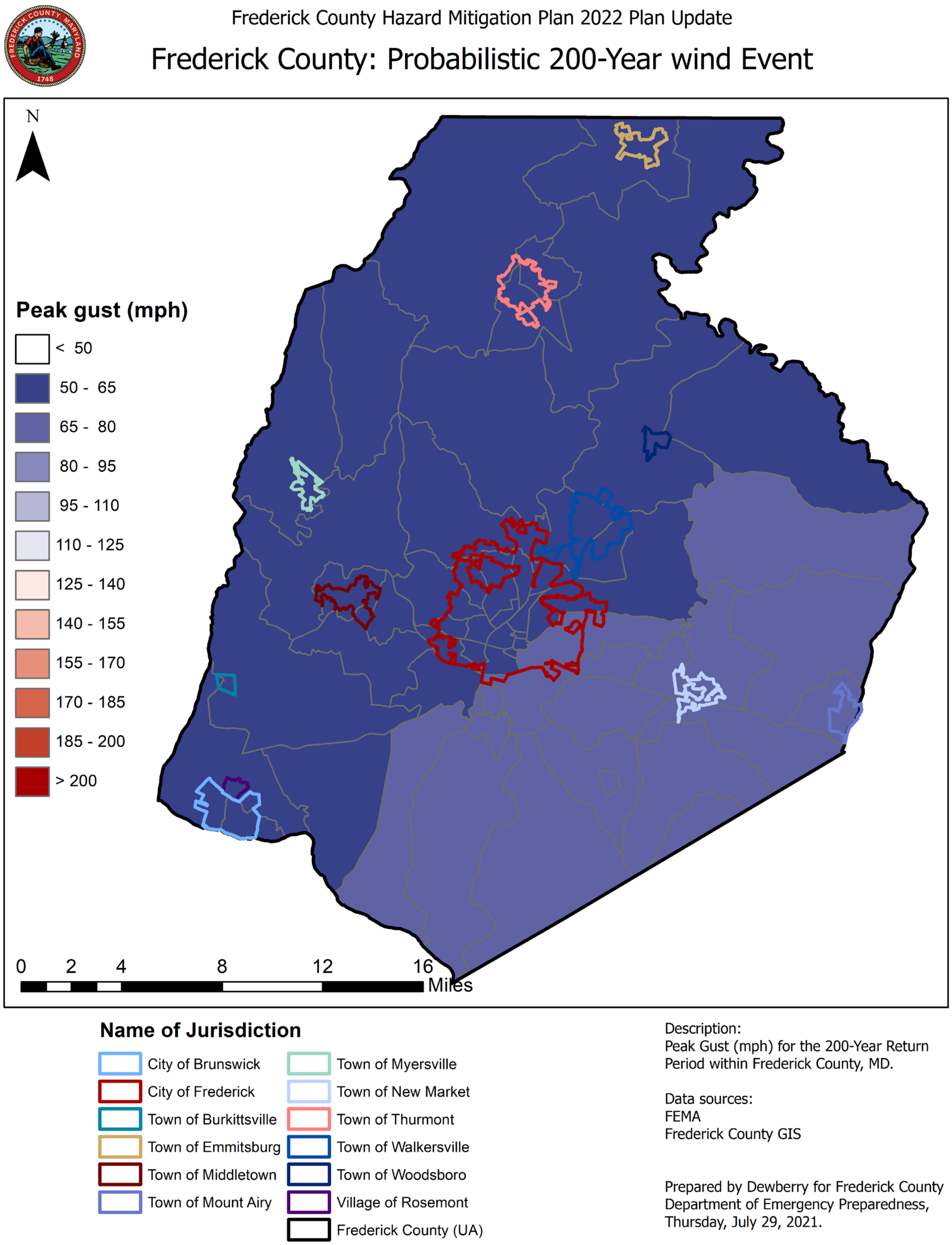


Figure 30 Frederick County 200-Year Wind Event

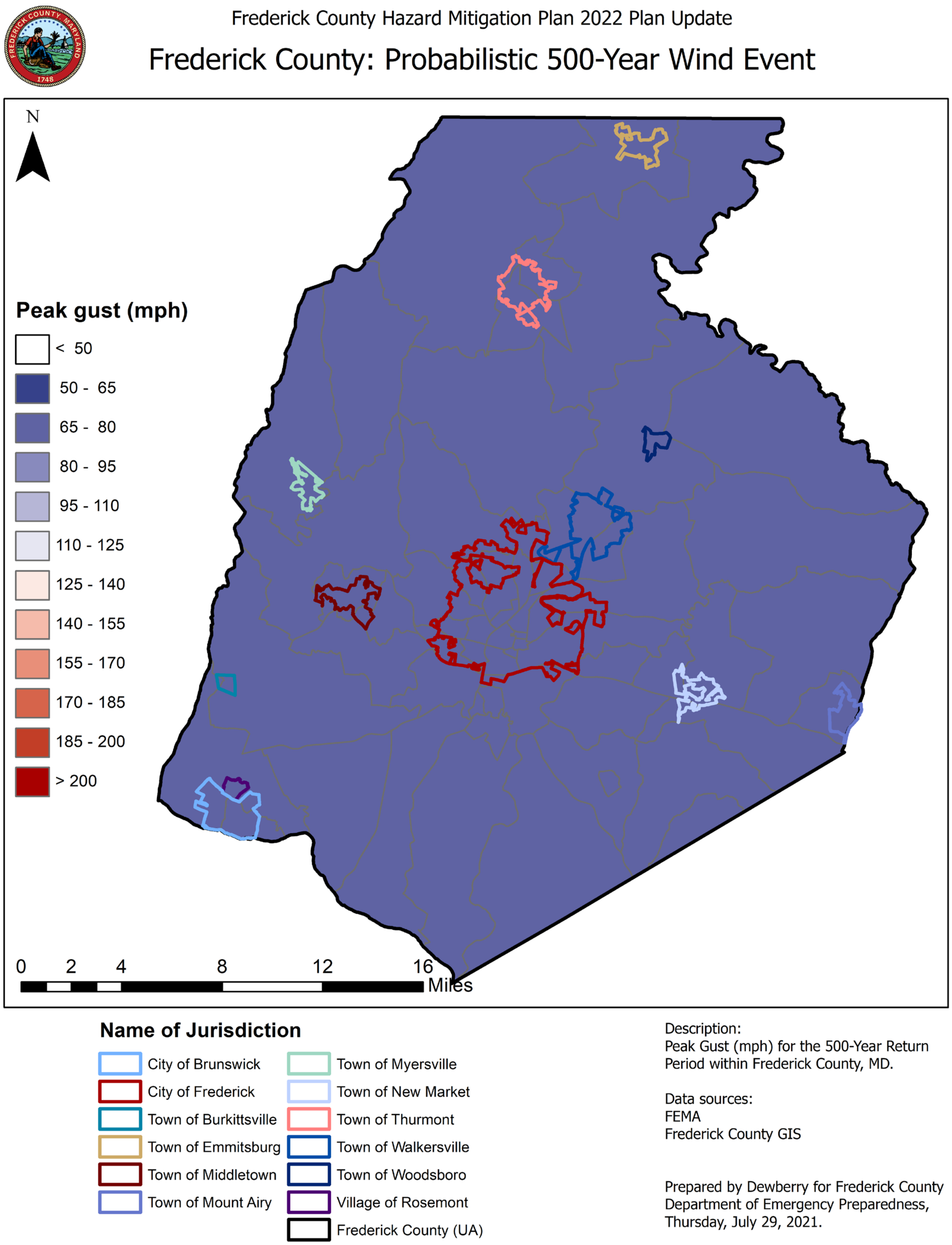
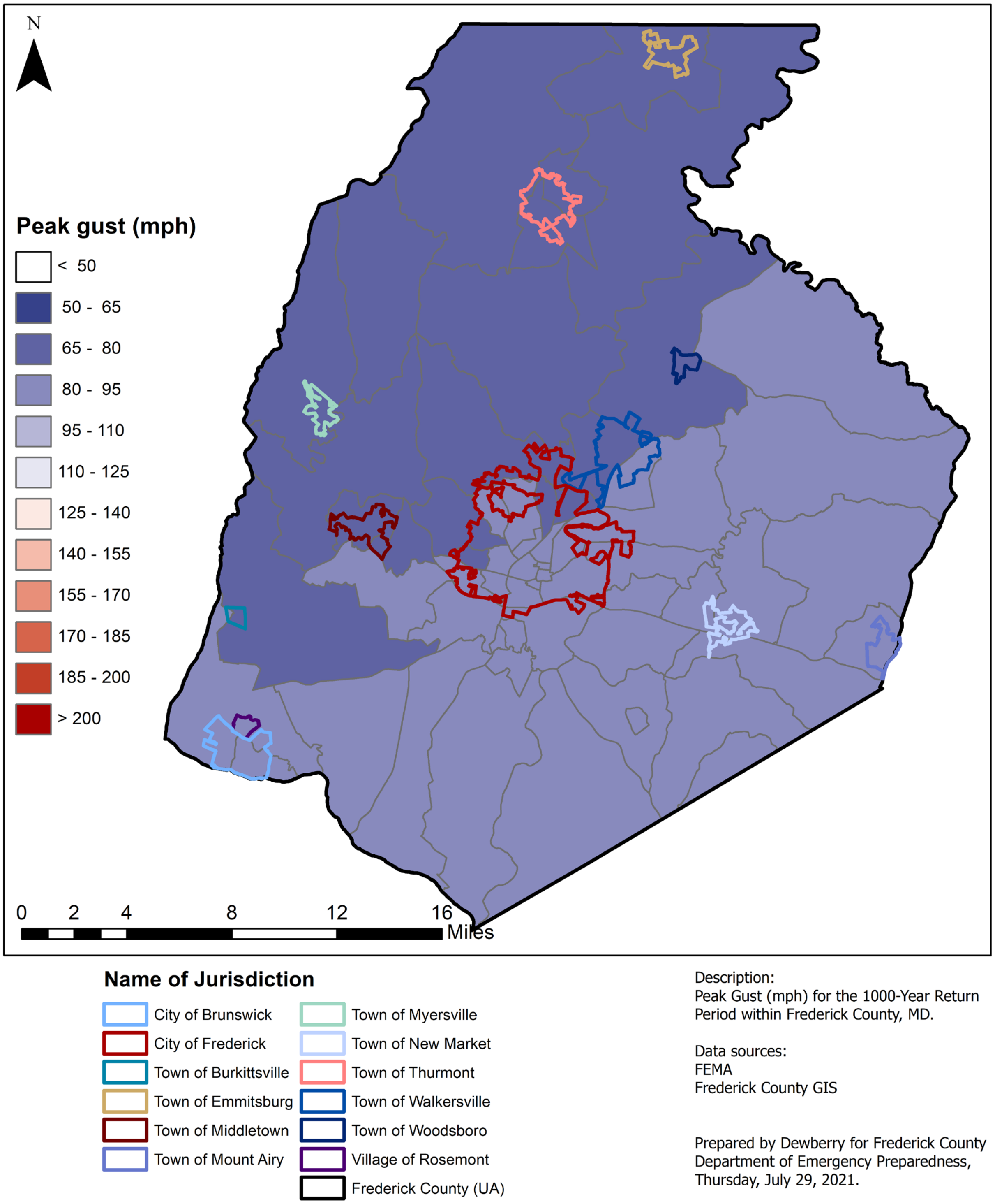


Figure 31 Frederick County 500-Year Wind Event

Frederick County Hazard Mitigation Plan 2022 Plan Update

Frederick County: Probabilistic 1000-Year Wind Event



Description:
Peak Gust (mph) for the 1000-Year Return Period within Frederick County, MD.

Data sources:
FEMA
Frederick County GIS

Prepared by Dewberry for Frederick County Department of Emergency Preparedness, Thursday, July 29, 2021.

Figure 32 Frederick County 1000-Year Wind Event

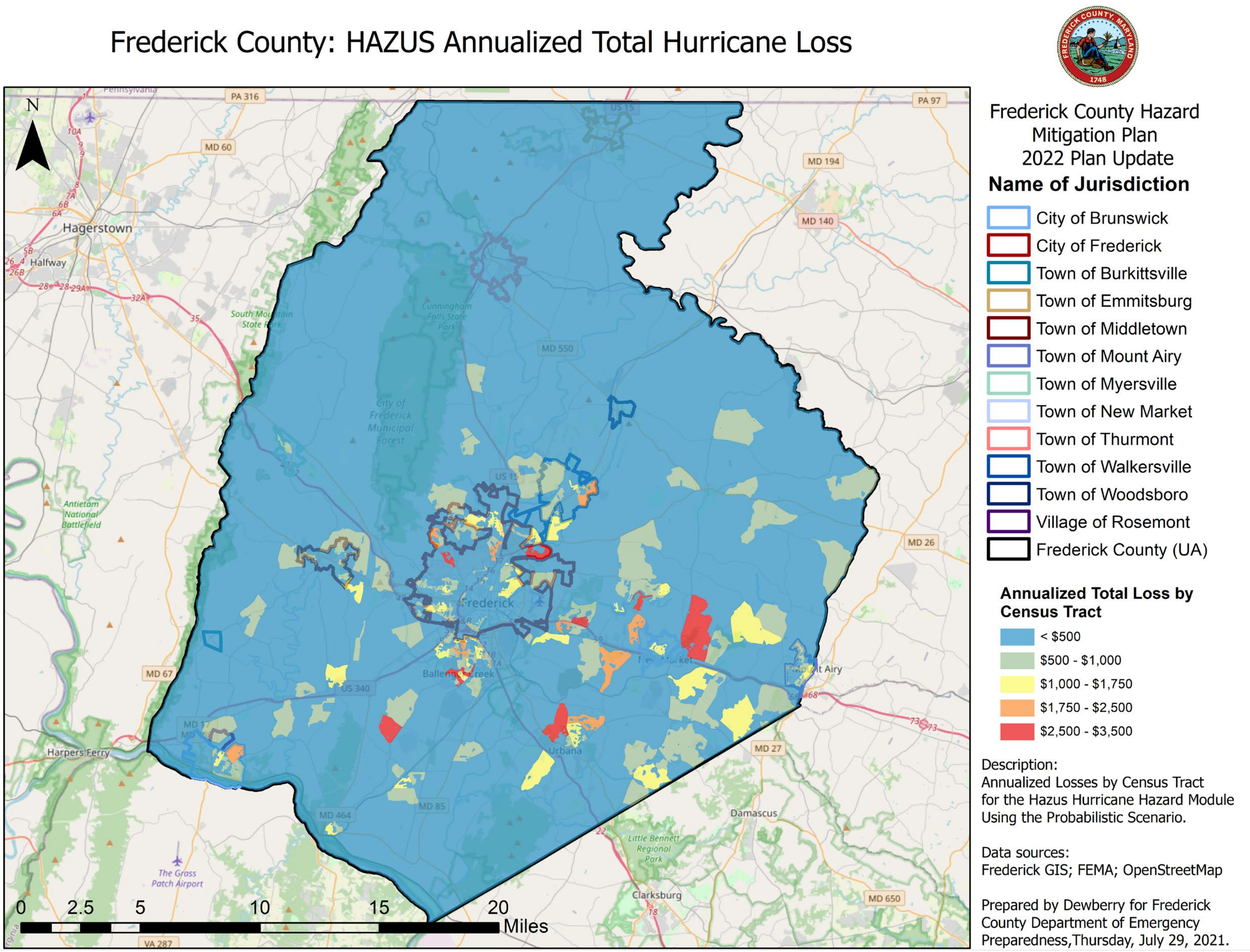


Figure 33 Frederick County Annualized Hurricane Losses.

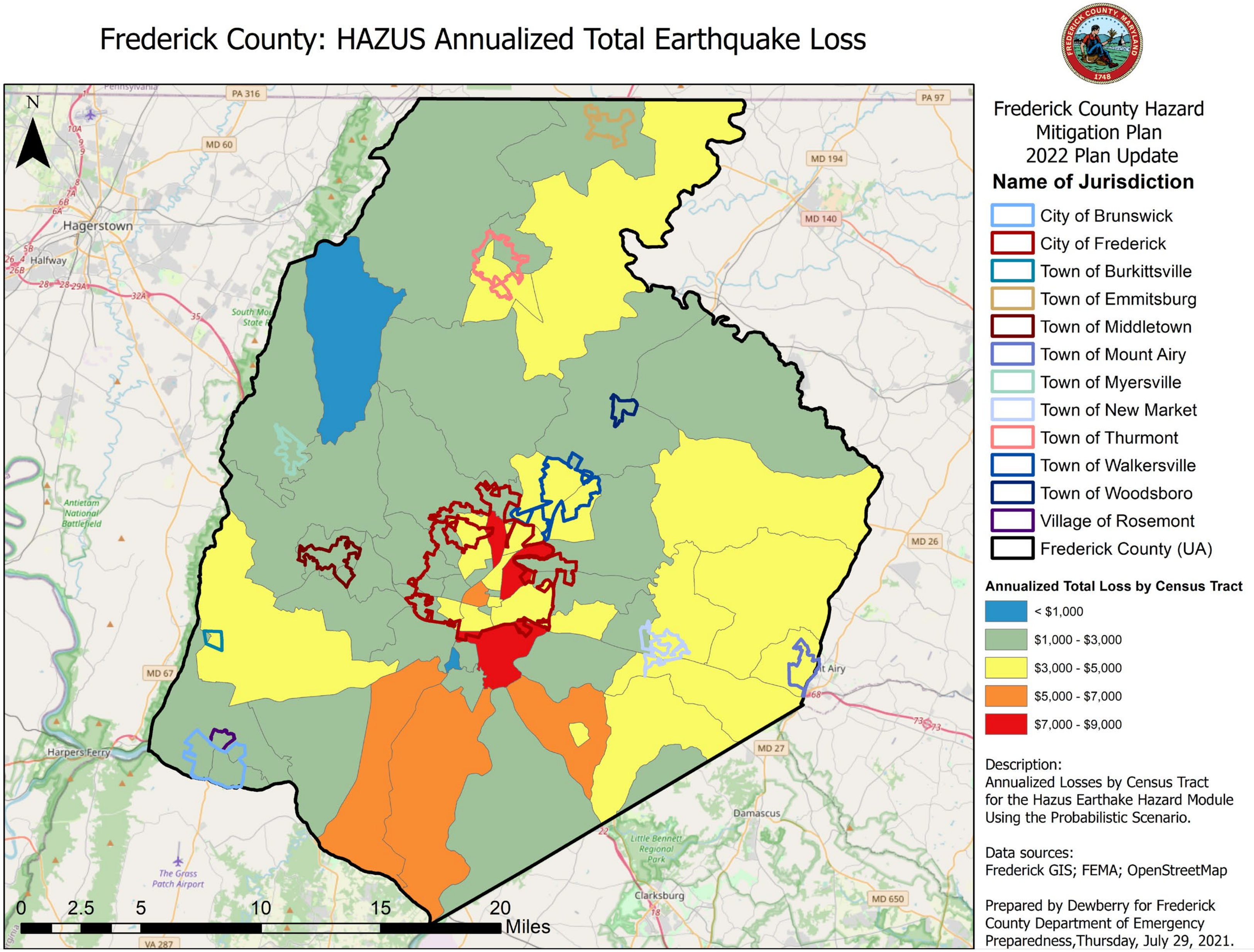
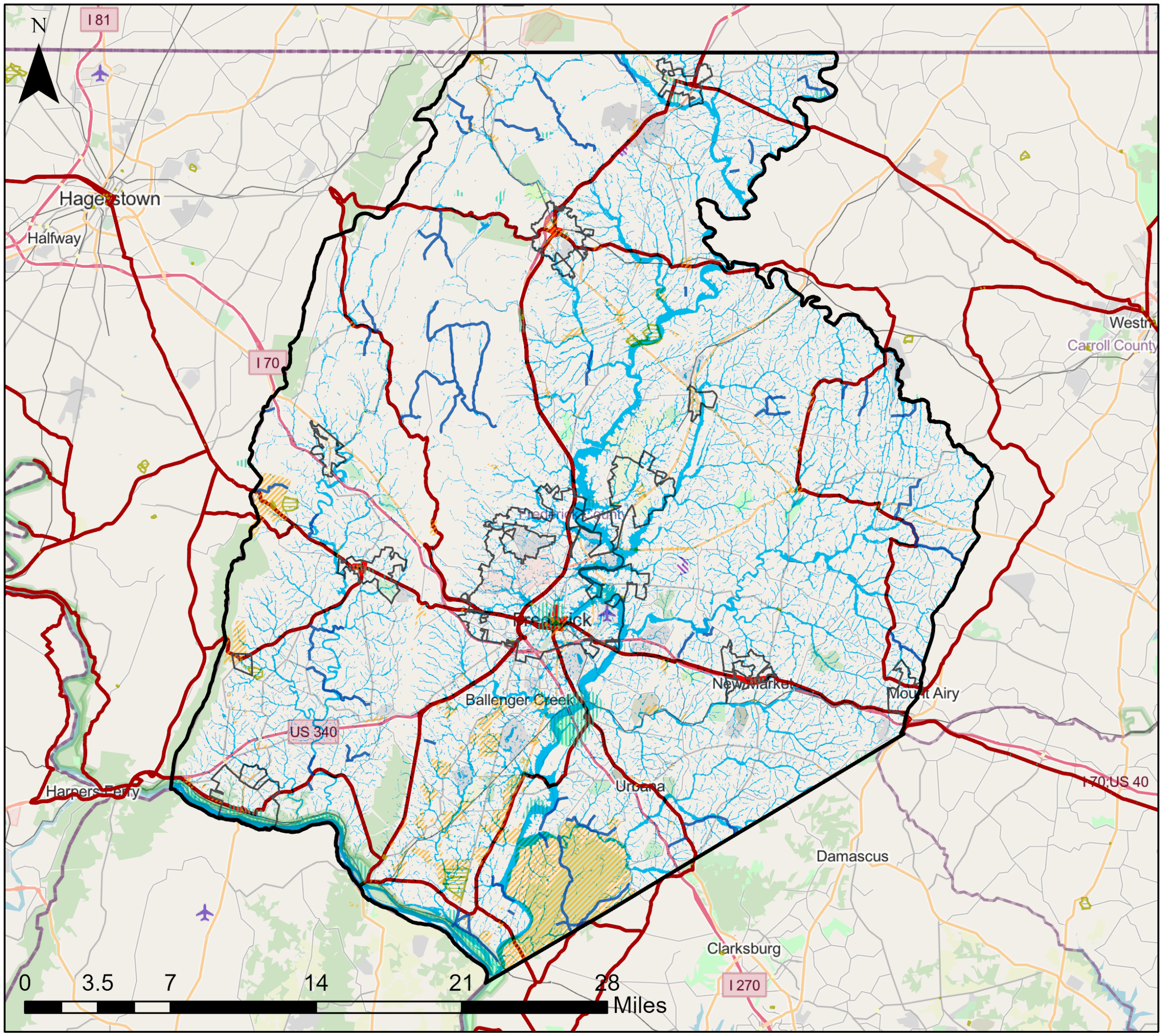


Figure 34 Frederick County Annualized Earthquake Losses

Frederick County: Cultural and Historic Resources in 100-Year 24-Hour Pluvial Flood Extent



Frederick County Hazard Mitigation Plan 2022 Plan Update

Legend

Pluvial Flood Hazard
- 100-Year 24-hour Pluvial Flood Extent

Jurisdictions
- Frederick County
- Municipalities

Historic Resources
- Maryland Historical Trust Preservation Easements
- Historic Roads
- Maryland Inventory of Historic Properties
- National Register of Historic Places
- Frederick County Register of Historic Places

Cultural Resources
- Main Street Areas
- Designated Scenic Byways

Description: Map of cultural historic resources, including sites, routes, and properties, in Frederick County overlaid with the spatial extent of the 100-year 24-hour pluvial flood event.

Data sources: FEMA; Frederick County GIS, Maryland Department of Housing and Community Development; Maryland Department of Planning; Maryland State Historic Preservation Office; NOAA; US Geological Survey; OpenStreetMap

Prepared by Dewberry for Frederick County Department of Emergency Preparedness, Monday, November 29, 2021.

Figure 35. Proximity of Cultural and Historic Resources to 100-Year 24-Hour Pluvial Flood Event Extent

APPENDIX F: INTERNAL PLANNING MEETING MATERIALS

The following pages in Appendix F contain meeting minutes and meeting attendance reports from the internal meetings held throughout the planning process, as well as select ad hoc communications with localities. The materials are in order of meeting date.

Meeting Minutes

Title:	Frederick County Hazard Mitigation Plan 2021 Update Kick-Off	Location:	Virtual, Microsoft Teams
Date:	Tuesday, July 13, 2021	Time:	1:00 – 3:00 PM ET

Purpose: The 2021 update of the Frederick County Hazard Mitigation Plan is underway. Dewberry will provide an overview of the planning process and the information and input that will be needed from Frederick County and its localities to develop the plan.

Attendees:
Scott Choquette, *Dewberry*
Jade Payne, *Dewberry*
Emma Kilkelly, *Dewberry*
Noelle Baffa, *Dewberry*
Abby Ingram, *Project Coordinator, Brunswick*
Dawn Ashbacher, *Sustainability Program Manager, Office of County Executive, County of Frederick*
David Barnes, *Asst. Deputy Chief Emergency Services, Dept. of Fire and Rescue*
Kimberly G. Brandt, *Director of Livable Frederick and Planning/Design Department*
Mary Domer, *Executive Assistant to Jack Markey, Frederick Emergency Management*
Donald Dorsey, *Sustainability Project Manager/CIP, Office of County Executive, Frederick Co.*
Dennis Dudley, *Director of the Department of Emergency Preparedness*
Kevin Fox, *Training and Emergency Management Coordinator, Mount Saint Mary's University*
Christine Gentry, *National Capitol Region Planner*
Jim Humerick, *Chief Administrative Officer for Town of Thurmont*
Todd Johnson, *Frederick Co. Health Dept Emergency Planner and Strategic Stockpile Coordinator*
Rowela Lascolette, *Hood College, Risk Manager*
Kendra Lindenberg, *Grant Manager at Frederick County Emergency Management*
Thurmond Maynard, *Director and Chief of Safety at Hood College*
Jack Markey, *Director of Frederick County Emergency Management*
Shannon Moore, *Sustainability Program, Office of County Executive, Frederick Co.*
Rohan Brown, *Planner, Dept. of Emergency Preparedness*
Sharon Riddell, *Administrative Aide, Frederick County Emergency Management*
Anthony Rosano, *Deputy Director at Frederick County Emergency Management*
Sean Williams, *Town Manager of Walkersville*
Robin Shusko, *Director of Campus Safety and Emergency Management at Frederick Community College*
Ryan Iacurso, *Intern at Frederick County's Sustainability Program*
Jason Stitt, *Dept. of Engineering and Construction Management, Frederick County*
Tracy Coleman, *City of Frederick, Department of Public Works*
Ryan Brown, *Planner at Frederick County Emergency Management*
David Warrington, Town of Mt Airy
Kristin Aleshire, *Town Manager for Myersville*

Meeting Summary

Scott Choquette (Dewberry) and Jade Payne (Dewberry) met with the Frederick County Hazard Mitigation Planning Committee (HMPC) on July 13, 2021 to provide an overview of the mitigation plan update process. A PowerPoint presentation was used to review the project purpose, schedule, public outreach plan, and the planned updates to each section. Discussions were held throughout the presentation so Dewberry could gather feedback from the HMPC on how the plan update should proceed. Discussion and presentation topics are grouped below.

Meeting Notes

HMP Process and New Priorities

- Stormwater, inland and flash flooding is a concern for multiple departments and jurisdictions, particularly how climate change will affect this hazard, where the problem areas are, and what strategies should be pursued
- Severe weather events are a concern for Public Health Department because can affect healthcare facilities and long-term care providers in the area
- Aging infrastructure, particularly the effects of weather on aging infrastructure
- Multiple departments and jurisdictions brought up climate change, and how climate will affect hazards frequency and severity in the future
    - Interested in how they can look ahead to evolving risk and use that information to form strategies and future actions

Public Outreach

Are there any stakeholders that were missed?

- Fort Detrick – the Fort surrounds Frederick CC and SPCS property, and have worked with Frederick CC before
    - Representative from Port Detrick was invited, but did not attend
- CSX Transportation (railroad?)
- Frederick County Public Schools
- City and County Economic Development
- State and National Parks, National Parks Service
    - Scott previously worked with a group focused on historic structures and their vulnerability to climate change
- Chamber of Commerce and Economic Development Office already involved, just need to ask the right questions
- Community groups representing different ethnicities

Continuous Improvement

[*No responses*]

Increase Consistency with Plans and Programs

Are there other efforts we should incorporate?

- Frederick City recently updated the Comprehensive Plan
- From introductions: Livable Frederick County Master Plan, and Washington Metro COG climate planning

Discussion: Existing Plan

- Jack M.: There is a challenge in creating a plan that you want to keep live but revamp it every five years. You don't know what you will need in the meantime between plan updates. Jurisdictions are encouraged to come up with solutions for identified hazards, even if they don't have all the details (like costs) ironed out).
    - From the chat: "FirstEnergy/Potomac Edison may also have input as it relates to the intersection of appropriate tree management and electric distribution reliability. The All Hazards Consortium (based in Frederick) may also participate www.ahcusa.org"

Hazard Ranking Priority

- Tornados are increasingly in the news for the Northeast, so maybe this could change in the future ranking
- Down drafts, derechos, high wind shear events
- Climate-related issues, like the rest of the country is experiencing
    - Frederick County last had a drought in 2001, but broader climatic changes – like extreme high temperatures for long periods of times, like the Southwest is having – could change how often they see droughts.
    - Worth having a discussion on how to incorporate climate change and related risks into the HMP.

HIRA Update – Data Call

- Last declaration was for flooding in May 2018 (Tropical Storm Michael?)
    - Over 500 homes were affected; County and cities received PA payments; and SBA was made available for residents

Goals and Objectives

- 2016 Goals are very specific, and some address specific hazards. 2021 Update can simplify and consolidate these for jurisdiction's review.
- Jack M.: "Simplicity is great for general awareness. Action requires details. I like the idea of simplifying where we can"

Public Involvement in Plan and Plan Maintenance

- Since 2016 Plan, a lot of work has happened, particularly since the 2018 floods, which has some USACE public meetings. However, not everyone on this call would say what they do is "mitigation," even though it is related to the HMP. This work only coalesces as a strategy every five years with the update, and agencies respond to emergency as needed. Agencies are continuously involved and working on mitigation, which should be captured in the 2021 Plan.

- only gets driven towards mitigation every 5 years as strategy comes into play for the update and emergency response as needed

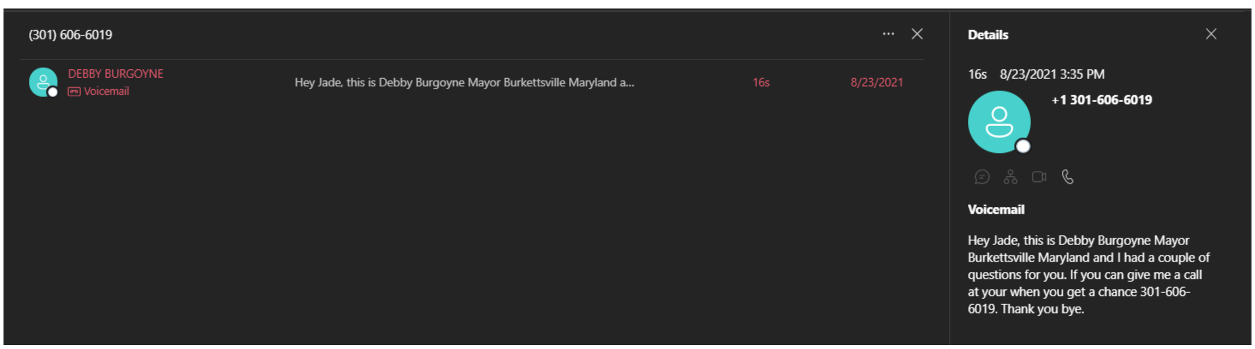
Questions/Comments?

- Jack M.: “Important to recognize the County and municipal bond rating agencies are increasingly asking what we are doing for mitigation and climate adaptation.”
  - There is a bond presentation on August 25.
  - Should add this note to the “why we do hazard mitigation plans”

Call Log – Meeting Notes

8/23/2021

- 3:35 PM: Debby Burgoyne, Mayor of Burkittsville, left a voicemail stating that she had some questions about the hazard mitigation planning process. She requested a call back.
- Approx. 4:00 PM: Jade Payne, Dewberry, returned Debby's call and answered her questions about the level of involvement, the need for Burkittsville to participate, and the County's role in the planning process.
    - Debby relayed concerns about the town's lack of capacity to handle a resource- and time-intensive process.
    - Jade confirmed that Burkittsville would need to participate to remain eligible for certain hazard mitigation funding, but the County has agreed to provide resources to assist the town.
    - The changes in the town since the last plan update in 2016 were discussed, including a change to the postal office and a recent fire.
    - Town priorities, such as the issues with flooding and responsibilities to control issues as they arise, were shared.



Meeting Summary

Total Number of Participants	2
Meeting Title	Frederick County Hazard Mitigation Plan Update - Middletown Planning Team Meeting #1
Meeting Start Time	8/24/2021, 9:57:44 AM
Meeting End Time	8/24/2021, 10:29:34 AM
Debug Id	32b0405e-ac43-4f73-aead-bf98ebe172dd

Full Name	Duration
Payne, Jade	31m 49s
Drew	20m 48s

Meeting Summary		
Total Number of Participants		2
Meeting Title	Frederick County Hazard Mitigation Plan Update - Hood College Planning Team Meeting #1	
Meeting Start Time	8/25/2021, 12:54:50 PM	
Meeting End Time	8/25/2021, 1:45:15 PM	
Debug Id	ef438975-39a0-4e91-8013-c72d4ff9819a	

Full Name	Duration
Payne, Jade	50m 25s
Maynard, Thurmond	44m 34s

Meeting Summary

Total Number of Participants	2
Meeting Title	Frederick County Hazard Mitigation Plan Update - Mount Airy Planning Team Meeting #1
Meeting Start Time	8/25/2021, 10:01:51 AM
Meeting End Time	8/25/2021, 11:00:56 AM
Debug Id	d4e926e7-19e5-4ff5-ac53-3afb65306a27

Full Name	Duration
Payne, Jade	59m 5s
13018291424	57m 33s

Meeting Summary	
Total Number of Participants	4
Meeting Title	Frederick County Hazard Mitigation Plan Update - Mount St. Mary's University Planning Team Meeting #1
Meeting Start Time	8/26/2021, 12:57:45 PM
Meeting End Time	8/26/2021, 2:01:08 PM
Debug Id	674720a4-8d60-4ffd-9b88-d736f3b597ff

Full Name	Duration
Payne, Jade	1h 3m
Fox, Kevin D.	1h 3m
Choquette, Scott	59m 18s
Hibbard, Ronald D.	55m 27s

Meeting Summary	
Total Number of Participants	17
Meeting Title	Frederick County Hazard Mitigation Plan Update - Planning Team Meeting #1
Meeting Start Time	8/30/2021, 12:57:15 PM
Meeting End Time	8/30/2021, 2:33:46 PM
Debug Id	2af03609-4f82-455a-953a-ff28060209c2

Full Name	Duration
Payne, Jade	1h 36m
Rosano, Anthony	1h 35m
Barthol, Sue	1h 35m
Dorsey, Donald	1h 35m
Rohan Brown (Guest)	1h 35m
Newman, Jon	1h 35m
Choquette, Scott	1h 35m
Ennis, David	1h 35m
Riddell, Sharon	1h 34m
Scott Blundell - FCPS (Guest)	1h 35m
Dudley, Dennis	1h 35m
Johnson, Todd (Health/HCC&P)	1h 33m
Paul Beliveau (Guest)	1h 34m
Brandt, Kimberly G.	1h 33m
Ashbacher, Dawn	1h 32m
Moore, Shannon	1h 32m
Stitt, Jason	1h 31m

Meeting Summary		
Total Number of Participants		4
Meeting Title	Frederick County Hazard Mitigation Plan Update - Walkersville Planning Team Meeting #1	
Meeting Start Time	8/30/2021, 10:52:08 AM	
Meeting End Time	8/30/2021, 11:46:58 AM	
Debug Id	c173a56d-4d62-4471-b617-0223db43b458	

Full Name	Duration
Payne, Jade	54m 49s
Joe Birch (Guest)	51m 43s
Choquette, Scott	51m 4s
Sean Williams (Guest)	46m 51s

Meeting Summary		
Total Number of Participants		2
Meeting Title	Frederick County Hazard Mitigation Plan Update - Myersville Planning Team Meeting #1	
Meeting Start Time	8/31/2021, 2:00:38 PM	
Meeting End Time	8/31/2021, 2:22:05 PM	
Debug Id	c573dcb4-2058-456a-a32d-cd9d1564e1e4	

Full Name	Duration
Payne, Jade	21m 26s
13012932517	21m 13s

Meeting Summary

Total Number of Participants	8
Meeting Title	Frederick County Hazard Mitigation Plan Update - Brunswick Planning Team Meeting #1
Meeting Start Time	8/31/2021, 10:54:12 AM
Meeting End Time	8/31/2021, 12:13:14 PM
Debug Id	d7a21e83-be3c-4624-bb95-e165d4ac3940

Full Name	Duration
Choquette, Scott	1h 15m
John Gerstner	1h 11m
Jeremy Mose (Guest)	1h 14m
Bruce (Guest)	1h 11m
Matt Lynch	1h 10m
Vaughn Ripley	1h 9m
Matt Campbell	3m 12s
Matt Campbell	1h 3m
Andy St. John (Guest)	1h 10m

Meeting Summary		
Total Number of Participants		4
Meeting Title	Frederick County Hazard Mitigation Plan Update - Frederick (City) Planning Team Meeting #1	
Meeting Start Time	8/31/2021, 12:55:21 PM	
Meeting End Time	8/31/2021, 2:01:12 PM	
Debug Id	da7f7028-0a40-4b05-9b28-923ec3ca23d9	

Full Name	Duration
Tracy Coleman	1h 5m
Choquette, Scott	1h 3m
Joe Lindstrom	1h 3m
Zack Kershner	59m 51s

Meeting Summary		
Total Number of Participants		3
Meeting Title	Frederick County Hazard Mitigation Plan Update - Emmitsburg Planning Team Meeting #1	
Meeting Start Time	8/31/2021, 9:55:58 AM	
Meeting End Time	8/31/2021, 10:32:34 AM	
Debug Id	69881c35-db79-4fdd-923c-77c88682114a	

Full Name	Duration
Payne, Jade	36m 35s
Zach Gulden (Guest)	35m 1s
Cathy, Dan, Jared (Guest)	32m 47s

Meeting Summary

Total Number of Participants	4
Meeting Title	Frederick County Hazard Mitigation Plan Update - Thurmont Planning Team Meeting #1
Meeting Start Time	9/7/2021, 12:56:25 PM
Meeting End Time	9/7/2021, 1:57:37 PM
Meeting Id	b390184c-d0e3-45f5-895f-74e245b617c5

Full Name	Duration
Choquette, Scott	57m 50s
Kelly (Guest)	57m 48s
Jim Humerick	55m 8s
Harold Lawson	36m 37s

Meeting Summary	
Total Number of Participants	7
Meeting Title	Frederick County Hazard Mitigation Plan Update - Frederick Community College Planning Team Meeting #1
Meeting Start Time	9/16/2021, 10:57:15 AM
Meeting End Time	9/16/2021, 12:10:27 PM
Meeting Id	8dba6ce0-a3d7-4d5f-a22d-a96d7c23cc0b
Full Name	Duration
Payne, Jade	1h 13m
Cathy Jones	52m 31s
Lewis Godwin	2m 14s
Lewis Godwin	1h 6m
Greg Solberg	1h 8m
Choquette, Scott	5m 24s
Robin Shusko	1h 7m
scott (Guest)	1h 2m

Meeting Minutes

Title:	Frederick County Hazard Mitigation Plan 2021 – HIRA Workshop	Location:	Virtual, Microsoft Teams
Date:	Thursday, October 14, 2021	Time:	10:00 am – 12:00 pm ET

Purpose: Dewberry will provide a status update on the project's progress and HIRA results.

Attendees:

1. Scott Choquette, *Dewberry*
2. Jade Payne, *Dewberry*
3. Noelle Baffa, *Dewberry*
4. Dano Wilusz*, Dewberry*
5. Captain Matt Lynch, *Police Department, City of Brunswick*
6. Joe Birch, *Planning & Zoning, Town of Walkersville*
7. Dawn Ashbacher, *Sustainability Program Manager, Office of County Executive*
8. Lewis Godwin, Chief of Operations Frederick Community College
9. Nathan Hupp, Safety, Security and Emergency Preparedness specialist at The City of Frederick
10. Vaughn Ripley, *City of Brunswick*
11. Zach Gulden, *Town of Emmitsburg*
12. Andy St. John, *City of Brunswick*
13. Bruce Carbaugh, Director of Public Works Middletown MD
14. Cathy Willets, *Town Manager, Town of Emmitsburg*
15. Drew Bowen, *Town Administrator, Town of Middletown*
16. David Ennis, *Department Head Department Highways and Facilities Maintenance, Frederick County Department of Public Works*
17. Kimberly G. Brandt, *Director of Livable Frederick and Planning/Design Department*
18. Mary Domer, *Executive Assistant to Jack Markey, Frederick Emergency Management*
19. Donald Dorsey, *Sustainability Project Manager/CIP, Office of County Executive, Frederick Co.*
20. Dennis Dudley, *Director of the Department of Emergency Preparedness*
21. Kevin Fox, *Training and Emergency Management Coordinator, Mount Saint Mary's University*
22. Todd Johnson, *Frederick Co. Health Dept Emergency Planner and Strategic Stockpile Coordinator*
23. Rowela Lascolette, *Hood College, Risk Manager*
24. Thurmond Maynard, *Director and Chief of Safety at Hood College*
25. Jack Markey, *Director of Frederick County Emergency Management*
26. Rohan Brown, *Planner, Dept. of Emergency Preparedness*
27. Sharon Riddell, *Administrative Aide, Frederick County Emergency Management*
28. Anthony Rosano, *Deputy Director at Frederick County Emergency Management*
29. Sean Williams, *Town Manager of Walkersville*
30. Robin Shusko, *Director of Campus Safety and Emergency Management at Frederick Community College*
31. Tracy Coleman, *City of Frederick, Department of Public Works*

Meeting Summary

Scott Choquette (Dewberry) and Jade Payne (Dewberry) met with the Frederick County Hazard Mitigation Planning Committee (HMPC) on October 14, 2021 to provide an update on project status and hazard identification and risk assessment (HIRA) results. Jade discussed climate adaptation integration and other new plan additions. Scott presented completed work on the HIRA section. Dano

Wilusz (Dewberry) presented progress on the 2-D Pluvial Flood Modeling and provided a live demonstration. Next steps and upcoming due dates were also discussed. Discussion and presentation topics are grouped below.

Meeting Notes

Project Status Update

- Great participation in survey so far- Dennis
- HIRA section drafted
- Draft plan will be to FEMA by November for review
- Public outreach strategy: Completed project website, online survey, videos, story map
- Virtual workshop for public – 10/21/21
- Over 500 survey responses from stakeholders, public, etc.

Climate Adaptation Integration and other new plan additions

- Climate change projections added to 2021 plan modeled after MA state plan.
    - Climate change and natural hazard taxonomy
        - Changes in precipitation
        - Rising temperatures
        - Extreme weather
        - Non-climate influences hazard
    - Hazard mitigation and climate adaption strategy
        - Identifying climate change interactions addresses by each action
    - Climate adaptation elements
        - Climate change projections for MD and Region
    - Integration with recs. From the Frederick Climate Emergency Mobilization Work Group
- Social vulnerability analysis (SVI)
    - One of the first HMPs to do this
    - CDC's SVI to measure relative vulnerability of US census tracts
    - Overlaid with hazard areas to create visual for where most vulnerable populations and increases hazard exposure intersect
    - Provides more complete picture of risk
    - SVI will be shown with flood hazard zones, dam inundation, wildland urban interface
    - New FEMA BRIC grant program gives favor to plans that address vulnerable populations
- Future Development
    - Comprehensive planning integration
        - Proposed community facilities
        - Proposed highway additions
        - Community growth areas
    - Overlaid with hazard areas to help ID future risk.

Hazard ID and Risk Assessment

- Purpose: provide factual basis for prioritizing hazards
- Components: Hazard ranking, climate impacts, probability, historical events, vulnerability and loss estimation, potential impacts, state HMP integration, hazard profiles
- 2021 updates: updated hazard ranking, social vulnerability & future dev., pluvial flood model and exposure analysis, climate adaptation, new analyses in each hazard section- HAZUS earthquake, dam inundation mapping, severe weather section, expanded exposure & loss estimation for almost every hazard, new maps based on updated data
- Risk levels ranked by probability & history, vulnerability, maximum threat, warning time, 2016 ranking.
- Data sources: NOAA NCEI Storm Events Database, FEMA Federal Declared Disasters
- 13 major disaster declarations for Frederick County- 9 flooding/ severe storm, 4 winter weather, 2 COVID
    - Hazard Mitigation Assistance available for COVID
- Loss estimation: HAZUS analysis for flood, hurricane wind, and earthquake
    - HAZUS flood: riverine flooding, 10-500-year events, annualized run, buildings
- HIRA Results
    - Winter weather: total of $615.3K- doesn't nuclide snow removal, etc.; annualized $24,6K a year in winter weather damages
    - Severe weather: 652 reported events since 1955. $6.8M in damages, $252.9K in annualized damages
    - Tornado: 38 tornados since 1950, $6.2M in damages, $86.6k annualized (1950-2021)
    - Hurricane winds HAZUS: total loss $509.5K per year
    - Extreme heat: becoming more frequent, intense and longer; social vulnerability with extreme heat
    - Drought: projected to increase due to climate change; annualized damage- $1.4M, largest for agriculture/ crop damages
    - Flooding: mapped floodplains and did exposure analysis; annualized damages of $53.1M (HAZUS), NCEI total reported damage $1.5M
    - Dam/Levee failure: 21 reported dam failures in Frederick County; $79.1M in property exposure in dam/levee areas
    - Wildfire: 6-year record period, 119 recorded events in County AMS, 13 year period with 382 total events recorded events in State DNR, 182.1k building footprints exposed to wildfire risk
    - Karst/ Land subsidence: total parcel value exposed $10.1M, $208k average building value
    - Earthquake: low probability, high potential damages. HAZUS annualized total losses by census tract- $187.9K annualized total loss, $121.6K of those damages to buildings
    - Landslide: $28.7M total exposure value of real estate

2-D

- Dano Wilusz (Dewberry): Pluvial Modeling
    - Focused on riverine flooding, urban surface flooding (pluvial)
    - Inputs-
        - Topography:1m DEM
        - Surface roughness- NLCD land use
        - Major conveyance structures- simplified bridges, culverts

        - River inflows- USGS regression equations
    - Method- 2D HEC-RAS model
    - Limitations and applications
        - Incomplete topography
        - Limited storm water mgmt. infrastructure
        - No stream bathymetry
        - Limited validation
    - Recommended uses
        - Useful for hazard planning and screening
        - Mapping riparian flooding at streams with no FEMA model
        - Evaluation potential for pluvial flooding
- Provides information the county doesn't have

Next Steps for Risk Analysis

- HIRA annexes
    - Frederick Community College, Mount St. Mary's University, Hood College
    - Annexes will have independent HIRA sections that utilize county-wide risk assessment, but w/ zoomed in focus on campuses
    - Will include human-caused hazards as prioritized by hazard surveys
- Mitigation goals, strategies & objectives
    - Climate adaptation mitigation strategy
- 2016 goals → strategic categories: hazard & climate focused
    - Physical projects
    - Capability & capacity building
    - Public awareness and education
    - Forward-looking policy and planning

Questions & Comments

- Jack Markey: applause for 2-D pluvial modeling. Very useful information, very exciting what has been done with pluvial. State of the art and a great foundation given recent flood events. This pluvial modeling can be incredibly valuable.
    - Scott: May be first in MD and even R3
- Todd Johnson, Health department: purposed to move from goals to strategic categories is it possible for ex. Goal H could end up in more than one of those categories?
    - Scott: could fall under multiple categories
- Jack Markey: sheltering would be tactical strategy rather than strategic category, make sure to get the goals broad
- Robin Shusko: during draft plan and workshop, will we be updating the info we submitted on the templates?
    - Jade: all of questionnaires and templates we've used to update beginning of plan, profile info, capability assessment
- Kevin Fox: Will the colleges and annexes have the pluvial flooding as well?
    - Scott: I think yes, would be important at that scale that it is reviewed.
    - Jack: since there aren't some of the non-public entities might be higher level than some unincorporated areas but would still be valuable

Next Steps

1. Public engagement meeting- 10/21
2. Online hazard mitigation survey closes- 10/22
3. HMPC to review mitigation goals and objectives- October 2021
4. Choose and rank mitigation strategies- Oct/ Nov 2021
5. County draft plan review & workshop- Nov/ Dec 2021
6. Stakeholder draft plan review & public meeting- Nov/Dec 2021

Meeting Summary		
Total Number of Participants		33
Meeting Title	Frederick Co. Hazard Mitigation Plan Update: HIRA Workshop	
Meeting Start Time	10/14/2021, 9:51:48 AM	
Meeting End Time	10/14/2021, 11:29:27 AM	
Meeting Id	bc72c99b-a63d-473c-bca8-312dc1ec59c8	

Full Name	Duration
Tracy Coleman	1h 28m
Nathan Hupp	1h 26m
Choquette, Scott	1h 25m
Dudley, Dennis	1h 25m
Sean Williams (Guest)	1h 26m
Riddell, Sharon	1h 25m
Baffa, Noelle	1h 24m
Brown, Rohan	1h 26m
Drew Bowen	1h 18m
Captain Matt Lynch (Guest)	1h 9m
Joe Birch (Guest)	1h 23m
Rosano, Anthony	1h 22m
Payne, Jade	1h 22m
Fox, Kevin D.	1h 22m
Bruce (Guest)	1h 25m
Lewis Godwin	1h 21m
Ennis, David	1h 20m
Domer, Mary	46m 6s
Andy St. John (Guest)	1h 20m
Wilusz, Dano	1h 20m
Lascolette, Rowela	1h 20m
Maynard, Thurmond	1h 19m
Zach Gulden (Guest)	1h 18m
Stitt, Jason	12m 26s
Vaughn Ripley	1h 20m
Cathy (Guest)	1h 27m
Robin Shusko	1h 18m
Johnson, Todd (Health/HCC&P)	1h 18m
Brandt, Kimberly G.	52m 58s
Ashbacher, Dawn	1h 17m
Markey, Jack	1h 10m
Drew Bowen	1h 5m
Barnes, David	18m 36s

Meeting Summary

Total Number of Participants		9
Meeting Title	Frederick Co. Hazard Mitigation Plan - Mitigation Strategy	
Meeting Start Time	11/30/2021, 2:50:46 PM	
Meeting End Time	11/30/2021, 4:32:19 PM	
Meeting Id	6fac2a2f-e5e9-4cb6-aa47-363ecd6a3bde	

Full Name	Duration
Payne, Jade	1h 41m
Choquette, Scott	1h 35m
Robin Shusko	51m 28s
Greg Solberg	50m 39s
Nathan Hupp	47s
Nathan Hupp	14m
Nathan Hupp	43m 31s
Lewis Godwin	46m 21s
Dudley, Dennis	1h 27m
John Anzinger	30m 52s
Tracy Coleman	59m 49s

Meeting Summary		
Total Number of Participants		5
Meeting Title	Frederick Co. Hazard Mitigation Plan - Mitigation Strategy	
Meeting Start Time	12/1/2021, 1:26:14 PM	
Meeting End Time	12/1/2021, 2:44:09 PM	
Meeting Id	ae127b8c-326e-41cc-9267-dbe6d6cfd9b8	

Full Name	Duration
Payne, Jade	1h 17m
Choquette, Scott	1h 17m
Bruce (Guest)	1h 14m
Captain Matt Lynch (Guest)	55m 12s
Dudley, Dennis	40m 13s

Meeting Summary		
Total Number of Participants		9
Meeting Title	Frederick Co. Hazard Mitigation Plan - Mitigation Strategy	
Meeting Start Time	12/2/2021, 9:25:56 AM	
Meeting End Time	12/3/2021, 3:54:36 PM	
Meeting Id	a9dc463c-cad1-4b49-9663-61b75e4c05a7	

Full Name	Duration
Payne, Jade	1h 56m
Payne, Jade	7s
Choquette, Scott	52m 44s
Zach Gulden (Guest)	21m 24s
Dudley, Dennis	21m 25s
Fox, Kevin D.	1h 19m
Cathy (Guest)	29h 53m
Jim Humerick	17m 28s
Jim Humerick	51m 23s
Kelly (Guest)	1h 20m
12406560439	1h 14m

Meeting Summary	
Total Number of Participants	20
Meeting Title	Frederick Co. Hazard Mitigation Plan Update - Mitigation Strategy
Meeting Start Time	12/2/2021, 3:24:45 PM
Meeting End Time	12/2/2021, 5:56:18 PM
Meeting Id	64d8ae12-c8bd-4513-8dd7-f29424dd84e4
Full Name	Duration
Choquette, Scott	2h 12m
Payne, Jade	2h 11m
Moore, Shannon	2h 10m
12404095450	52m 2s
Newman, Jon	1h 17m
Dudley, Dennis	2h 9m
Ennis, David	2h 9m
Brown, Rohan	2h 9m
Shawn Burnett	48m 4s
Rachel Elizabeth Rosenberg Goldstein	49m 34s
Johnson, Todd (Health/HCC&P)	1h 25m
Markey, Jack	2h 5m
Stitt, Jason	1h 39m
Rosano, Anthony	2h 5m
Ashbacher, Dawn	2h 5m
Rogers, Rebecca	1h 59m
13016066019	2h 22m
debby burgoyne (Guest)	1h 40m
Dorsey, Donald	1h 43m
Tom Watson (12408311975)	45m 45s

Meeting Summary

Total Number of Participants		11
Meeting Title	Frederick County Community Rating System Analysis	
Meeting Start Time	12/8/2021, 12:54:33 PM	
Meeting End Time	12/8/2021, 2:15:19 PM	
Meeting Id	cc1e584b-3620-459b-9c59-789e251f94d8	

Full Name	Duration
Choquette, Scott	1h 17m
Brown, Rohan	1h 19m
Rogers, Rebecca	1h 17m
Payne, Jade	1h 16m
Ennis, David	1h 5m
Dorsey, Donald	2m 53s
Dorsey, Donald	1h 7m
12407390574	3m 59s
Dudley, Dennis	1h 13m
DeSa, Tolson	1h 12m
Rosano, Anthony	1h 9m
Ashbacher, Dawn	1m 5s

From:	ricewoodsboro@aol.com
To:	Payne, Jade
Subject:	Re: [ACTION REQUIRED] Woodsboro Hazard Mitigation Actions Follow-Up
Date:	Tuesday, December 14, 2021 2:18:01 PM
Attachments:	2022 Frederick Mitigation Actions - Woodsboro 12-14-21.xlsx Frederick HMP Goals 2022 12-14-21.docx Frederick-County-HMP Strategy-Disposition 12-14-21.docx image009.png image007.png image005.png image003.png image001.png

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Please find attached the requested forms for return.

Mary E Rice
Town Clerk
Town of Woodsboro
301-898-3800
ricewoodsboro@aol.com

-----Original Message-----
From: Payne, Jade <jpayne@Dewberry.com>
To: hbarnes@woodsboro.org <hbarnes@woodsboro.org>; ricewoodsboro@aol.com <ricewoodsboro@aol.com>
Sent: Tue, Dec 7, 2021 8:36 am
Subject: [ACTION REQUIRED] Woodsboro Hazard Mitigation Actions Follow-Up

Good Morning,

I am following up after the mitigation strategy meeting last week.

I have attached the following documents:

1. 2022 Hazard Mitigation Goals [FOR REVIEW]
2. Strategy Disposition/status updates on actions being removed [FOR REVIEW]
3. 2022 Mitigation Actions [EDITS REQUIRED]

Please review the first two documents and, if necessary, make edits or comments and return to me. The third document has minor *required* edits/input highlighted in yellow, and it should not take long at all. Please return to me ASAP this week as we are under tight deadlines.

Reminder: The final hazard mitigation plan update public meeting is being held this Thursday at 7 pm (the invite says 6:30 pm, but it starts at 7 pm). Please circulate and help us boost turnout:

Virtual Meeting Administrator is inviting you to a scheduled Webex meeting.

From:	Debby Burgoyne
To:	Payne, Jade
Subject:	Re: [ACTION REQUIRED] Burkittsville Hazard Mitigation Actions Follow-Up
Date:	Wednesday, December 8, 2021 5:51:33 PM
Attachments:	image001.png image002.png image003.png image004.png image005.png

Jade, thank you so much. [redacted]. We have all decided to stay together a few extra days.
Sincerely,
Mayor Debby Burgoyne
Burkittsville, MD
(301) 606-6019

Don't forget to like us on Facebook. www.facebook.com/Burkittsville.Maryland

On Wed, Dec 8, 2021 at 2:08 PM Payne, Jade <jpayne@dewberry.com> wrote:

> Thank you, Debby. If early next week works better because you are traveling, please feel free to take that extra time. Thanks for your help!
>
> **Jade Payne**
>
> **Planner II**
>
> **D 703.849.0478 C 727.420.9622**
>
> **www.dewberry.com**
>
> ---
>
> **From:** Debby Burgoyne <Mayor@burkittsville-md.gov>
> **Sent:** Wednesday, December 8, 2021 6:57 AM
> **To:** Payne, Jade <jpayne@Dewberry.com>
> **Subject:** Re: [ACTION REQUIRED] Burkittsville Hazard Mitigation Actions Follow-Up
>
>

Jade,   I am traveling I will return late tomorrow afternoon.   I will do my best to deliver a copy by late friday. If i can get my hands on a spare copy I will overnight it to you .

Sincerely,

Mayor Debby Burgoyne

Burkittsville, MD
(301) 606-6019

Don't forget to like us on Facebook. www.facebook.com/Burkittsville.Maryland

On Tue, Dec 7, 2021 at 8:37 AM Payne, Jade <jpayne@dewberry.com> wrote:

Good Morning,

I am following up after the mitigation strategy meeting last week. Thank you again for sharing your time and expertise—it is greatly appreciated!

I have attached the following documents:

1. 2022 Hazard Mitigation Goals [FOR REVIEW]
2. Strategy Disposition/status updates on actions being removed [FOR REVIEW]
3. 2022 Mitigation Actions [EDITS REQUIRED]

Please review the first two documents and, if necessary, make edits or comments and return to me. The third document has minor *required* edits/input highlighted in yellow, and it should not take long at all. Please return to me ASAP this week as we are under tight deadlines.

In addition, can you please forward me the document that contains the additional projects you had mentioned on the call? Thanks!

Reminder: The final hazard mitigation plan update public meeting is being held this Thursday at 7 pm (the invite says 6:30 pm, but it starts at 7 pm). Please circulate and help

From:	Dudley, Dennis
To:	Payne, Jade
Cc:	Choquette, Scott
Subject:	Burkittsville Project
Date:	Wednesday, December 15, 2021 9:30:55 AM
Attachments:	image001.png 20211215094204858.pdf
Importance:	High

Mayor Burgoyne dropped off the Town of Burkittsville Green Streets and Storm water Master Plan. I have scanned the Storm Drain and Natural Resources Management sections.

The Plan has four projects Storm Drain system, Natural Resources Management and Restoration; Traffic Calming Devices and continuous sidewalks.

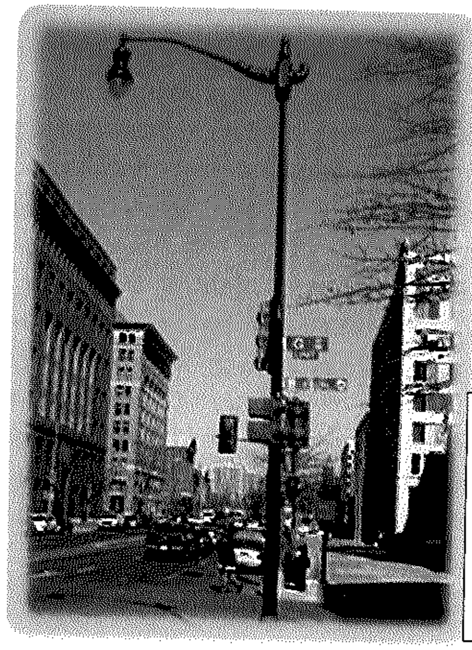
Burkittsville has no storm drains. The Storm Drain System is estimated to cost 1,527,463 dollars.

The Natural Resources Management and Restoration estimate is 3,530,862.50 Dollars.

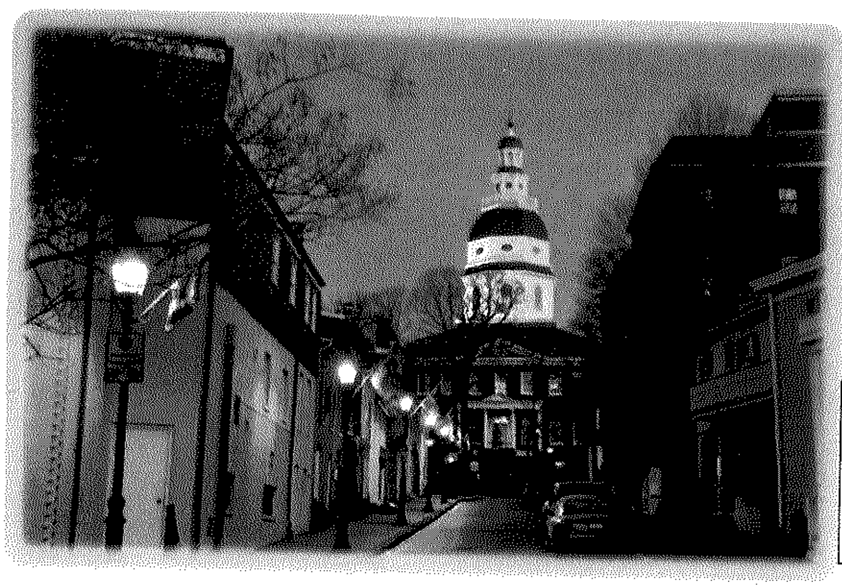
Advise if you need more information. Dennis

Dennis K. Dudley
Director, Department of Emergency Preparedness
Division of Emergency Management
301-600-1418
240-357-7819

Precedence Image 11: Pedestrian Scale Historic Looking Lighting



Precedence Image 12: Historic Looking Cobra Style Fixture



Precedence Image 13: Pedestrian Scale Historic Look Lighting at Night

Storm Drain Network:

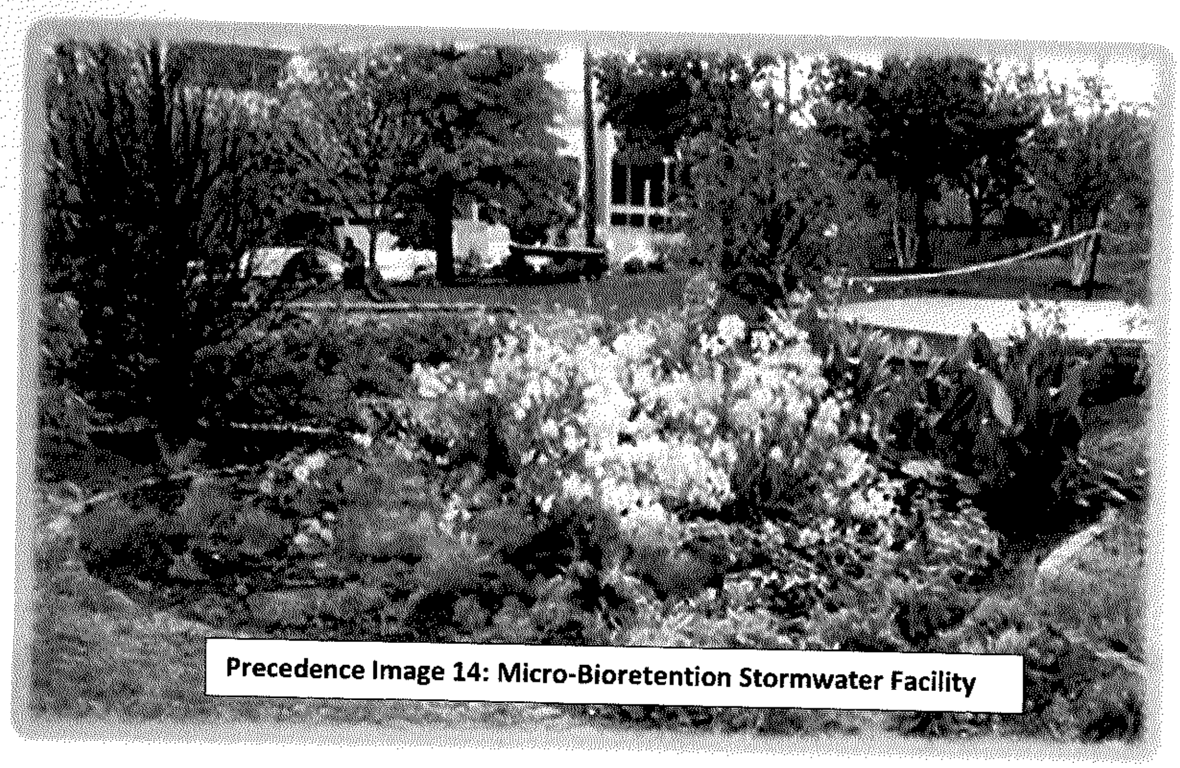
There is currently no storm drain system within Main Street. The lack of a storm drain system leads to street flooding during high intensity rainfall events. A storm drain consists of inlets, manholes and a pipe network that is designed to collect and provide safe conveyance of stormwater runoff (from streets) to treatment facilities and/or off the street. In addition to providing safe conveyance, sump pumps and roof drains may be discharged into the storm drain system-eliminating the potential for ice to form on the street because of direct discharges. A storm drain system will be required to install stormwater water quality devices such as Filterra or other retro-fit BMPs, therefore it should be considered a high priority.

Culvert Upgrades/Flooding Mitigation:

The town has several areas where natural drainage features (streams or swales) area conveyed across Main Street. For the Streetscape design three areas are considered, one West Main Street (at the bottom of the hill prior to entry into the populated limits of town) and two on East Main Street (at the culvert that was recently replaced and where the park is located) have been analyzed. Culverts are sized using methodology that calculates runoff and peak flows based on drainage area characteristics such as land use, soils and other conditions. Based on a preliminary hydraulic and hydrologic (H&H) analysis (Appendix 1), the existing culverts/storm drains as discussed above, are not sized appropriately. Appropriate sizing and replacement is recommended (as shown on streetscape design schematics which follow). Culverts should be designed to safely pass a minimum of the 10-year peak -flow and possible the 100-year flow on East Main Street based on the potential for homes to flood. The culverts will serve as the trunk to the storm drain conveyance system for the street and should be considered as part of the storm drain conveyance system design. Appendix 1 includes drainage area mapping used to determine hydrologic and hydraulic characteristics for modeling, as well as preliminary drainage area analysis and calculation of peak flows which have been used for planning of future designs. (Drainage areas calculations need to be field verified during final design.)

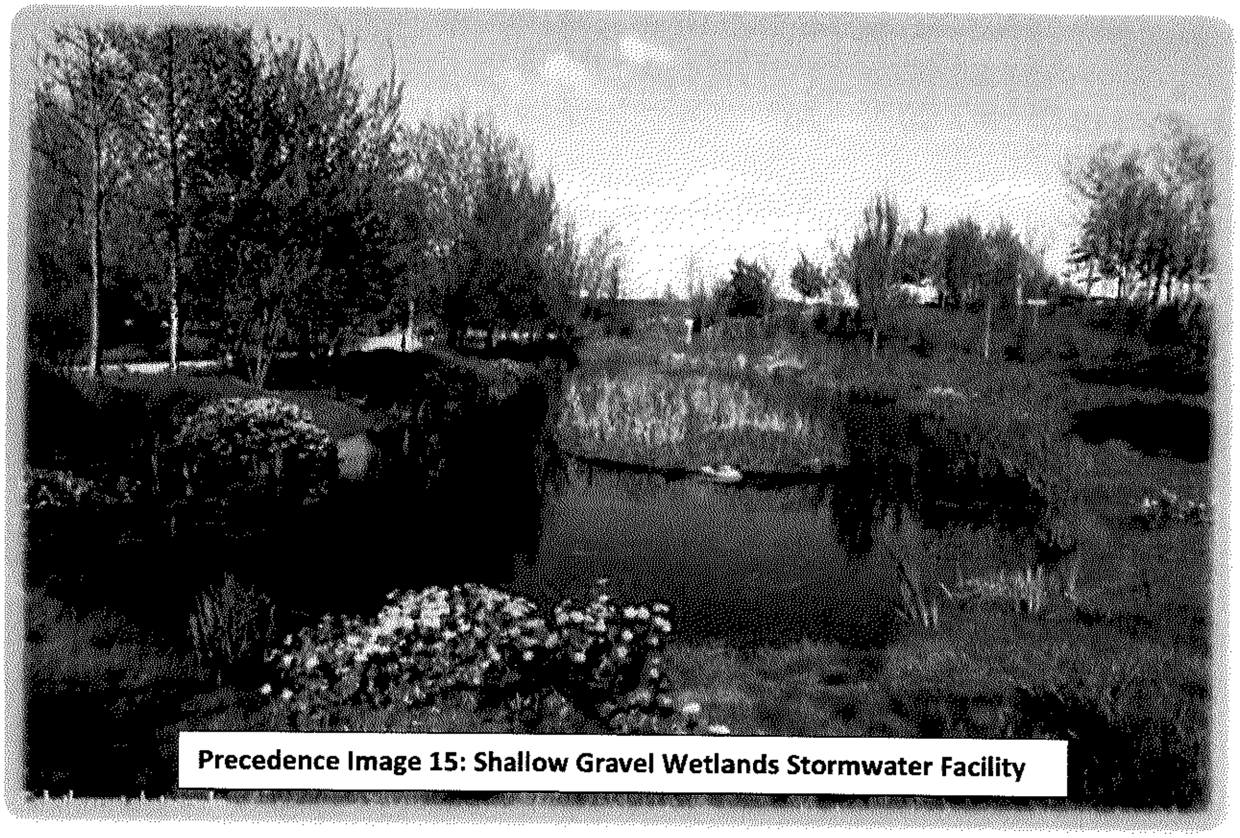
Stormwater Management-ESD and Water Quality:

To permit streetscape design, providing stormwater management for disturbed areas will be required per Maryland and Frederick County requirements. A cornerstone for providing treatment is Environmental Site Design (ESD). ESD treatment facilities (as referenced in this report) include micro-bioretention, rain gardens and shallow gravel wetlands.



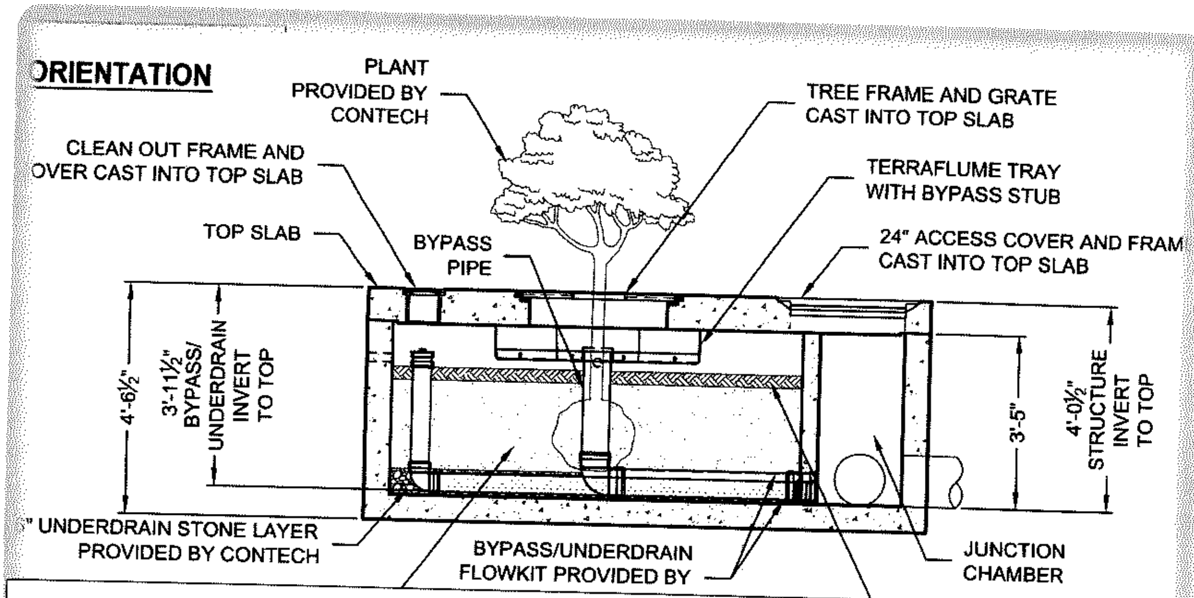
Precedence Image 14: Micro-Bioretention Stormwater Facility

The Town's geology (with potential high water tables) and possible locations of facilities suggests that shallow gravel wetlands could be the treatment device of choice.



Precedence Image 15: Shallow Gravel Wetlands Stormwater Facility

Islands, within the streetscape design, are proposed in several locations in the drawings. Where possible, the bumpouts should accommodate stormwater management treatment such as rain gardens or micro-bioretention facilities. Currently, the town is trying to acquire a vacant piece of property located on East Main Street. This piece of property has been recommended as a stormwater park. It is recommended that the lower portion of this park be considered for use of treatment of stormwater from East Main Street. In addition, other suitable areas for stormwater treatment, currently located on private property, have been identified. If requirements for ESD cannot be met, additional structural practices such as Filterra Tree Boxes or other filtration systems may need to be implemented.



Precedence Image 16: Filterra Treebox Stormwater Treatment Device Diagram

Precedence Image 17: Filterra Treebox Stormwater Treatment Device Installation

These systems are costly and require routine maintenance, however, are effective at treating stormwater quality. In addition, tree boxes can provide added aesthetic beauty in the form of a tree. To implement and/or provide retrofit opportunities for stormwater management in most town, a storm drain system will be required to be installed.

Note on Town Center:

Depending on the length of time before and present condition of the existing SHA street improvements (stamped concrete and preservation of historic drainage cobbles) at final design, improvement on MD 17 may be required. The GSSMP proposes no design other than adding herringbone sidewalk at the location of the SHA improvements. Additional SHA permits will be required to be obtained for improvements in the SHA right-of-way. Coordination with SHA for traffic control and other design related requirements shall be included by the consultants completing design.

Note on Green Alleys:

Burkittsville's alleys are utilized for walking by the town residents. As an alternate option to and/or along with walkable sidewalks, the design engineer shall consider practical options for beautification, functionality, connectivity of pedestrian and/or bicycles paths. Alleys could be paved with permeable pavers for aesthetic appearance and for stormwater treatment.

VIII. NATURAL RESOURCES MANAGEMENT AND RESTORATION

The Town of Burkittsville is surrounded by land that is utilized for agricultural and steep wooded hills to the west. The geography and use of surrounding are for agriculture generally lead to higher runoff rates. Geology and soils (See Appendix 4) in and around the Town point to a high or seasonably ground water table as evidenced during site visits and based on complaints of flooded basements. In addition, given the historic nature of the town, there is very little functional stormwater or storm drain infrastructure in place. Homes were historically built close to drainage ways and no stormwater management devices exist.

There are numerous concerns related to natural resources degradation which include:

- Stream flooding at alleys
- Sheet flow from agriculture fields into yards/homes
- Stream erosion/degradation
- Sediment deposition from agricultural runoff
- Water quality of agricultural runoff
- Basement flooding

To address the above concerns, a list of potential projects is provided, along with component description and a general template for possible design solutions. It is noted that many of the possible design solutions are proposed on private property. Coordination and cooperative community efforts with all stakeholders will be a key to successful implementation. "Illustration 14. Natural Resources Management and Restoration Key" (on the following page) shows the location of different projects and provides a reference callout that corresponds to following subsections and costs located in "Table 2: Opinion of Probably Costs for Natural Resources Management and Restoration".

Culvert Upgrades at Alleys (CULVERT):

As it applies to peak flow conveyance for culverts in Main Street (as reviewed in the streetscape design section above, under Culvert Upgrades and Flooding Mitigation), the existing culverts located alleys are undersized. Further analysis and design should be completed with the goal of replacing the culverts to avoid frequent flooding. If possible, the design, permitting and construction should be considered as part of the associated stream restoration/relocation projects.

Buffers (F1, F2, F3, G):

A perennial and ephemeral stream flows within the Town. The perennial stream flows in the rear yard of several residential properties with little to no riparian buffer. A seep leading to an ephemeral stream flows from the agricultural field. A vegetated buffer zone of native grasses, perennials, shrubs and trees would filter runoff and improve habitat for aquatic wildlife while providing food and cover for wildlife. Vegetated buffers will trap sediments, nutrients and pollutants. A minimum of 15-25 feet is recommended along the stream's edge within the residential area, while a more expansive 25-50 feet is recommended within the agricultural area. Along the streams, large trees and shrubs that tolerate wet conditions should be planted to stabilize the stream banks. Further from the stream bank, a diverse mix of native trees and shrubs should be planted. A mix of native grasses and wildflowers can be used to transition into the formal residential yards. In agricultural areas, the outer limits of the vegetated buffer are the most important zone for slowing runoff and trapping sediments. Reintroduction of the buffers next to streams or in wetlands may require state and federal permits and a qualified professional should be consulted. Based on space constraints in town because of existing infrastructure and outside of town because of agricultural uses, smaller 10' buffers are shown on the plans. Precedence images 18 and 19 are provided on the following page. Plants that are typically associated with buffers include:

Buffers (upland) and Meadows

- White Fringetree, *Chionanthus virginicus*
- Eastern Redbud, *Cercis canadensis*
- Pawpaw, *Asimina triloba*
- White Pine, *Pinus strobus*
- Eastern hophornbeam, *Ostrya virginiana*
- Viburnum spp.
- Winterberry, *Ilex verticillata*
- Sumacs (*Rhus glabra, Rhus typhina*)

Stream Buffers (lowland) and Wetlands

- Pin Oak, *Quercus palustris*
- Hackberry, *Celtis occidentalis*
- Chokeberry, *Aronia arbutifolia*
- Buttonbush, *Cephalanthus occidentalis*
- Cardinal Flower, *Lobelia cardinalis*
- Soft Rush, *Juncus effusus*
- Broomsedge, *Andropogon virginicus*
- Swamp Milkweed, *Asclepias incarnate*
- New England Aster, *Aster novae-angliae*

Stream Restoration and Relocation (C, D, G):

Streams and drainage ways are natural features which convey water. Streams can be categorized as perineal (flow continuously), intermittent (may cease flowing for a period of time) or ephemeral (flowing only during and briefly after storm events) and a variety of other biological and physical conditions. The health of the stream is dependent on the drainage area (and resulting runoff characteristics) and preserving the riparian (interface of stream to surrounding land) area around the stream.

There are two sections of stream that flow through the developed portion of town (C and D) and 2 sections that are located outside of the urban development in agricultural fields. In all cased, the health of the stream is impacted by agriculture (sedimentation and nutrient laden runoff), impervious areas (increased excess flows) and a lack of a riparian buffer. There are areas along the stream where the bank is becoming incised and showing signs of erosion.

The first portion of the stream located in developed areas of the town (C) is on the south west side of East Main Street between the alley (Lakeside Drive) and the headwall for the recently replaced storm drain in East Main. This portion of the stream is located completely on a homeowner's property and is maintained as a small incised V-channel with >1:1 bank slopes and manicured grass areas surrounding it. This portion of the stream is located directly adjacent to a lot that the town would like to acquire for the purposes of providing additional natural resource and stormwater management. The stream should be relocated onto the lot and returned to its natural sinuosity. As most of the runoff is generated in agricultural fields, providing wetland stream buffers around the stream will allow additional treatment of the runoff and ground water.

The second portion of the stream located in developed areas of town (D) starts at the outfall of the recently replaced culvert and flows through the town-owned park and to the alley (Locust Road). This portion of the stream flows through the backyards of 8 residents. Reconnecting the floodplain to the stream through grading and providing grade control structures will slow down water, improve water quality and dissipate erosive energy. In areas with reduced lot sizes, stabilization of the banks with imbricated stone, live stakes and plantings will provide cost effective solutions while contributing to the overall buffer management. (See Section V about constraints associated with septic field locations.)

The two sections of stream located in agricultural areas (G) flow through agricultural areas. Portions of the areas have been impacted grading, sedimentation, agriculture, ATV traffic and may contain little to no riparian buffer. Restoration of degraded stream bank was estimated to be approximately 30% of the stream reach and establishment of a minimum of a 10' riparian buffer and reconnection with the floodplain on both sides of the stream should be considered.

Providing wetland stream buffers around the stream at the location of the town-owned park (review in the following section) will allow additional treatment of the runoff and ground water. Work on the channel will require easements from homeowners. Work in and around the stream channel may require state and federal permits and a design professional should be consulted. Precedence Images 20-22 follow.

Plants that may be used on stream banks for stabilization include:

- Silky Dogwood, *Cornus amomium*
- Grey Stem Dogwood, *Cornus racemose*
- Black Willow, *Salix nigra*
- River Birch, *Betula nigra*
- Buttonbush, Cephalanthus occidentalis
- Spicebush, *Lindera benzoin*

Designed Stream Buffer Wetland (B1, B2):

Wetlands are natural water filters – and important part of stream health water quality. There are two opportunities for providing stream buffer wetlands. The first is in the existing town park located at Locust Road. The stream runs through the park property and could be utilized to establish a wetland buffer wetland. The second possible project is the vacant property next to which the ephemeral/intermittent stream currently flows through a town residents side yard. This property provides a unique opportunity for a designed stream buffer wetland in conjunction with the stream restoration reviewed above. By trapping and holding water, nutrients and pollutants will be removed from the stream, allowing cleaner water to flow downstream. The wetland buffer will also work to help mitigate flooding, provide groundwater recharge. The envisioned design can be noted in the following precedence image.

Precedence Image 23: Stream Buffer Wetland

Natural Resources Management and Restoration Opinion of Probable Cost

Base level all-inclusive construction cost have been provided for the different projects considered:

MAP KEY	Natural Resources Management and Restoration	Unit	Unit Price	Quantity	Cost
A1 and A2	LARGE" RCP (stream conveyance through alleys)	lf	$300.00	60	$18,000.00
	Head Walls/ Manholes	ea	$10,000.00	4	$40,000.00
B1 and B2	Stream Buffer Wetland	sf	$15.00	12000	$180,000.00
C	Stream Relocation	lf	$800.00	240	$192,000.00
D	Stream Restoration	lf	$500.00	990	$495,000.00
E1, E2, E3 AND E4	Vegetated Swale	lf	$50.00	4000	$200,000.00
F1, F2 AND F3	Perineal Meadow Buffer	sf	$5.00	40000	$200,000.00
G	Riparian Zone Buffer	sf	$15.00	55240	$828,600.00
	Stream Resoration	lf	$500.00	829	$414,300.00
				SUBTOTAL	$2,567,900.00
	Design, Permitting and Engineering (15%)	ls		1	$385,185.00
	Construction Administration (10%)	ls		1	$256,790.00
				TOTAL	$3,209,875.00
				10% CONTIGENCY	$320,987.50
				TOTAL BUDGETARY	**$3,530,862.50**

Table 2: Opinion of Probably Costs for Natural Resources Management and Restoration

Meeting Summary		
Total Number of Participants		24
Meeting Title	Frederick County HMP Update: Draft Review Workshop	
Meeting Start Time	1/26/2022, 3:25:15 PM	
Meeting End Time	1/26/2022, 4:06:57 PM	
Meeting Id	024c4403-419c-4ec2-bf6c-04a5bc505af6	

Full Name	Duration
Tracy Coleman	40m 27s
Payne, Jade	39m 37s
Sean Williams (Guest)	39m 27s
Dudley, Dennis	39m 37s
Rogers, Rebecca	38m 54s
Ennis, David	38m 38s
Jim Humerick	38m 13s
Newman, Jon	38m 14s
Kelly (Guest)	37m 58s
Joe Birch (Guest)	37m 50s
Muntz, Tyler	38m 43s
Dorsey, Donald	37m 3s
Fox, Kevin D.	36m 52s
Lascolette, Rowela	36m 9s
Riddell, Sharon	34m 34s
Hibbard, Ronald D.	25m 25s
Brown, Rohan	35m 41s
Nathan Hupp	33m 44s
Abby Ingram (Brunswick) (Guest)	33m 58s
Lewis Godwin	33m 32s
Rosano, Anthony	33m 22s
Robin Shusko	32m 1s
Ashbacher, Dawn	31m 9s
Maynard, Thurmond	28m 49s

APPENDIX G: PUBLIC OUTREACH MATERIALS

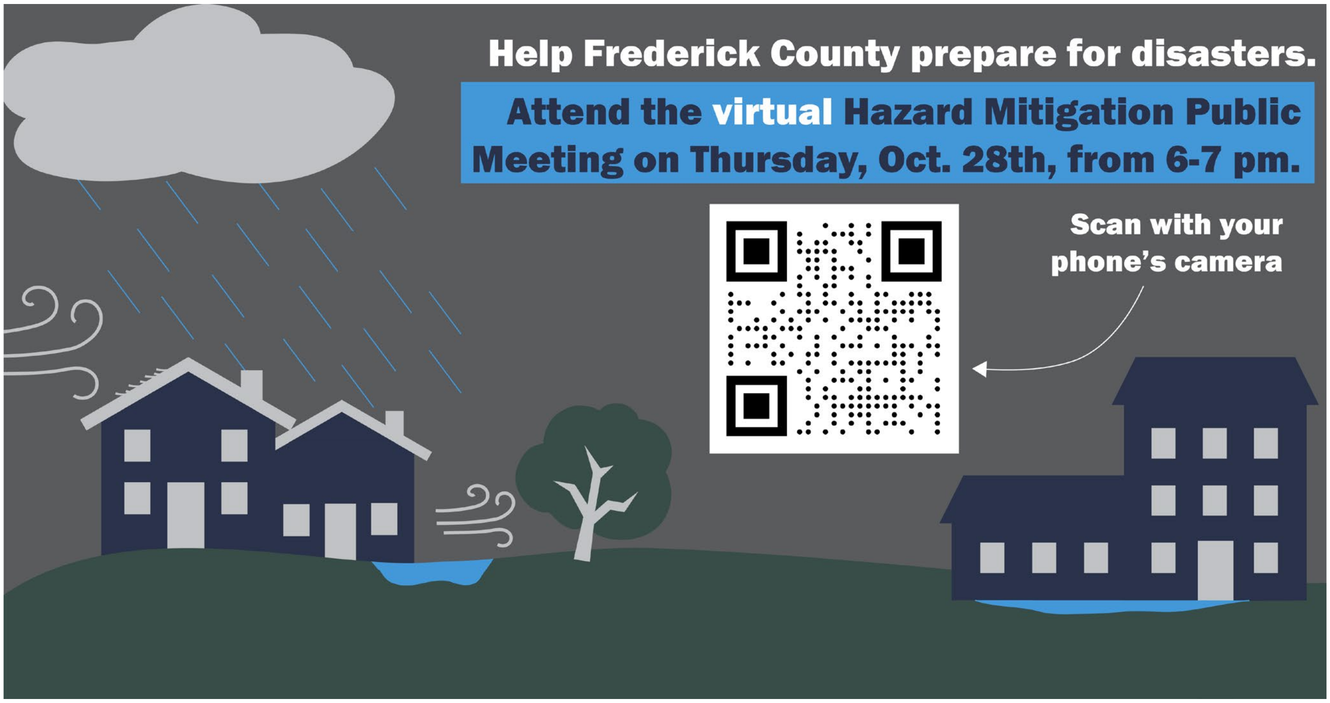


Figure 36. Public Meeting #1 Social Media, Email, and Newsletter Advertisement

Figure 37. Public Meeting #2 Social Media Advertisement

Posted by u/WP-Hazard-Mitigation 19 hours ago

14

TONIGHT: Public Hazard Mitigation Meeting

Hey everyone!

Frederick County is updating its hazard mitigation plan, and there is a public meeting being held tonight at 7 PM to go over the process and offer a chance for the public to ask questions. If you have any interest in natural hazards/disasters in the county and preventing damage from them, please consider joining!

You can watch the meeting live on FCG TV (Channel 19 or online https://frederickcountymd.gov/1225/FCG-TV) or on the public portal online at https://publicinput.com/YF8841.

Virtual public input is accepted on the public portal online at https://publicinput.com/YF8841.

To provide public input over the phone, please dial 1-855-925-2801, enter code 2329 and press * for meeting options:

· Press 1 to listen to the meeting

· Press 2 to record a comment

· Press 3 to be placed in a muted queue to speak during the meeting

You must state your name at the beginning of your phone call, message or voicemail for your message or voicemail to be presented during the meeting. Please do not say your phone number as this will be made public.

If you have any questions, feel free to drop them here and I can answer them. There will also be a draft plan for review/comment in the next couple weeks. More information will be posted on this webpage: https://www.frederickcountymd.gov/HMP

1 Comment Share Edit Post Save Hide ... 100% Upvoted

Figure 38. Public Meeting #2 Reddit Advertisement

Frederick County MD Events And Activites

Jade Payne
· Just now ·

Hey everyone!

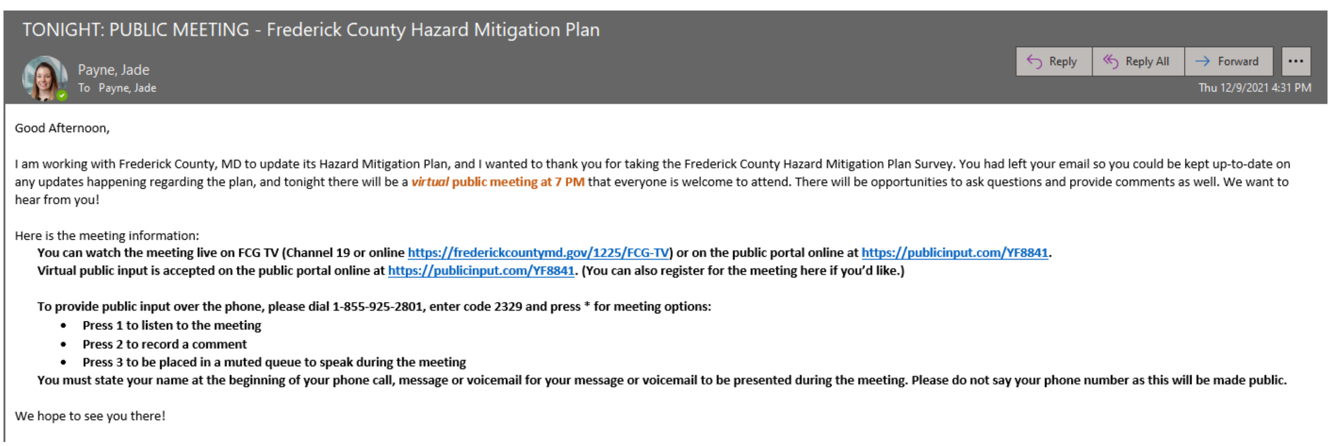
Frederick County is updating its hazard mitigation plan, and there is a public meeting being held tonight at 7 PM to go over the process and offer a chance for the public to ask questions. If you have any interest in natural hazards/disasters in the county and preventing damage from them, please consider joining!

You can watch the meeting live on FCG TV (Channel 19 or online https://frederickcountymd.gov/1225/FCG-TV) or on the public portal online at https://publicinput.com/YF8841.

You can submit questions and comments through the public portal as well! Hope to see you there!

Like Comment Share

Figure 39. Public Meeting #2 Facebook Advertisement



TONIGHT: PUBLIC MEETING - Frederick County Hazard Mitigation Plan

Payne, Jade
To Payne, Jade

Reply Reply All Forward

Thu 12/9/2021 4:31 PM

Good Afternoon,

I am working with Frederick County, MD to update its Hazard Mitigation Plan, and I wanted to thank you for taking the Frederick County Hazard Mitigation Plan Survey. You had left your email so you could be kept up-to-date on any updates happening regarding the plan, and tonight there will be a ***virtual* public meeting at 7 PM** that everyone is welcome to attend. There will be opportunities to ask questions and provide comments as well. We want to hear from you!

Here is the meeting information:

You can watch the meeting live on FCG TV (Channel 19 or online https://frederickcountymd.gov/1225/FCG-TV) or on the public portal online at https://publicinput.com/YF8841.
Virtual public input is accepted on the public portal online at https://publicinput.com/YF8841. (You can also register for the meeting here if you'd like.)

To provide public input over the phone, please dial 1-855-925-2801, enter code 2329 and press * for meeting options:

- **Press 1 to listen to the meeting**
- **Press 2 to record a comment**
- **Press 3 to be placed in a muted queue to speak during the meeting**

You must state your name at the beginning of your phone call, message or voicemail for your message or voicemail to be presented during the meeting. Please do not say your phone number as this will be made public.

We hope to see you there!

Figure 40. Public Meeting #2 Email Blast Advertisement

Dewberry

Meeting Agenda

Title:	Frederick County Hazard Mitigation Plan 2021 – Public Meeting #1	Location:	Virtual, Microsoft Teams
Date:	Thursday, October 21, 2021	Time:	6:00 pm – 7:00 pm ET
Purpose:	Provide an overview of the hazard mitigation planning process and status update		

Agenda Items

Topic	Presenter	Time
Welcome and opening remarks	Dennis Dudley, Frederick County Emergency Management, Department of Emergency Preparedness	6:00 – 6:05 pm
Hazard mitigation planning background - What is hazard mitigation? - Plan purpose - Hazard mitigation grants - Plan update requirements	Scott Choquette, Dewberry	6:05 – 6:10 pm
Project status update - Milestones - Public outreach opportunities	Jade Payne, Dewberry	6:10 – 6:15 pm
New plan components - Climate adaptation - Social vulnerability analysis - Future development analysis	Jade Payne, Dewberry	6:15 – 6:25 pm
Hazard identification and risk assessment - Overview - Hazard assessment sample	Scott Choquette, Dewberry	6:25 – 6:40 pm
Mitigation goal development	Jade Payne, Dewberry	6:40 – 6:45 pm
Next steps & opportunity for questions and feedback	Scott Choquette, Dewberry	6:45 – 7:00 pm

Frederick County Hazard Mitigation Plan – 2021 Update

Figure 41. Public Meeting #1 Agenda

Dewberry

Meeting Agenda

Title:	Frederick County Hazard Mitigation Plan 2021 – Public Meeting #2	Location:	Virtual Meeting – Follow the link at the bottom of the page.
Date:	Thursday, December 9, 2021	Time:	7:00 pm – 8:00 pm ET
Purpose:	Provide an overview of the hazard mitigation planning process and solicit public input		

Agenda Items

Topic	Presenter	Time
Welcome and opening remarks	Dennis Dudley, Frederick County Emergency Management, Department of Emergency Preparedness	7:00 – 7:05 pm
Why a hazard mitigation plan - What is hazard mitigation? - Plan purpose	Scott Choquette, Dewberry	7:05 – 7:10 pm
Where we are in the process - Milestones - Mitigation strategy development	Jade Payne, Dewberry	7:10 – 7:15 pm
New plan components - Climate adaptation - Social vulnerability analysis - Future development analysis	Jade Payne, Dewberry	7:15 – 7:25 pm
Risk assessment overview	Scott Choquette, Dewberry	7:25 – 7:35 pm
Public survey results	Jade Payne, Dewberry	7:35 – 7:45 pm
Public input on mitigation actions	Scott Choquette, Dewberry	7:45 – 7:50 pm
Questions and next steps	Jade Payne, Dewberry	7:50 – 8:00 pm

Follow link to the meeting:
https://frederickcountymd.webex.com/frederickcountymd/j.php?MTID=mddf2a26c4987f80c1ff17f3c74e409b1

Frederick County Hazard Mitigation Plan – 2021 Update

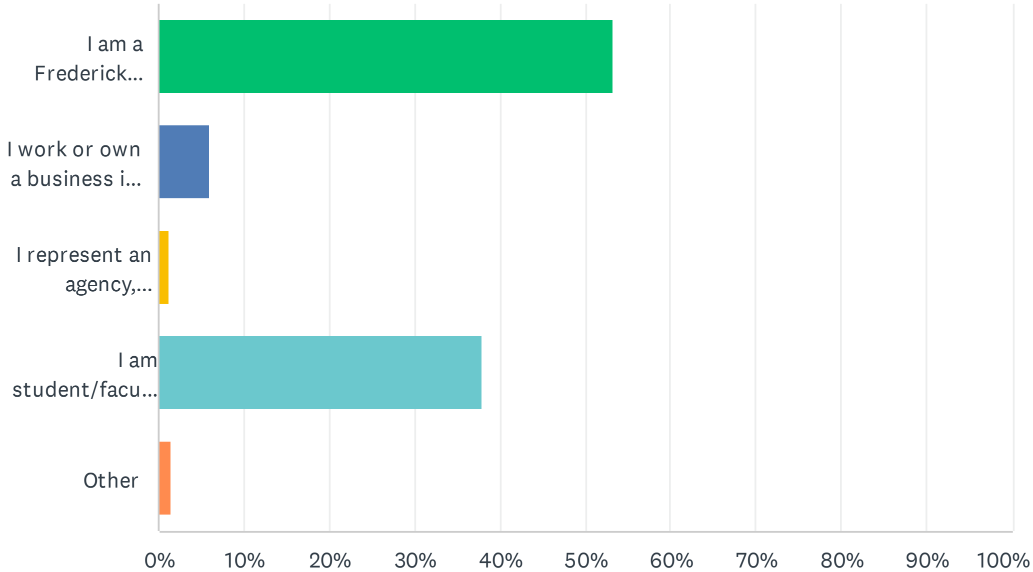
Figure 42. Public Meeting #2 Agenda

Hazard Mitigation Survey

The hazard mitigation survey that was advertised to the public is contained on the following pages. It shows the questions asked as well as responses received. Personally-identifiable information has been redacted for privacy concerns.

Q1 Which best describes you?

Answered: 684 Skipped: 0

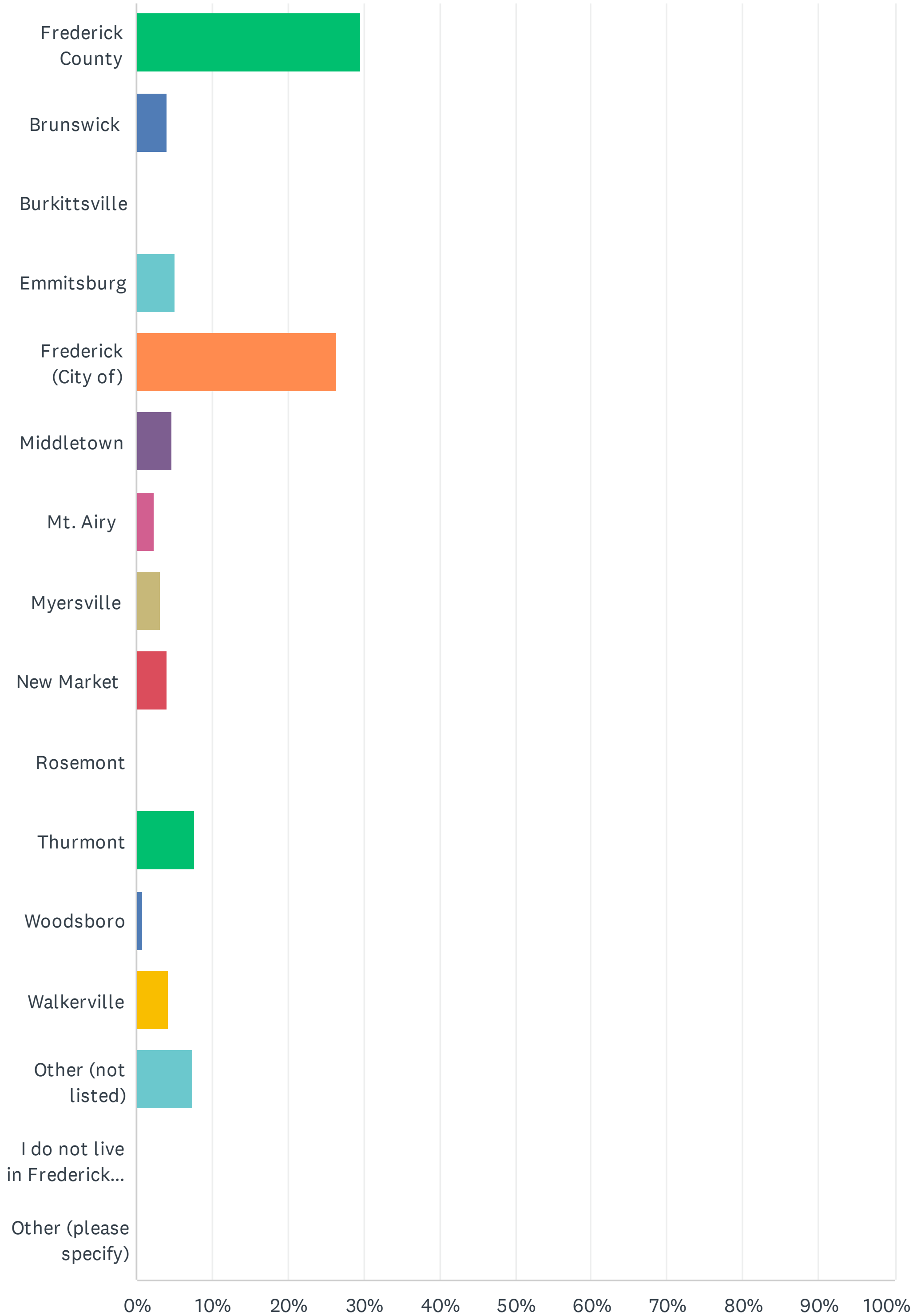


ANSWER CHOICES	RESPONSES	
I am a F eder ck County es dent.	53.22%	364
I wo k o own a bus ness n F ede ck County, but I do not ve n F ede ck County.	5.99%	41
I ep esent an agency, mun c pa ty, ju sd ct on, o o gan zat on with a vested nterest n F eder ck County, but I do not ve n F ede ck County.	1.32%	9
I am student/facu ty/staff of a col ege or un ve s ty ocated n F ede ck County.	38.01%	260
Othe	1.46%	10
TOTAL		684

#	OTHER	DATE
1	I am a Frederick County resident and work for Frederick County	10/20/2021 4:03 PM
2	Work, with a vested interest and live in the county	9/30/2021 7:22 PM
3	I am a Frederick County resident and I own a business here.	9/30/2021 8:13 AM
4	I work for and represent an agency in Frederick County and live in the county.	9/30/2021 8:04 AM
5	I work for and represent an agency in Frederick County and live in the county.	9/30/2021 8:03 AM
6	Frequent shopper	9/29/2021 2:13 PM
7	I own a Frederick county business and reside in Frederick county	9/29/2021 9:33 AM
8	Own a business and live in Frederick	9/29/2021 9:27 AM
9	I'm a Frederick County Resident and I work for the Frederick County's Zoning office.	9/29/2021 8:49 AM
10	I represent an agency, municipality, jurisdiction, or organization with a vested interest in Frederick County and I am a resident.	9/24/2021 8:45 AM

Q2 Which jurisdiction do you live in?

Answered: 348 Skipped: 336



ANSWER CHOICES	RESPONSES	
Frederick County	29.60%	103
Brunswick	4.02%	14
Burkittsville	0.00%	0
Emmitsburg	5.17%	18
Frederick (City of)	26.44%	92
Middletown	4.60%	16
Mt. Airy	2.30%	8
Myersville	3.16%	11
New Market	4.02%	14
Rosemont	0.29%	1
Thurmont	7.76%	27
Woodsboro	0.86%	3
Walkerville	4.31%	15
Other (not listed)	7.47%	26
I do not live in Frederick County	0.00%	0
Other (please specify)	0.00%	0
TOTAL		348

#	OTHER (PLEASE SPECIFY)	DATE
	There are no responses.	

Q3 What is your zip code?

Answered: 349 Skipped: 335

#	RESPONSES	DATE
1	21788	10/25/2021 11:02 AM
2	21727	10/24/2021 4:24 PM
3	21727	10/22/2021 1:58 PM
4	21701	10/22/2021 9:18 AM
5	21727	10/21/2021 5:24 PM
6	21774	10/21/2021 1:57 PM
7	21727	10/21/2021 1:20 PM
8	21773	10/21/2021 12:04 PM
9	21727	10/21/2021 11:48 AM
10	21704	10/21/2021 11:32 AM
11	21773	10/21/2021 8:06 AM
12	21788	10/20/2021 9:30 PM
13	21702	10/20/2021 6:46 PM
14	21703	10/20/2021 6:31 PM
15	21702	10/20/2021 4:09 PM
16	21790	10/20/2021 4:05 PM
17	21702	10/20/2021 3:57 PM
18	21702	10/20/2021 1:07 PM
19	21701	10/20/2021 12:10 PM
20	21788	10/20/2021 12:01 PM
21	21716	10/20/2021 11:56 AM
22	21755	10/20/2021 11:52 AM
23	21701	10/20/2021 11:49 AM
24	21793	10/20/2021 11:48 AM
25	21703	10/19/2021 8:05 PM
26	21769	10/19/2021 8:22 AM
27	20842	10/18/2021 4:16 PM
28	21701	10/18/2021 11:23 AM
29	21701	10/18/2021 9:30 AM
30	21702	10/18/2021 3:22 AM
31	21777	10/17/2021 5:28 PM
32	21777	10/17/2021 5:27 PM
33	21769	10/16/2021 11:15 AM

34	21701	10/16/2021 9:25 AM
35	21703	10/15/2021 8:54 PM
36	21701	10/15/2021 8:27 PM
37	21769	10/15/2021 5:49 PM
38	21783	10/15/2021 3:32 PM
39	21703	10/15/2021 12:27 PM
40	21704	10/15/2021 12:11 PM
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42	21710	10/15/2021 11:54 AM
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44	21701	10/15/2021 11:42 AM
45	21716	10/14/2021 8:37 PM
46	21716	10/14/2021 7:02 PM
47	21716	10/13/2021 6:22 PM
48	21758	10/13/2021 7:56 AM
49	21703	10/11/2021 3:35 PM
50	21774	10/11/2021 12:49 PM
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52	21774	10/8/2021 7:22 AM
53	21773	10/7/2021 4:05 PM
54	21769	10/7/2021 12:11 PM
55	21701	10/7/2021 8:28 AM
56	21710	10/6/2021 4:37 PM
57	21755	10/6/2021 3:09 PM
58	21703	10/6/2021 11:21 AM
59	21769	10/6/2021 11:08 AM
60	21755	10/6/2021 11:06 AM
61	21701	10/5/2021 8:27 PM
62	21788	10/5/2021 4:24 PM
63	21774	10/5/2021 4:05 PM
64	21703	10/5/2021 2:38 PM
65	21703	10/5/2021 1:38 PM
66	21780	10/5/2021 12:33 PM
67	21702	10/5/2021 10:42 AM
68	21702	10/5/2021 9:26 AM
69	21755	10/5/2021 9:06 AM
70	21701	10/4/2021 8:15 PM
71	21788	10/4/2021 2:11 PM

72	21704	10/4/2021 2:08 PM
73	21702	10/4/2021 1:33 PM
74	21788	10/4/2021 12:38 PM
75	21754	10/4/2021 11:33 AM
76	21702	10/4/2021 11:23 AM
77	21755	10/4/2021 9:43 AM
78	21701	10/4/2021 8:48 AM
79	21703	10/4/2021 8:32 AM
80	21788	10/4/2021 8:29 AM
81	21703	10/4/2021 8:15 AM
82	21727	10/4/2021 8:03 AM
83	21727	10/3/2021 9:46 PM
84	21702	10/3/2021 7:59 PM
85	21702	10/3/2021 2:05 PM
86	21701	10/3/2021 12:11 PM
87	21701	10/3/2021 11:04 AM
88	21727	10/3/2021 8:42 AM
89	21788	10/3/2021 8:09 AM
90	21703	10/3/2021 7:45 AM
91	21788	10/3/2021 12:45 AM
92	21793	10/2/2021 4:38 PM
93	21701	10/2/2021 11:02 AM
94	21703	10/2/2021 11:00 AM
95	21771	10/2/2021 6:52 AM
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97	21703	10/1/2021 8:50 PM
98	21702	10/1/2021 5:54 PM
99	21727	10/1/2021 5:44 PM
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102	21727	10/1/2021 1:21 PM
103	21710	10/1/2021 1:01 PM
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105	217770	10/1/2021 9:12 AM
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111	21774	9/30/2021 3:38 PM
112	21702	9/30/2021 3:26 PM
113	21701	9/30/2021 11:12 AM
114	21755	9/30/2021 10:45 AM
115	21710	9/30/2021 10:43 AM
116	21727	9/30/2021 10:24 AM
117	21701	9/30/2021 9:20 AM
118	21703	9/30/2021 9:19 AM
119	21788	9/30/2021 8:43 AM
120	21798	9/30/2021 8:31 AM
121	21701	9/30/2021 8:04 AM
122	21769	9/30/2021 8:02 AM
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129	21701	9/29/2021 10:10 PM
130	21716	9/29/2021 9:55 PM
131	21774	9/29/2021 9:20 PM
132	21771	9/29/2021 8:42 PM
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165	21701	9/29/2021 12:16 PM
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206	21702	9/29/2021 9:59 AM
207	21793	9/29/2021 9:59 AM
208	21757	9/29/2021 9:56 AM
209	21703	9/29/2021 9:53 AM
210	21702	9/29/2021 9:47 AM
211	21773	9/29/2021 9:42 AM
212	21703	9/29/2021 9:38 AM
213	21702	9/29/2021 9:38 AM
214	21769	9/29/2021 9:35 AM
215	21755	9/29/2021 9:33 AM
216	21703	9/29/2021 9:28 AM
217	21701	9/29/2021 9:23 AM
218	21778	9/29/2021 9:15 AM
219	21702	9/29/2021 9:15 AM
220	21702	9/29/2021 9:13 AM
221	21703	9/29/2021 9:08 AM
222	21701	9/29/2021 9:07 AM
223	21701	9/29/2021 9:07 AM

224	21701	9/29/2021 9:07 AM
225	21703	9/29/2021 9:06 AM
226	21788	9/29/2021 8:59 AM
227	21774	9/29/2021 8:59 AM
228	21793	9/29/2021 8:58 AM
229	21701	9/29/2021 8:57 AM
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259	21701	9/29/2021 7:32 AM
260	21774	9/29/2021 7:28 AM
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262	21701	9/29/2021 7:20 AM
263	21702	9/29/2021 7:05 AM
264	21703	9/29/2021 7:00 AM
265	21757	9/29/2021 6:46 AM
266	21773	9/29/2021 6:37 AM
267	21727	9/29/2021 6:13 AM
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269	21793	9/29/2021 5:44 AM
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296	21703	9/28/2021 5:11 PM
297	21774	9/28/2021 5:06 PM
298	21702	9/28/2021 5:05 PM
299	21703	9/28/2021 5:04 PM

300	21716	9/28/2021 4:54 PM
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337	21702	9/28/2021 8:06 AM

338	21788	9/28/2021 8:06 AM
339	21701	9/28/2021 8:06 AM
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341	21702	9/25/2021 3:53 PM
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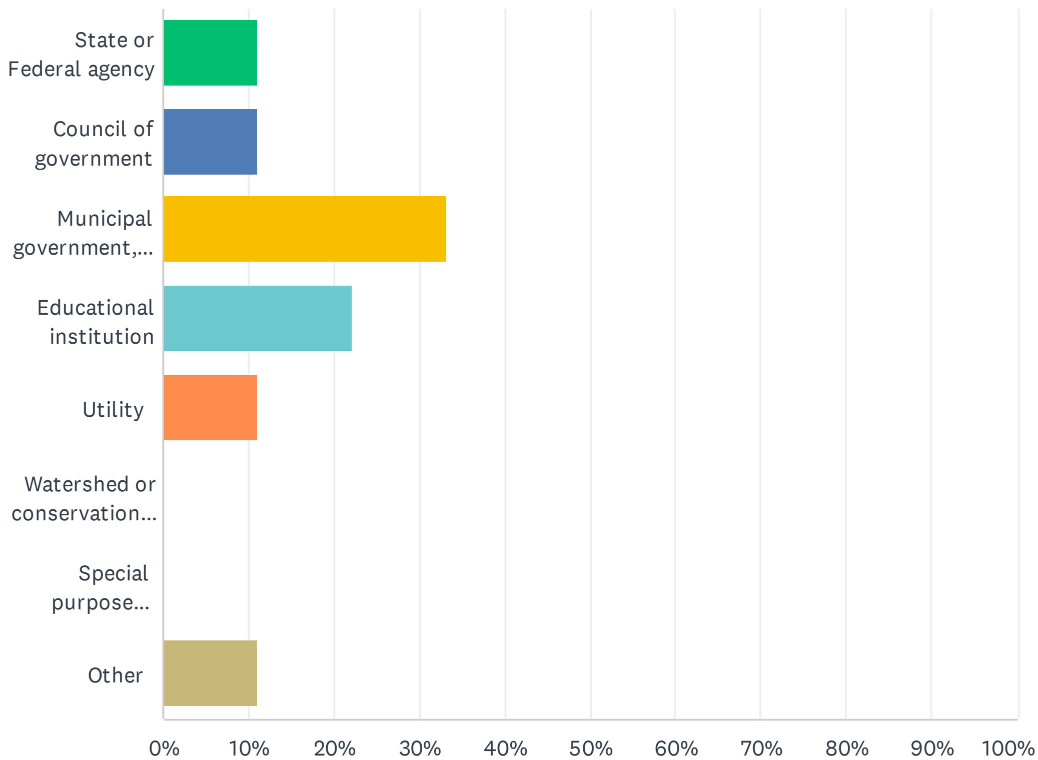
343	21727	9/24/2021 9:24 AM
344	21702	9/24/2021 8:55 AM
345	21703	9/24/2021 8:47 AM
346	21703	9/24/2021 8:28 AM
347	21702	9/24/2021 7:57 AM
348	21702	9/14/2021 8:10 AM
349	21702	8/30/2021 10:52 AM

Q4 Which type of organization do you represent?

Answered: 9 Skipped: 675

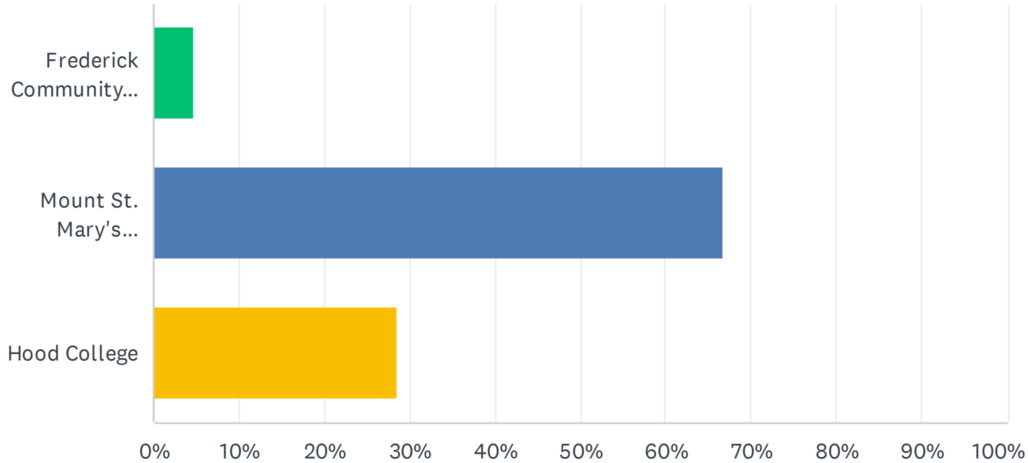


ANSWER CHOICES	RESPONSES	
State or Fede a agency	11.11%	1
Counc of gove nment	11.11%	1
Mun c pal gove nment, boa d, o comm ss on	33.33%	3
Educat ona nst tut on	22.22%	2
Ut ty	11.11%	1
Watershed o conse vat on o gan zat on	0.00%	0
Spec a pu pose d st ct	0.00%	0
Othe	11.11%	1
TOTAL		9

#	OTHER	DATE
1	County Employee	9/30/2021 6:30 PM

Q5 Which college or university are you associated with?

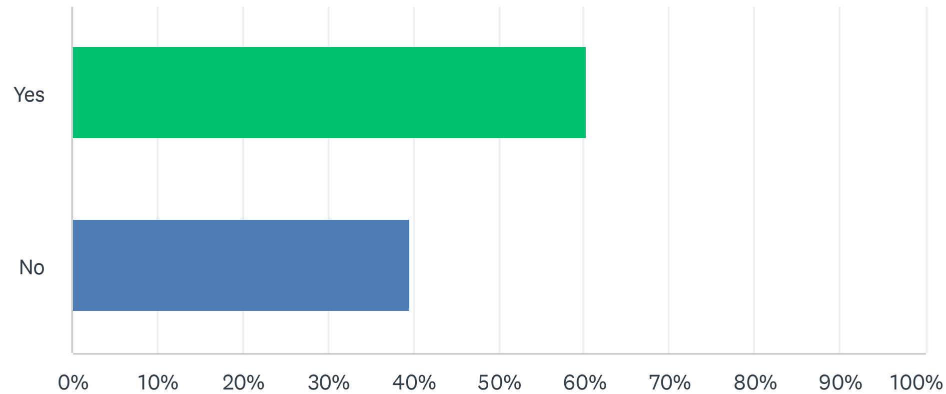
Answered: 259 Skipped: 425



ANSWER CHOICES	RESPONSES	
F eder ck Commun ty Co ege	4.63%	12
Mount St. Ma y's Un ve s ty	66.80%	173
Hood Co ege	28.57%	74
TOTAL		259

Q6 Are you aware that Mount St. Mary's University maintains a hazard mitigation plan?

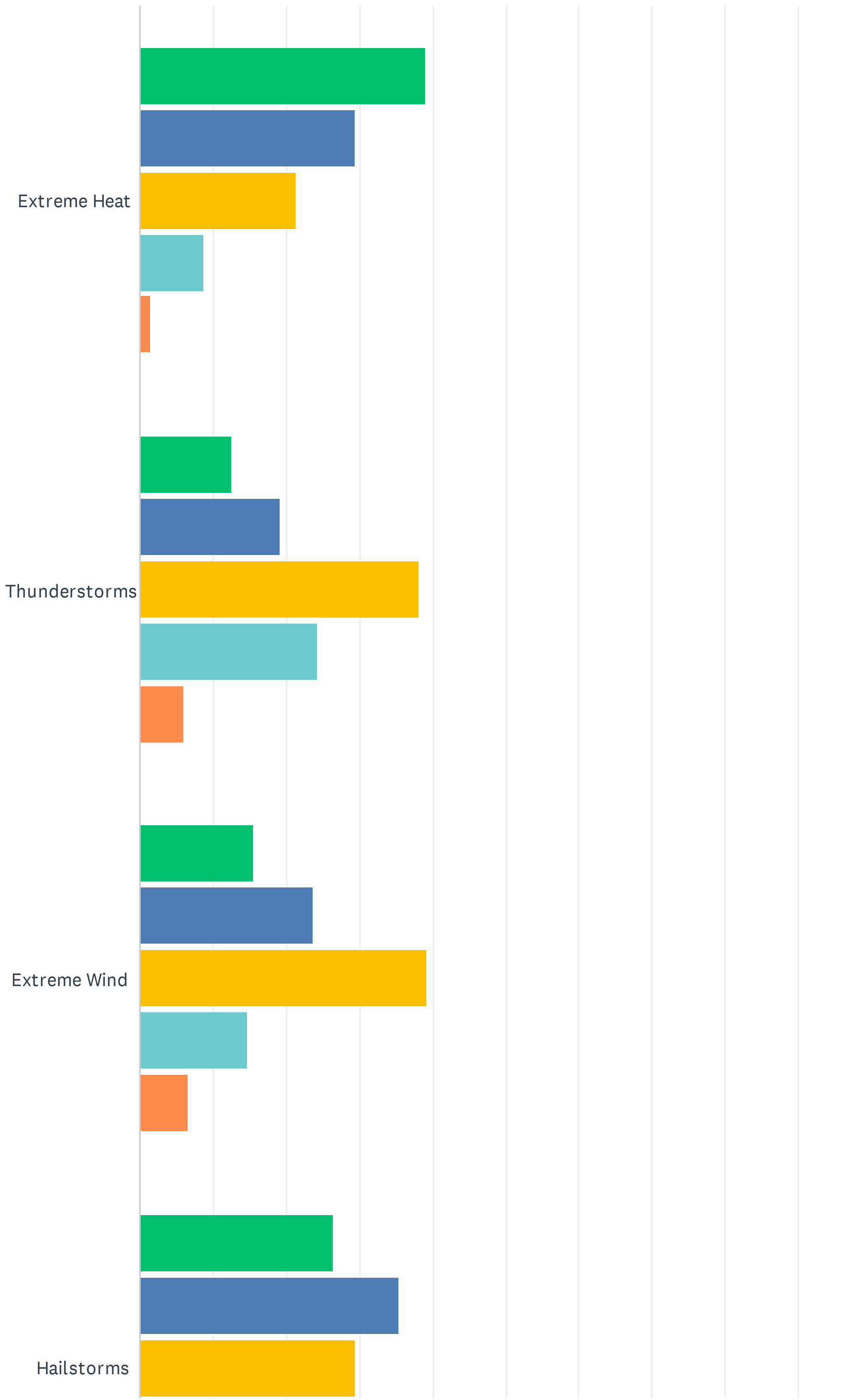
Answered: 139 Skipped: 545

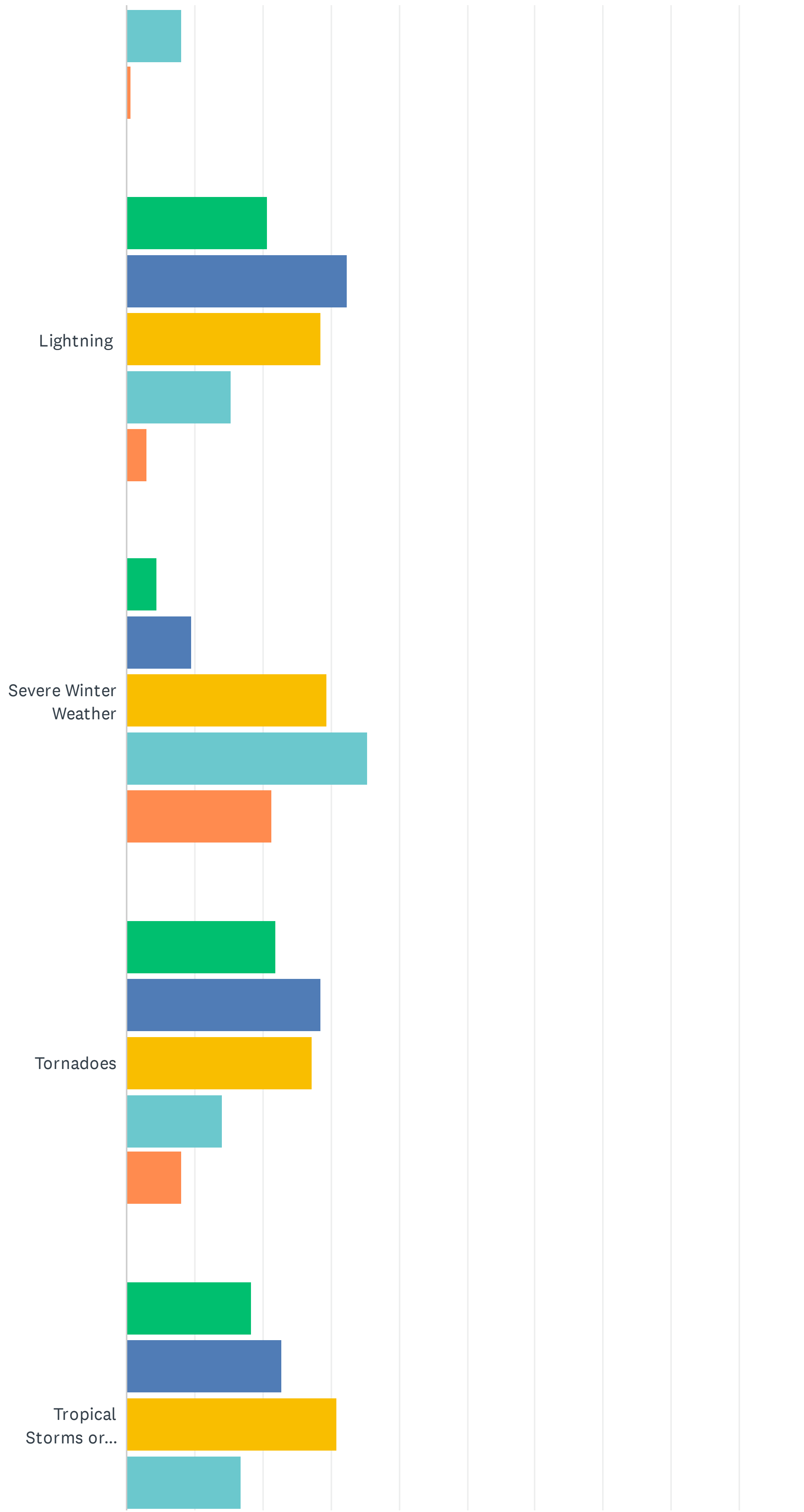


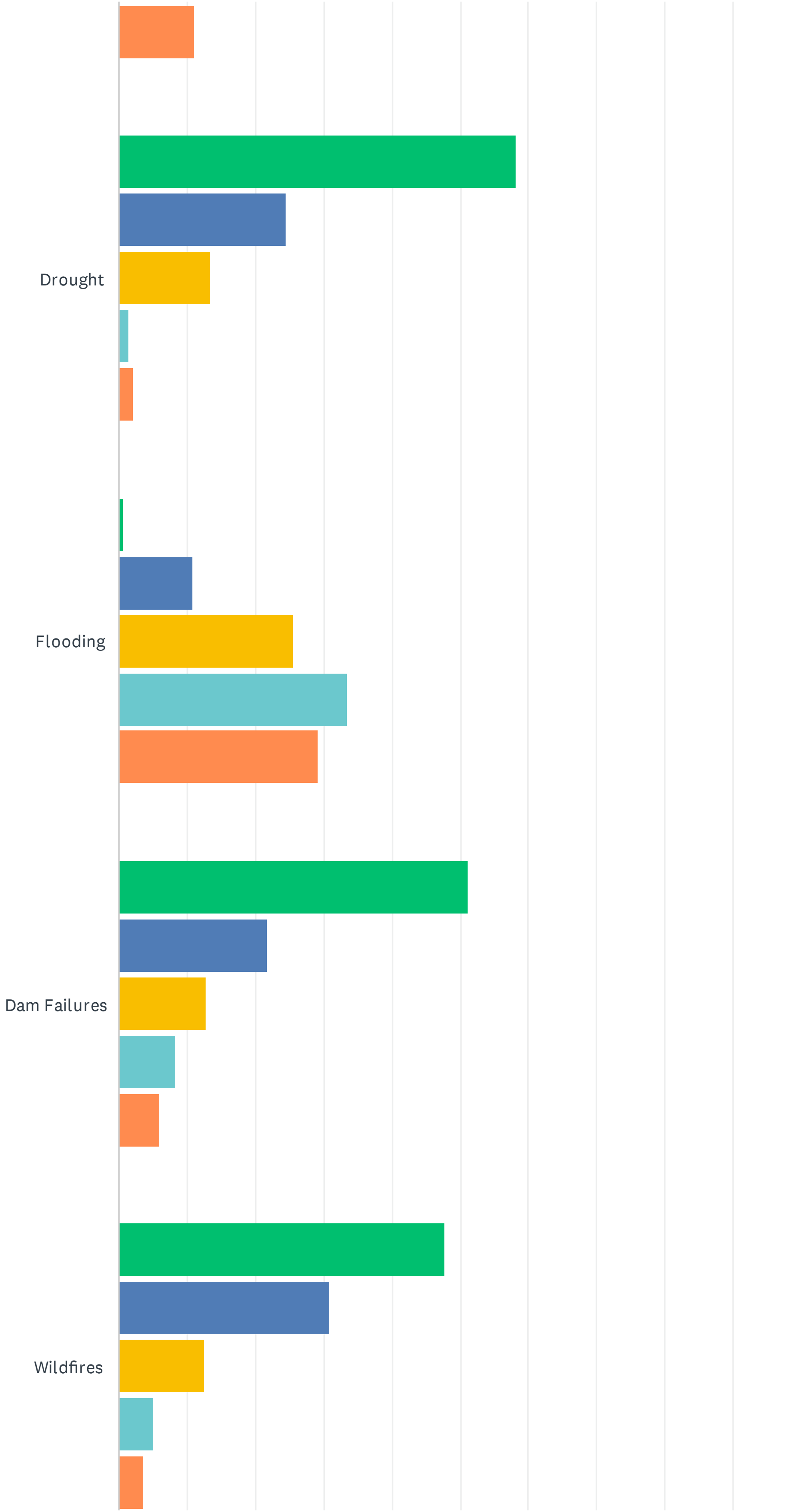
ANSWER CHOICES	RESPONSES	
Yes	60.43%	84
No	39.57%	55
TOTAL		139

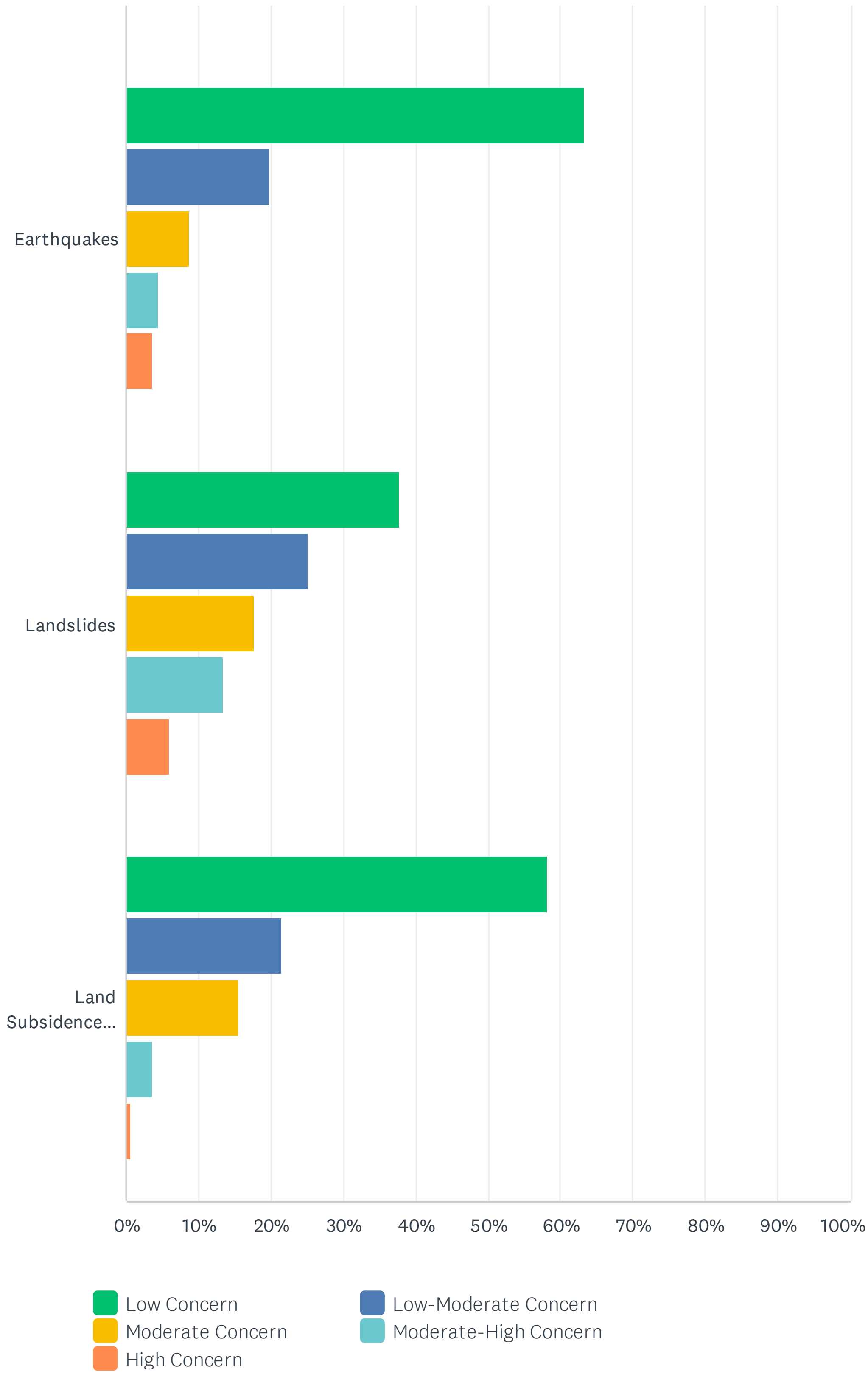
Q7 What is your level of concern for each of the following natural hazards impacting the campus?

Answered: 137 Skipped: 547




Lightning
Severe Winter Weather
Tornadoes
Tropical Storms or...

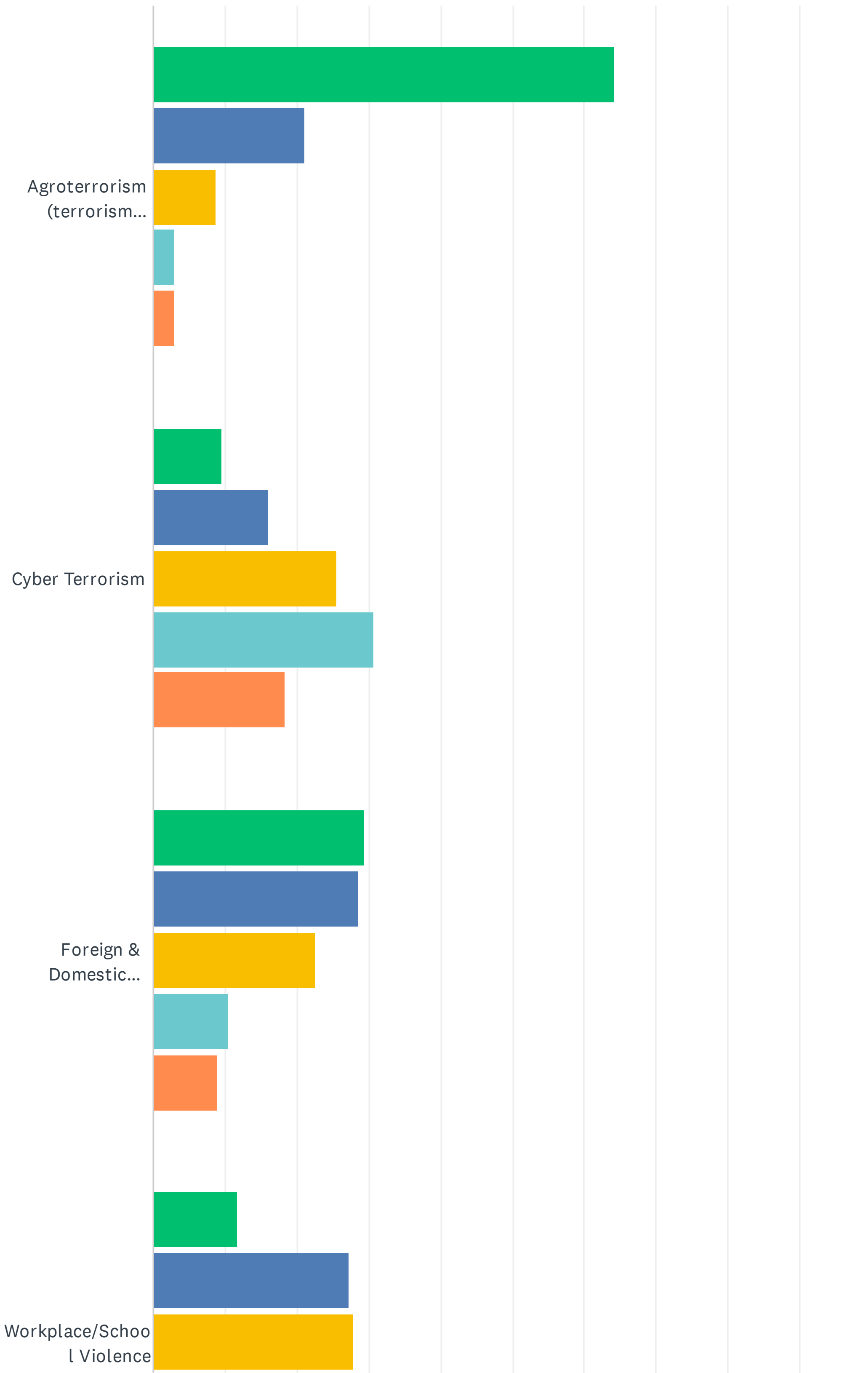

Drought
Flooding
Dam Failures
Wildfires

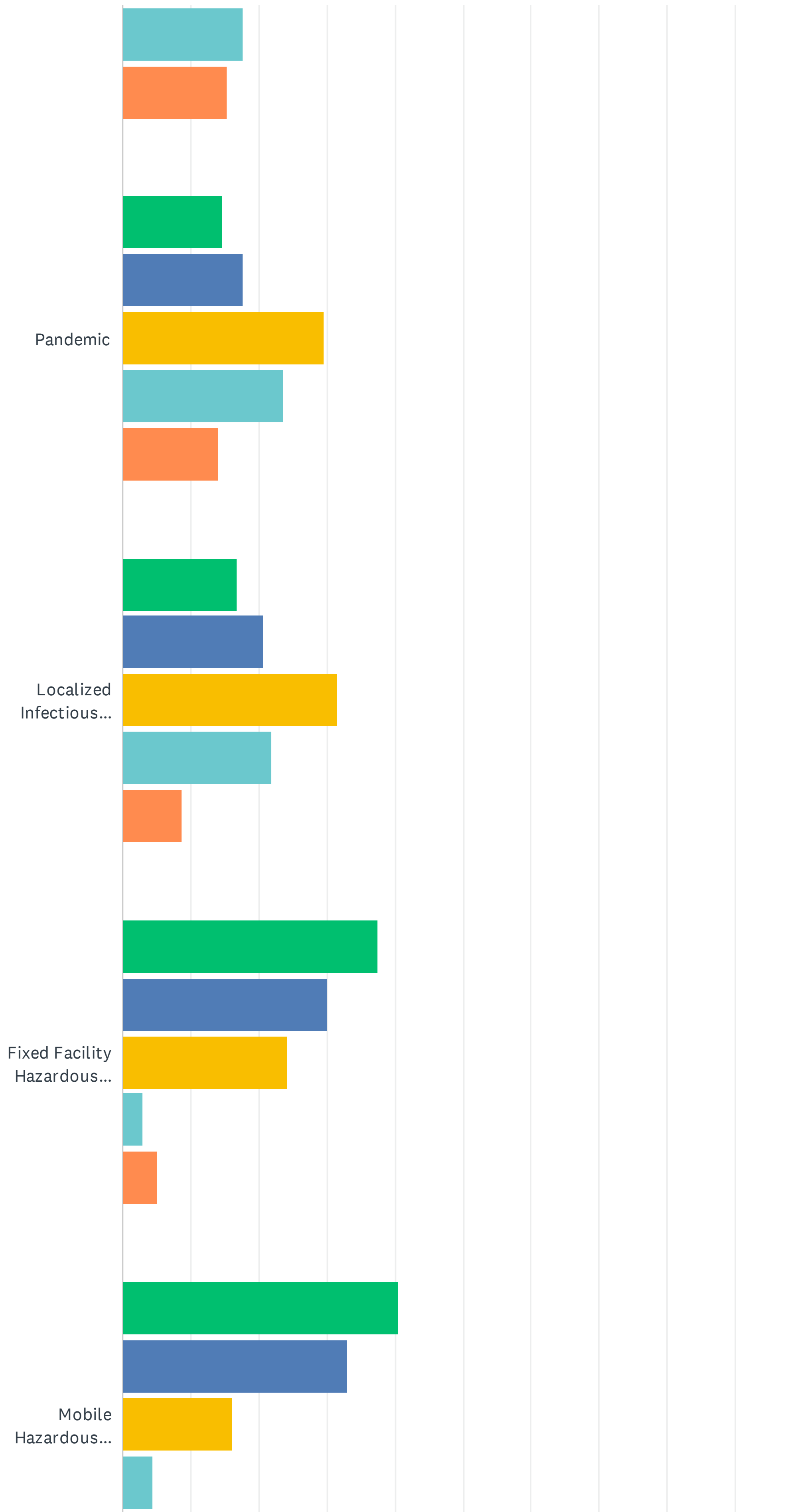

Earthquakes
Landslides
Land Subsidence...
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Low Concern
Low-Moderate Concern
Moderate Concern
Moderate-High Concern
High Concern

	LOW CONCERN	LOW-MODERATE CONCERN	MODERATE CONCERN	MODERATE-HIGH CONCERN	HIGH CONCERN	TOTAL
Extreme Heat	38.97% 53	29.41% 40	21.32% 29	8.82% 12	1.47% 2	136
Thunderstorms	12.50% 17	19.12% 26	38.24% 52	24.26% 33	5.88% 8	136
Extreme Wind	15.56% 21	23.70% 32	39.26% 53	14.81% 20	6.67% 9	135
Hailstorms	26.47% 36	35.29% 48	29.41% 40	8.09% 11	0.74% 1	136
Lightning	20.59% 28	32.35% 44	28.68% 39	15.44% 21	2.94% 4	136
Severe Winter Weather	4.41% 6	9.56% 13	29.41% 40	35.29% 48	21.32% 29	136
Tornadoes	22.06% 30	28.68% 39	27.21% 37	13.97% 19	8.09% 11	136
Tropical Storms or Hurricanes	18.38% 25	22.79% 31	30.88% 42	16.91% 23	11.03% 15	136
Drought	58.21% 78	24.63% 33	13.43% 18	1.49% 2	2.24% 3	134
Flooding	0.73% 1	10.95% 15	25.55% 35	33.58% 46	29.20% 40	137
Dam Failures	51.13% 68	21.80% 29	12.78% 17	8.27% 11	6.02% 8	133
Wildfires	47.79% 65	30.88% 42	12.50% 17	5.15% 7	3.68% 5	136
Earthquakes	63.24% 86	19.85% 27	8.82% 12	4.41% 6	3.68% 5	136
Landslides	37.78% 51	25.19% 34	17.78% 24	13.33% 18	5.93% 8	135
Land Subsidence (Karst)	58.21% 78	21.64% 29	15.67% 21	3.73% 5	0.75% 1	134

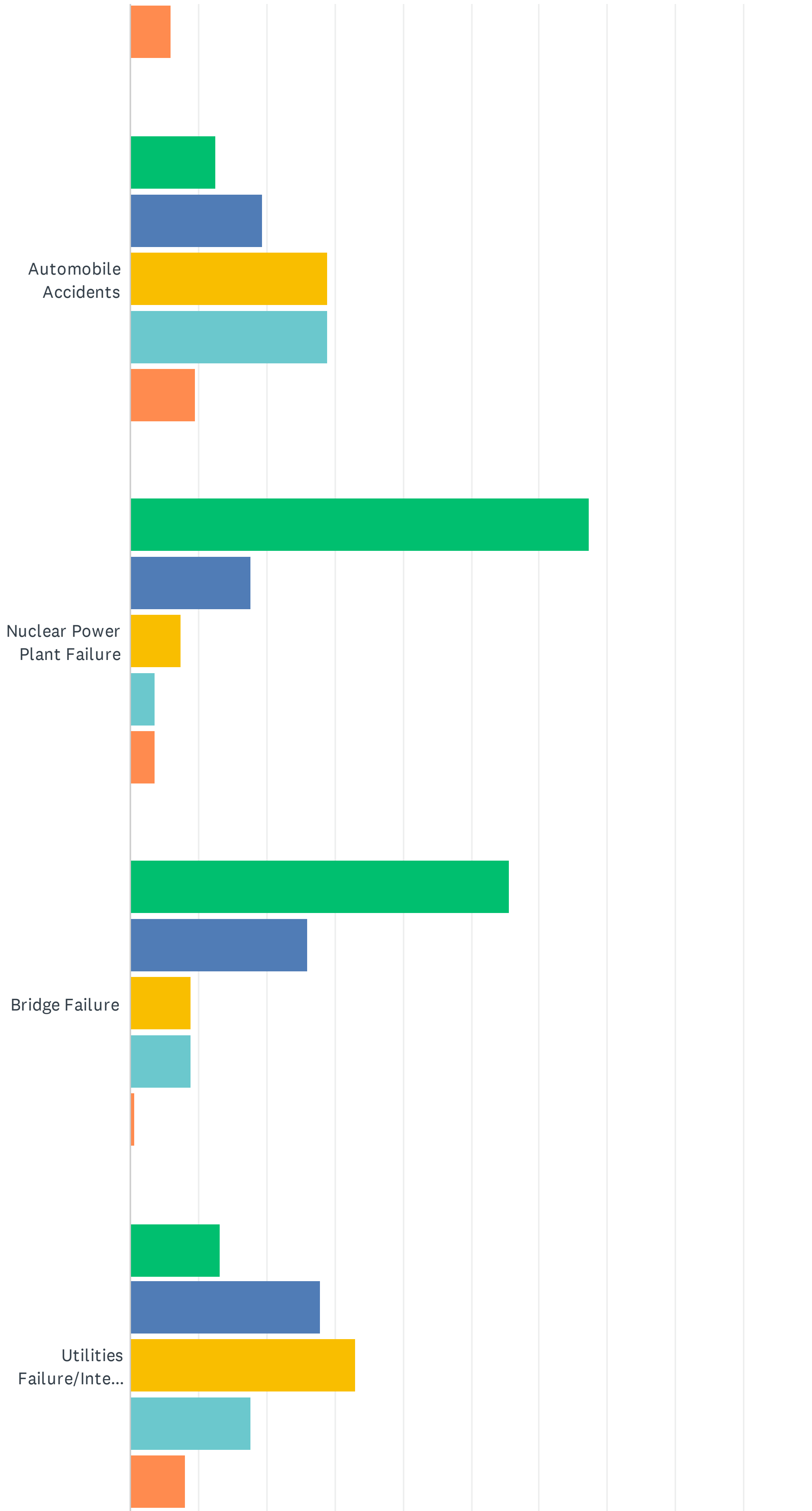
Q8 What is your level of concern for the following human-caused hazards impacting the campus?

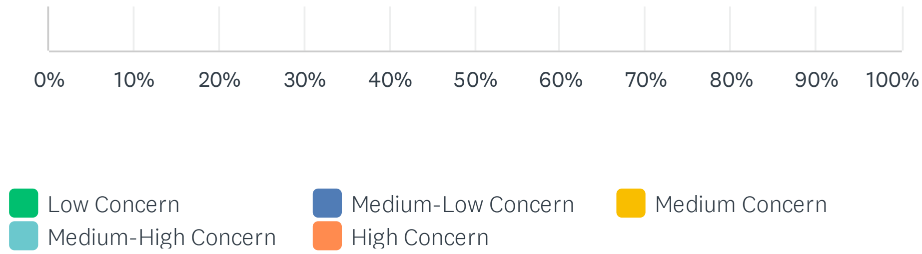
Answered: 138   Skipped: 546





Pandemic
Localized Infectious...
Fixed Facility Hazardous...
Mobile Hazardous...


Automobile Accidents
Nuclear Power Plant Failure
Bridge Failure
Utilities Failure/Inte...



	LOW CONCERN	MEDIUM-LOW CONCERN	MEDIUM CONCERN	MEDIUM-HIGH CONCERN	HIGH CONCERN	TOTAL	WEIGHTED AVERAGE
Ag ote ro sm (te o sm effect ng c ops)	64.23% 88	21.17% 29	8.76% 12	2.92% 4	2.92% 4	137	1.59
Cyber Ter o ism	9.49% 13	16.06% 22	25.55% 35	30.66% 42	18.25% 25	137	3.32
Fo e gn & Domest c Ter o ism	29.32% 39	28.57% 38	22.56% 30	10.53% 14	9.02% 12	133	2.41
Wo kp ace/School V o ence	11.76% 16	27.21% 37	27.94% 38	17.65% 24	15.44% 21	136	2.98
Pandem c	14.81% 20	17.78% 24	29.63% 40	23.70% 32	14.07% 19	135	3.04
Loca zed Infect ous D sease Outb eak	16.91% 23	20.59% 28	31.62% 43	22.06% 30	8.82% 12	136	2.85
F xed Fac ty Haza dous Mate ia s Re ease	37.50% 51	30.15% 41	24.26% 33	2.94% 4	5.15% 7	136	2.08
Mob e Haza dous Mate ia s Re ease	40.44% 55	33.09% 45	16.18% 22	4.41% 6	5.88% 8	136	2.02
Automobi e Acc dents	12.69% 17	19.40% 26	29.10% 39	29.10% 39	9.70% 13	134	3.04
Nuc ea Power P ant Fa u e	67.41% 91	17.78% 24	7.41% 10	3.70% 5	3.70% 5	135	1.59
B dge Fa u e	55.56% 75	25.93% 35	8.89% 12	8.89% 12	0.74% 1	135	1.73
Ut t es Fa u e/Inte upt on	13.24% 18	27.94% 38	33.09% 45	17.65% 24	8.09% 11	136	2.79

Q9 Have any recent hazard events made your more aware of the dangers of hazards on campus?

Answered: 94 Skipped: 590

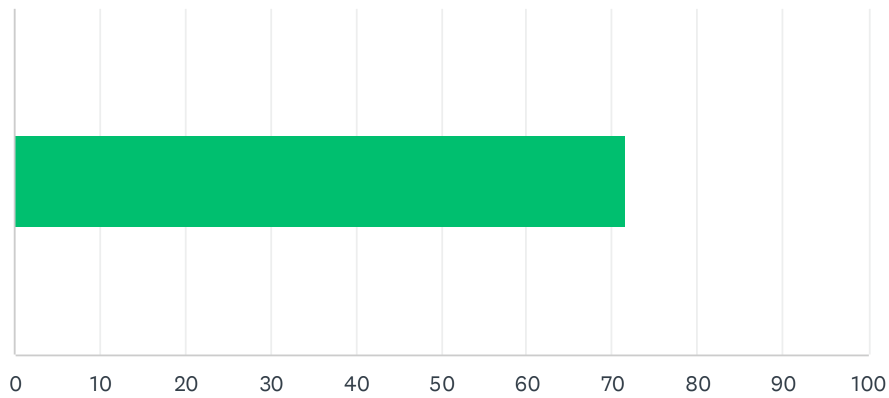
#	RESPONSES	DATE
1	sexual assault cases	10/10/2021 2:54 PM
2	Flooding and of course the pandemic.	10/7/2021 11:07 AM
3	flooding	10/6/2021 12:53 PM
4	Exceptionally heavy rainfall recently caused some flooding on campus, including inside some buildings. However, quick action apparently reduced long-term issues from the flooding.	10/5/2021 11:42 PM
5	On campus flooding due to after-effects of Hurricane Ida	10/5/2021 3:29 PM
6	The scam emails at the Mount make me cautious about cyber threats	10/5/2021 2:18 PM
7	We frequently get tornado warnings. There was significant flooding after Hurricane Ida.	10/5/2021 12:33 PM
8	Flooding after extreme rain event about a month ago	10/5/2021 9:25 AM
9	Flooding in buildings from the recent Hurricane Ida remnants.	10/5/2021 9:18 AM
10	Flood	10/5/2021 9:09 AM
11	flooding after summer storms	10/5/2021 8:34 AM
12	Pandemic, flooding, violence	10/4/2021 11:05 PM
13	Flooding from rain produced from remnants of Hurricane Ida.	10/4/2021 5:35 PM
14	The recent tropical storm Iva made me more aware of the flooding concern here at the Mount. With the mountain terrain, it would lead me to wonder about landslide should we have too much rain. Large trees are also a concern on the mountain for high winds.	10/4/2021 4:52 PM
15	flood	10/4/2021 4:17 PM
16	No	10/4/2021 2:31 PM
17	Yes; it's remarkable how enough rainfall (4" or more) can run off the mountain at such a dangerous rate.	10/4/2021 2:22 PM
18	Flooding	10/4/2021 1:42 PM
19	Flooding from the storms in Sept, 2021.	10/4/2021 1:23 PM
20	flooding	10/4/2021 1:03 PM
21	Heavy rains causing flooding.	10/4/2021 1:03 PM
22	Hurricane Ida and the intense flooding that occurred on campus	10/4/2021 12:56 PM
23	Cyber attacks	10/4/2021 12:55 PM
24	Hurricane Ida caused a small rock side to come onto Bradley parking lot from off the mountain. There are automobile accidents too frequently because of Rte 15 and the customary speed (70) which violates the state speed limit (55)	10/4/2021 12:52 PM
25	recent heavy rains caused significant run off the hillside. I expected mudslides in addition to the water.	10/4/2021 11:56 AM
26	Flooding	10/4/2021 11:34 AM
27	bad flooding on campus in September	10/4/2021 11:16 AM

28	Covid 19 pandemic, recent flooding on campus, cyberterrorism nationally (not necessarily on campus)	10/4/2021 10:53 AM
29	Flash flooding	10/4/2021 10:40 AM
30	The floods on campus made me aware of the incline we are on	10/4/2021 10:39 AM
31	The recent hurricane and COVID-19 pandemic	10/4/2021 10:26 AM
32	Flooding on Wednesday, September 1, 2021	10/4/2021 10:24 AM
33	The flooding on campus this semester.	10/4/2021 10:18 AM
34	Very Heavy Rain	10/4/2021 10:06 AM
35	Localized flooding during hurricane.	10/4/2021 10:05 AM
36	Localized flooding after a recent heavy rainstorm	10/4/2021 10:02 AM
37	We did have recent flash flooding due to the last tropical storm, but I think that the response made me less concerned.	10/4/2021 10:02 AM
38	Flooding event behind Bradley Hall.	10/4/2021 9:34 AM
39	Flash flooding	10/4/2021 9:26 AM
40	no	10/4/2021 8:58 AM
41	The recent severe storm, flooding, and the pandemic	10/4/2021 8:47 AM
42	The flooding from Hurricane Ida	10/4/2021 8:26 AM
43	Covid-19; Tropical Storm Ida; any campus violence that makes the news	10/4/2021 8:17 AM
44	Hurricane Ida flooding	10/4/2021 7:52 AM
45	Tropical Storm in September left damage to the campus	10/4/2021 6:06 AM
46	No	10/4/2021 5:28 AM
47	The floods that came down the side of the mountain	10/4/2021 12:15 AM
48	The flooding from the hurricane	10/4/2021 12:13 AM
49	Yes— flooding from hurricane ida	10/3/2021 7:15 PM
50	Flooding during storms. Everyone getting sick recently	10/3/2021 5:46 PM
51	Yes.	10/3/2021 5:25 PM
52	Flooding	10/3/2021 5:01 PM
53	Not necessarily. I have been to myself recently so the only hazard I've seen was the major flooding	10/3/2021 3:19 PM
54	The flooding on campus in early September	10/3/2021 2:32 PM
55	Flooding from excessive rain.	10/3/2021 2:05 PM
56	flooding	10/3/2021 1:46 PM
57	Flooding from Ida strongly affected the campus.	10/3/2021 1:40 PM
58	The recent flooding the campus experienced a few weeks ago from the hurricane made me more aware of the flooding possibility on campus.	10/3/2021 12:59 PM
59	Flooding	10/3/2021 12:59 PM
60	The Covid-19 pandemic. Fire on the roof of the arena during a high school graduation. Tornado warnings. Flooding.	10/3/2021 12:56 PM
61	Flooding	10/3/2021 12:13 PM
62	No	10/3/2021 12:10 PM

63	Remnants of Hurricane Ida and subsequent floods	10/3/2021 12:09 PM
64	Yes - In early September (Sept. 1?) we had the remains of a tropical storm come through Maryland, and we had major flooding on campus (roads closed, and water rushing into the first floor of some buildings, such as Pangborn). The flooding happened very quickly and I felt unprepared.	10/3/2021 12:00 PM
65	Flooding and sink hole recently; Pandemic; Landslide with high rains	10/3/2021 11:32 AM
66	Yes, flooding from Hurricane Ida	10/3/2021 11:06 AM
67	No	10/3/2021 11:03 AM
68	Extreme measure of rain.	10/3/2021 10:56 AM
69	Yes, floods on campus	10/3/2021 10:44 AM
70	My room completely flooded and nothing was done to ensure it wouldn't happen again the next time it rains really hard. I am concerned the next time it won't only be a few inches of water that ruins everything on my floor.	10/3/2021 10:36 AM
71	Pandemic and school shootings around the country	10/3/2021 10:27 AM
72	Flooding at mount st Mary's university	10/3/2021 10:25 AM
73	Flash Flood	10/3/2021 10:23 AM
74	Recent hurricane and flooding	10/3/2021 10:23 AM
75	Poor flooding mitigation and awareness.	10/3/2021 10:20 AM
76	The flooding after the tropical storm went through.	10/3/2021 10:19 AM
77	Flooding during Ida storm	10/3/2021 10:18 AM
78	None	10/3/2021 10:12 AM
79	flash flooding	10/3/2021 10:10 AM
80	The recent flooding a few weeks ago was eye opening for me.	10/3/2021 9:31 AM
81	Flooding on campus	10/3/2021 8:49 AM
82	Our recent flooding	10/3/2021 8:46 AM
83	Flooding	10/3/2021 8:44 AM
84	The flooding that occurred during hurricane Ida.	10/3/2021 8:37 AM
85	Flooding	10/3/2021 8:32 AM
86	Site flooding with recent heavy rains (twice)	10/3/2021 8:25 AM
87	Flooding	10/3/2021 8:13 AM
88	Flood waters coming from the mountain	10/3/2021 7:57 AM
89	Flooding	10/3/2021 7:47 AM
90	Hurricane involving major flooding in September	10/3/2021 7:36 AM
91	Hurricane Ida	10/3/2021 7:31 AM
92	Several floods	10/3/2021 7:28 AM
93	flooding	9/30/2021 9:26 AM
94	Flooding	9/30/2021 9:23 AM

Q10 How safe from hazards do you feel on campus?

Answered: 136 Skipped: 548



ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	72	9,756	136
Total Respondents: 136			

#		DATE
1	94	10/10/2021 2:54 PM
2	50	10/7/2021 11:07 AM
3	60	10/6/2021 12:53 PM
4	88	10/5/2021 11:42 PM
5	65	10/5/2021 10:28 PM
6	90	10/5/2021 3:29 PM
7	95	10/5/2021 2:18 PM
8	83	10/5/2021 12:33 PM
9	75	10/5/2021 9:25 AM
10	52	10/5/2021 9:18 AM
11	10	10/5/2021 9:09 AM
12	50	10/5/2021 8:34 AM
13	90	10/5/2021 7:53 AM
14	80	10/4/2021 11:05 PM
15	86	10/4/2021 5:35 PM
16	85	10/4/2021 4:52 PM
17	10	10/4/2021 4:17 PM
18	43	10/4/2021 2:31 PM
19	92	10/4/2021 2:22 PM
20	80	10/4/2021 1:54 PM

21	100	10/4/2021 1:50 PM
22	80	10/4/2021 1:42 PM
23	75	10/4/2021 1:23 PM
24	85	10/4/2021 1:15 PM
25	68	10/4/2021 1:03 PM
26	95	10/4/2021 1:03 PM
27	59	10/4/2021 12:58 PM
28	69	10/4/2021 12:56 PM
29	70	10/4/2021 12:55 PM
30	92	10/4/2021 12:52 PM
31	84	10/4/2021 12:37 PM
32	80	10/4/2021 12:05 PM
33	72	10/4/2021 11:56 AM
34	92	10/4/2021 11:34 AM
35	85	10/4/2021 11:16 AM
36	70	10/4/2021 11:03 AM
37	75	10/4/2021 10:53 AM
38	53	10/4/2021 10:40 AM
39	80	10/4/2021 10:40 AM
40	100	10/4/2021 10:39 AM
41	65	10/4/2021 10:26 AM
42	50	10/4/2021 10:24 AM
43	40	10/4/2021 10:24 AM
44	90	10/4/2021 10:18 AM
45	61	10/4/2021 10:06 AM
46	51	10/4/2021 10:05 AM
47	14	10/4/2021 10:02 AM
48	83	10/4/2021 10:02 AM
49	83	10/4/2021 10:00 AM
50	90	10/4/2021 9:34 AM
51	50	10/4/2021 9:26 AM
52	90	10/4/2021 9:15 AM
53	90	10/4/2021 8:58 AM
54	66	10/4/2021 8:47 AM
55	88	10/4/2021 8:41 AM
56	75	10/4/2021 8:26 AM
57	87	10/4/2021 8:17 AM
58	62	10/4/2021 8:06 AM

59	88	10/4/2021 7:52 AM
60	97	10/4/2021 7:40 AM
61	82	10/4/2021 7:24 AM
62	61	10/4/2021 7:15 AM
63	74	10/4/2021 6:06 AM
64	100	10/4/2021 5:28 AM
65	55	10/4/2021 12:15 AM
66	72	10/4/2021 12:13 AM
67	75	10/3/2021 11:30 PM
68	32	10/3/2021 7:15 PM
69	80	10/3/2021 7:04 PM
70	90	10/3/2021 6:25 PM
71	90	10/3/2021 5:46 PM
72	70	10/3/2021 5:43 PM
73	43	10/3/2021 5:25 PM
74	42	10/3/2021 5:01 PM
75	92	10/3/2021 4:21 PM
76	21	10/3/2021 3:20 PM
77	67	10/3/2021 3:19 PM
78	88	10/3/2021 2:32 PM
79	95	10/3/2021 2:21 PM
80	82	10/3/2021 2:05 PM
81	72	10/3/2021 1:50 PM
82	40	10/3/2021 1:46 PM
83	68	10/3/2021 1:40 PM
84	95	10/3/2021 12:59 PM
85	85	10/3/2021 12:59 PM
86	30	10/3/2021 12:56 PM
87	86	10/3/2021 12:16 PM
88	75	10/3/2021 12:13 PM
89	51	10/3/2021 12:10 PM
90	99	10/3/2021 12:09 PM
91	72	10/3/2021 12:09 PM
92	85	10/3/2021 12:00 PM
93	46	10/3/2021 11:56 AM
94	58	10/3/2021 11:49 AM
95	37	10/3/2021 11:32 AM
96	84	10/3/2021 11:19 AM

97	83	10/3/2021 11:06 AM
98	80	10/3/2021 11:03 AM
99	85	10/3/2021 10:56 AM
100	74	10/3/2021 10:53 AM
101	78	10/3/2021 10:44 AM
102	75	10/3/2021 10:36 AM
103	65	10/3/2021 10:27 AM
104	52	10/3/2021 10:25 AM
105	75	10/3/2021 10:23 AM
106	42	10/3/2021 10:23 AM
107	90	10/3/2021 10:23 AM
108	65	10/3/2021 10:20 AM
109	83	10/3/2021 10:19 AM
110	63	10/3/2021 10:18 AM
111	80	10/3/2021 10:18 AM
112	80	10/3/2021 10:12 AM
113	72	10/3/2021 10:10 AM
114	85	10/3/2021 10:10 AM
115	75	10/3/2021 9:38 AM
116	80	10/3/2021 9:31 AM
117	90	10/3/2021 8:49 AM
118	59	10/3/2021 8:48 AM
119	81	10/3/2021 8:47 AM
120	31	10/3/2021 8:46 AM
121	65	10/3/2021 8:44 AM
122	46	10/3/2021 8:42 AM
123	80	10/3/2021 8:39 AM
124	90	10/3/2021 8:37 AM
125	82	10/3/2021 8:32 AM
126	41	10/3/2021 8:25 AM
127	53	10/3/2021 8:13 AM
128	55	10/3/2021 8:05 AM
129	70	10/3/2021 7:57 AM
130	70	10/3/2021 7:47 AM
131	81	10/3/2021 7:36 AM
132	82	10/3/2021 7:34 AM
133	66	10/3/2021 7:31 AM
134	82	10/3/2021 7:28 AM

135	85	9/30/2021 9:26 AM
136	89	9/30/2021 9:23 AM

Q11 What area on campus is especially vulnerable to hazards? (Example: an area that often floods)Instructions: Click the area on the campus map and describe the concern in the text box below.

Answered: 1 Skipped: 683

Q12 Describe the area of concern, the hazard, and why it is vulnerable:

Answered: 59 Skipped: 625

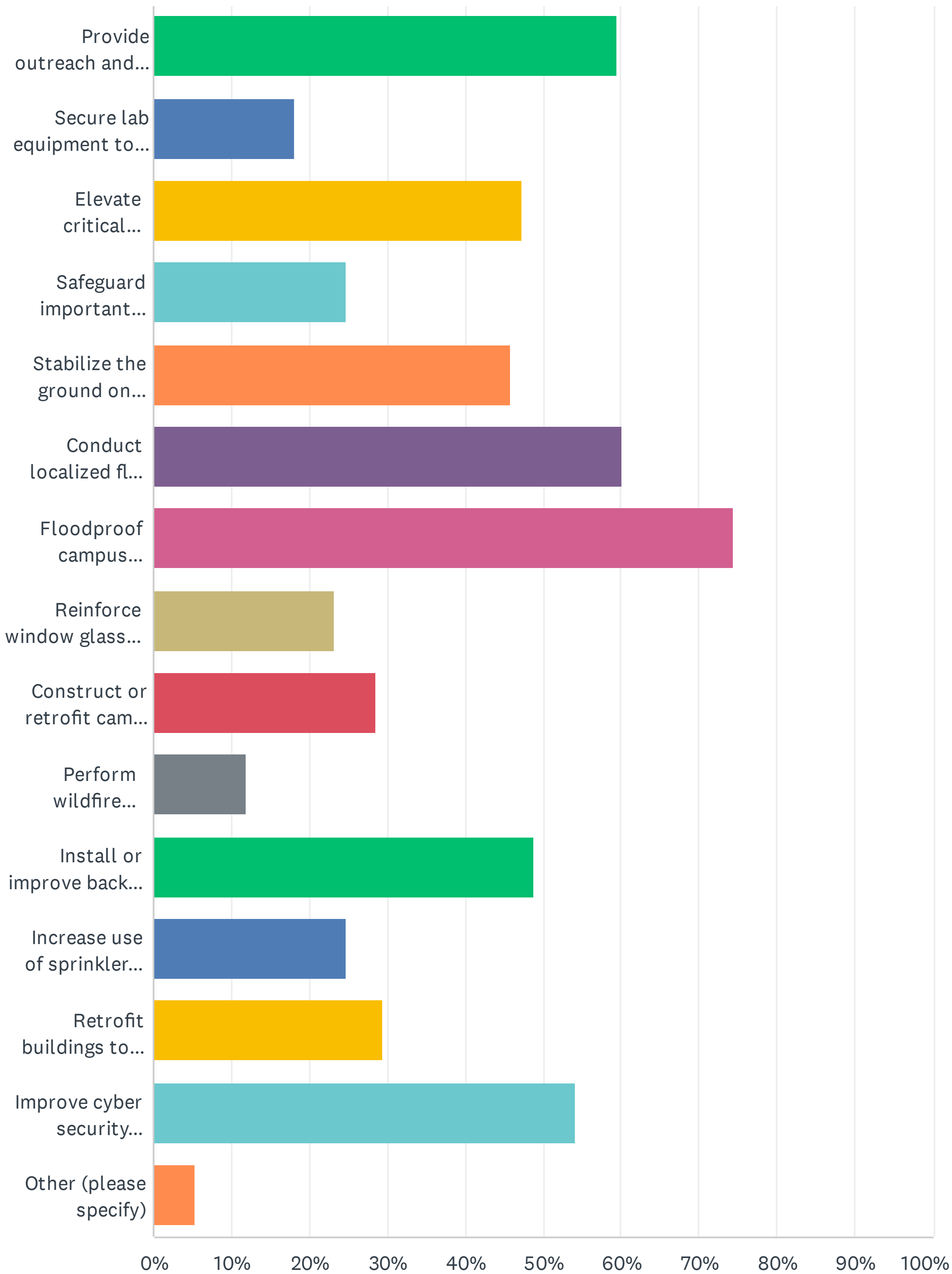
#	RESPONSES	DATE
1	There is no campus map for question #8. However, flooding is a concern on our campus, as well as being vulnerable to infectious disease with so many people living and working together. Also, our close proximity to Route 15 could make us susceptible to issues on our campus.	10/7/2021 11:07 AM
2	NA	10/6/2021 12:53 PM
3	The only concerns I have is cyber threats and flooding since I noticed puddles of water leaking in buildings during periods of heavy rain	10/5/2021 2:18 PM
4	During a thunderstorm, IC Chapel feels very unsafe because of the glass windows and rain.	10/5/2021 12:33 PM
5	Area behind the Towers and Pangborn hall from mountain rainwater runoff	10/5/2021 9:18 AM
6	Being situated at the base of a small mountain range any significant rain storm has the potential for flooding (although improvements to the drainage systems in recent years has helped)	10/5/2021 8:34 AM
7	(The map is not visible). Route 15 is a high risk site for traffic accidents, flooding on the western edge of campus.	10/4/2021 11:05 PM
8	Flooding from runoff water coming from the mountain on the west side of campus.	10/4/2021 5:35 PM
9	no campus map available on survey but behind Bradley Hall, Terrace, etc. is especially vulnerable to flooding.	10/4/2021 4:52 PM
10	Steps outside flooding	10/4/2021 2:31 PM
11	By the foot of the mountain in back of the campus. There is the possibility of water runoff and mudslides.	10/4/2021 1:23 PM
12	Water easily rushing down the mountain creating rivers of runoff that flood everywhere closest to the mountain.	10/4/2021 12:56 PM
13	Being on the side of the mountain, mudslides are possible. Also the possibility of wildfires in the woods on the hillside.	10/4/2021 11:56 AM
14	Bradley Hall floods because water rushes down the mountain; sidewalks and parking lots are hazardous during severe winter weather.	10/4/2021 10:53 AM
15	We are at the base of a mountain, older structures are easily flooded	10/4/2021 10:40 AM
16	A very steep incline, subject for flooding	10/4/2021 10:39 AM
17	Behind the seminary complex flood waters rapidly fill the drains as the water flows off the mountain. The side door to Keating hall has been worn away due to several floods entering the building via the door. There have been several trees that have fallen due to soil erosion and several more appear vulnerable. If they fall, they could impact equipment and buildings in the back of the seminary. While the doors in the back of the seminary are all secure via key cards, there are no security cameras in the back to record suspicious activity.	10/4/2021 10:26 AM
18	The Seminary and the Terrace--flood waters running off of the mountain.	10/4/2021 10:24 AM
19	Water coming off the mountain	10/4/2021 10:06 AM
20	disruption of utilities, flooding, highway that runs through the middle of campus	10/4/2021 10:05 AM
21	I did not see a map, but I think that the roadway on east side of campus looked prone to flash flooding. COAD and other buildings downhill of it could be at risk.	10/4/2021 10:02 AM
22	Workplace / School violence. In the event of an active shooter Frederick County Police are not close to campus and could take 15-20 minutes to arrive.	10/4/2021 9:34 AM

23	flooding on campus	10/4/2021 8:06 AM
24	Bradley parking lot	10/4/2021 7:52 AM
25	Water reservour needs attention. If the area overflows then it creates damage to the campus.	10/4/2021 6:06 AM
26	Areas where water rushes fast and doesn't drain. Powell residence hall, behind Bradley hall.	10/4/2021 12:15 AM
27	Everywhere. We are on a mountain so that makes sense	10/3/2021 5:46 PM
28	Behind Mcaffrey and Sheridan (going to no run off for water)	10/3/2021 5:43 PM
29	(There is no campus map to click on in the previous question) --- We use our own water supply, so if that is damaged in any way it could hurt our ability to function. We also get a lot of water off the mountain with heavy rain, with buildings backed right up to the mountain. If that rain ever causes a landslide, those buildings will be heavily damaged.	10/3/2021 5:25 PM
30	Anywhere near the top of campus mainly because there is nothing to stop the flooding from growing and the drainage process is very small so most things become over flooded or rocks clog	10/3/2021 3:19 PM
31	behind bradley/annex	10/3/2021 1:46 PM
32	The buildings farther up the mountain and the general sloping areas of the campus allow for flooding and quick rivers running down campus.	10/3/2021 12:59 PM
33	Dorms such as Pangborn and the Apartments due to the way they're designed	10/3/2021 12:59 PM
34	Behind Bradley-flooding due to water coming off the mountain and poor drainage. Improper storage of pool chemicals at the ARCC. No emergency action plan for the ARCC.	10/3/2021 12:56 PM
35	I don't know if I clicked that correctly, but behind Bradley and near the knot academic center it floods a lot	10/3/2021 12:13 PM
36	Flood	10/3/2021 12:10 PM
37	In general, rain comes down the mountain during severe thunderstorms and can carry debris. It can collect in low lying areas.	10/3/2021 12:09 PM
38	No map to click. The whole West campus can be affected by large rainstorms	10/3/2021 12:09 PM
39	Campus map is not showing up in my web browser (Firefox). We recently found out that Pangborn is vulnerable to flooding. Science building is vulnerable when the power goes out (I'm not concerned about being exposed to anything hazardous, but much of the science research and materials depend on having power for incubators, freezers, etc.) When we had the early September flooding, I was also concerned about all the Computer Science equipment in the first floor of the Science building, which is downhill from Pang (which was being flooded).	10/3/2021 12:00 PM
40	Just flooding some times	10/3/2021 11:49 AM
41	Behind Bradley Hall is an area of concern.	10/3/2021 11:32 AM
42	(No text box) The parking lot of the science building (Coad) is at the bottom of a hill, so it could be prone to flooding or being too difficult to get out of if there is ice	10/3/2021 11:06 AM
43	McCaffrey cause of how it's built.	10/3/2021 11:03 AM
44	Flooding caused by excessive rain.	10/3/2021 10:56 AM
45	Dorm rooms. I watched many dorms flood.	10/3/2021 10:25 AM
46	Map not working	10/3/2021 10:23 AM
47	Behind Bradley, pangborn lot, outside of towers… floof very easily.	10/3/2021 10:20 AM
48	The part of campus closer to the mountain flood more.	10/3/2021 10:19 AM
49	pangborn area because it flooded the most	10/3/2021 10:10 AM
50	The area between Bradley Hall and Archbishop Borders is prone to flooding, as was shown when there was a hurricane coming through campus a few weeks ago. This caused flooding in the Pangborn residential hall as well.	10/3/2021 10:10 AM

51	Grotto has a number of old, dying trees that are liable to fall in extreme conditions.	10/3/2021 9:38 AM
52	Behind the terrace floods because there's a pond/stream back there	10/3/2021 9:31 AM
53	flooding	10/3/2021 8:49 AM
54	Automobile accidents on the road next to the Cottages or a you pull in our out of that area. There is no barrier between the road and sidewalk and people rarely follow speed limit rules or pay attention to pedestrians.	10/3/2021 8:46 AM
55	Can't see a map	10/3/2021 8:44 AM
56	mklkm;lknm;	10/3/2021 8:42 AM
57	The area next to the mountain is vulnerable and has twice flooded in the past month, affecting the seminary and several other buildings and parking lots. Site drainage and storm water management near the buildings, especially the seminary, are inadequate. Permanent placement of sandbags, as is now done, is not a serious storm water management plan.	10/3/2021 8:25 AM
58	The dorms that line the mountain. Extreme flood waters come down the mountain and hit that building.	10/3/2021 7:57 AM
59	Terrace because it's right after the mountain, most level area for water to begin collecting and also because I live there	10/3/2021 7:36 AM

Q13 What are the most important things that Mount St. Mary's University can do to help mitigate hazards and become more resilient over time?

Answered: 133 Skipped: 551



ANSWER CHOICES	RESPONSES	
Provide outreach and education to students, faculty, and staff to help them understand their risks and mitigate hazards	59.40%	79
Secure lab equipment to prevent damage during an earthquake or high-wind event	18.05%	24
Elevate critical services, equipment, and/or materials to prevent damage from floodwaters (communications services, computers, books, art, etc.)	47.37%	63
Safeguard important research documents and specimens and make duplicate copies of reports and store them separately from the originals	24.81%	33
Stabilize the ground on slopes to prevent slope failures/landslides	45.86%	61
Conduct localized flood risk reduction projects, such as stormwater management projects or stabilizing roads	60.15%	80
Floodproof campus buildings	74.44%	99
Reinforce window glass and frames for high-wind events	23.31%	31
Construct or retrofit campus safe rooms for hurricanes, tornadoes, etc.	28.57%	38
Perform wildfire mitigation projects, such as creating defensible space, retrofitting buildings with ignition-resistant building materials, or vegetation management	12.03%	16
Install or improve backup systems such as generators, computer databases, etc.	48.87%	65
Increase use of sprinkler systems, fireproofing, and/or fire-resistant building materials	24.81%	33
Retrofit buildings to reduce future damages from erosion, high winds, earthquakes, snow, or some human-caused hazards	29.32%	39
Improve cyber security defenses	54.14%	72
Other (please specify)	5.26%	7
Total Respondents: 133		

#	OTHER (PLEASE SPECIFY)	DATE
1	Reinforce windows due to easy leakage and huge mold problems due to the leakage	10/4/2021 12:56 PM
2	Stop herbicide use so that groundcovers help hold soil on slopes.	10/4/2021 12:52 PM
3	fix locks on doors so rooms can be secured if there is an active shooter	10/4/2021 10:53 AM
4	Communicate emergency plans and have team leaders to help when an emergency occurs	10/4/2021 7:24 AM
5	Update climate control within the buildings in order to prevent students from freezing/overheating	10/3/2021 3:19 PM
6	Better response and monitoring of students with mental health issues	10/3/2021 11:32 AM
7	Prepare for school violence	10/3/2021 8:46 AM

Q14 If you could choose one action that could be taken by Mount St. Mary's University to reduce its vulnerability to hazards, what would it be?

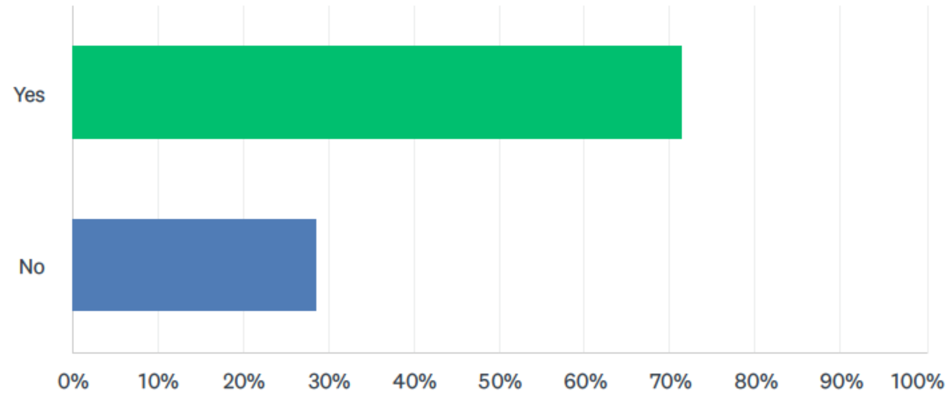
Answered: 57   Skipped: 627

#	RESPONSES	DATE
1	Practice drills, education on what to do in emergency situations, and land protection of the campus.	10/7/2021 11:07 AM
2	Localized flood risk reduction projects	10/5/2021 11:42 PM
3	That's difficult to answer because The Mount is always actively trying to do things to keep us & the campus safe.	10/5/2021 3:29 PM
4	Make sure the buildings have less leaking during heavy rain	10/5/2021 2:18 PM
5	Utilities failure	10/5/2021 9:25 AM
6	Flood improvements from mountain rainwater runoff.	10/5/2021 9:18 AM
7	flood risk reduction	10/5/2021 9:09 AM
8	outreach to the Mount campus community (they are working on the other things noted above already)	10/5/2021 8:34 AM
9	Improve cyber security defenses and education.	10/4/2021 11:05 PM
10	Improve cyber security defenses	10/4/2021 5:35 PM
11	idk	10/4/2021 4:17 PM
12	Something to prevent flooding	10/4/2021 2:31 PM
13	Flood reduction projects	10/4/2021 1:50 PM
14	Increase awareness of hazards. Perhaps run practice drills as appropriate.	10/4/2021 1:23 PM
15	Install flood barriers and improve mountain runoff systems	10/4/2021 12:56 PM
16	Improve cyber security	10/4/2021 12:55 PM
17	Build a bridge across Rte 15 for students to cross without U turning.	10/4/2021 12:52 PM
18	improve cybersecurity protection	10/4/2021 11:56 AM
19	Improve security from active shooters	10/4/2021 10:53 AM
20	Flood risk reduction projects.	10/4/2021 10:26 AM
21	Install backup systems, in case an event does happen.	10/4/2021 10:24 AM
22	Modernize older buildings (electrical, lab rooms in general, fire safety systems)	10/4/2021 10:02 AM
23	I am not sure what our risk is for natural disasters, but I think making sure buildings are safe from fires or landslides would be top priority (increase flooding means more likely erosion or landslides)	10/4/2021 10:02 AM
24	Better building security in the form of key cards.	10/4/2021 9:34 AM
25	Education to have a more informed community about what hazard preventions are even in place.	10/4/2021 8:47 AM
26	Make people in their office aware of the conditions outside so they can leave in a timely manner.	10/4/2021 8:26 AM
27	Improve cyber security defenses	10/4/2021 7:52 AM

28	Dorms need sprinkler systems in the older building	10/4/2021 6:06 AM
29	Elevate critical services, equipment, and/or materials to prevent damage from floodwaters (communications services, computers, books, art, etc.) i.e. the servers	10/4/2021 12:13 AM
30	More flooding preparations	10/3/2021 5:46 PM
31	Get ahold of the water situation -- flood proof buildings and perhaps build something like a trench/dry creek at the immediate base of mountain to prevent uncontrolled water flow.	10/3/2021 5:25 PM
32	Mass-renovation of current student housing buildings	10/3/2021 3:19 PM
33	Flood proof buildings	10/3/2021 1:50 PM
34	more cameras	10/3/2021 1:46 PM
35	The main hazard would be flooding, so anything that can redirect flood waters from running down campus would be beneficial.	10/3/2021 12:59 PM
36	To create updated Emergency Action Plans and train everyone on campus so EVERYONE knows what to do in the event of ANY emergency.	10/3/2021 12:56 PM
37	Flood proof apartments/dorms	10/3/2021 12:13 PM
38	Stop focusing on giving students parking tickets at 2am and focus on the safety and security of our school. Flooding and malfunctioning electronics are the number one things on campus everyone fears. Focus your attention on that instead of someone who forgot to move there car	10/3/2021 12:10 PM
39	Flood mitigation	10/3/2021 12:09 PM
40	Improve flood prevention, reinforce for landslides	10/3/2021 11:32 AM
41	Not sure	10/3/2021 11:06 AM
42	Better building infrastructure and drainage.	10/3/2021 11:03 AM
43	Floodproof buildings	10/3/2021 10:56 AM
44	I would recommend they fix the storm water drainage since they easily become impacted with debris and then flood our buildings. It rains heavily often in Emmitsburg and further actions should be taken.	10/3/2021 10:36 AM
45	Flood risk program	10/3/2021 10:25 AM
46	Floodproofing the buildings	10/3/2021 10:23 AM
47	Reduce flooding, AC fixes and usage, snow emergency plan remake	10/3/2021 10:20 AM
48	Teach students and faculty about cyber security since there are several phishing attempts per year.	10/3/2021 10:19 AM
49	Education	10/3/2021 10:18 AM
50	Make sure the when it floods that there is place for the water to go preventing erosion	10/3/2021 10:12 AM
51	Mitigate flood risk	10/3/2021 9:31 AM
52	Flooding	10/3/2021 8:49 AM
53	Safe rooms	10/3/2021 8:46 AM
54	As much as localized flooding has been seen to be a serious and very real problem, I am more concerned about hazards such as hazardous material spills or traffic accidents on Route 15.	10/3/2021 8:25 AM
55	Allow for traffic to drive under 15 to safely get to the otherside of campus	10/3/2021 7:57 AM
56	Flood prevention	10/3/2021 7:47 AM
57	Reinforce windows and water proof	10/3/2021 7:36 AM

Q15 Are you aware that Frederick Community College maintains a hazard mitigation plan?

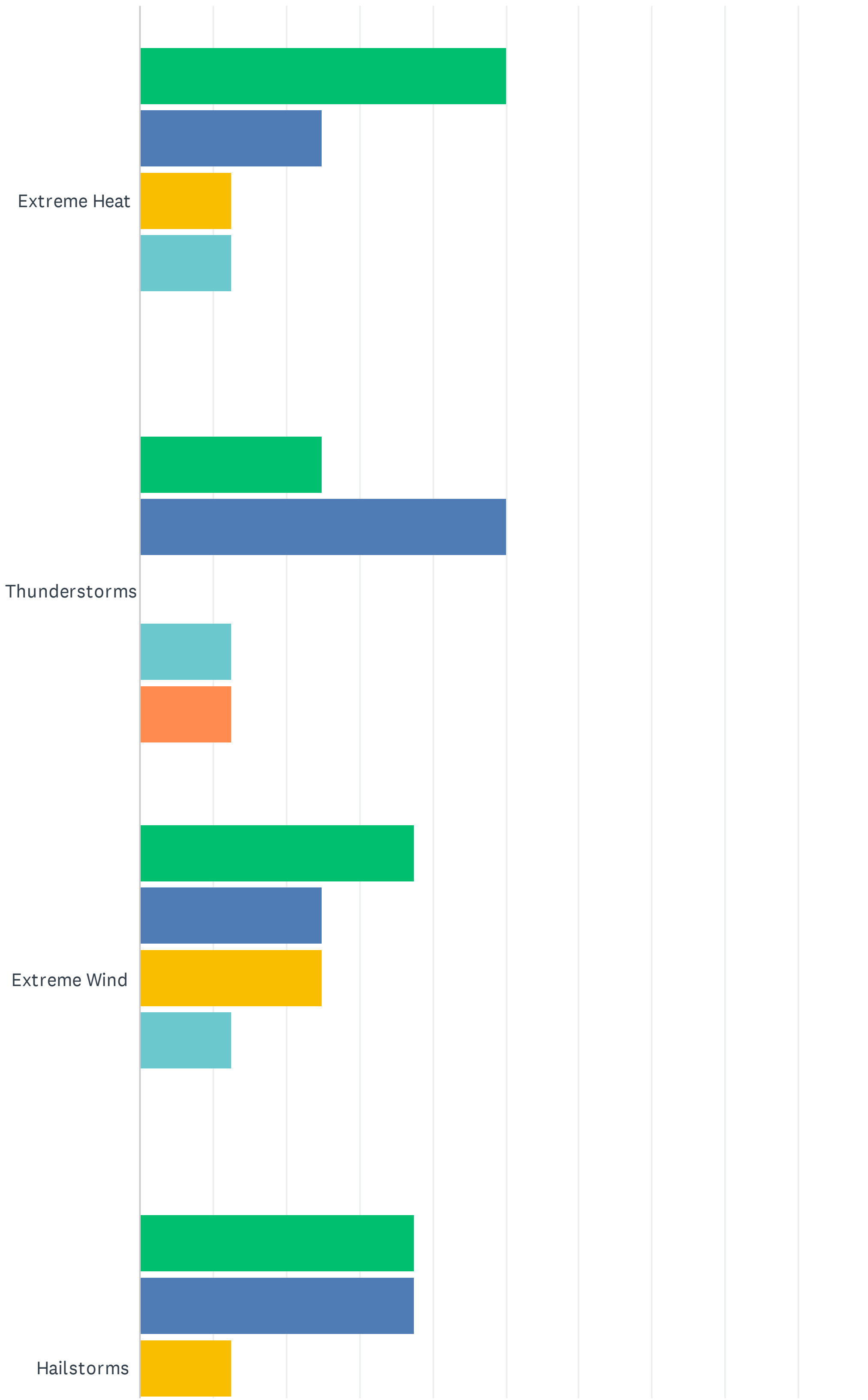
Answered: 7 Skipped: 677

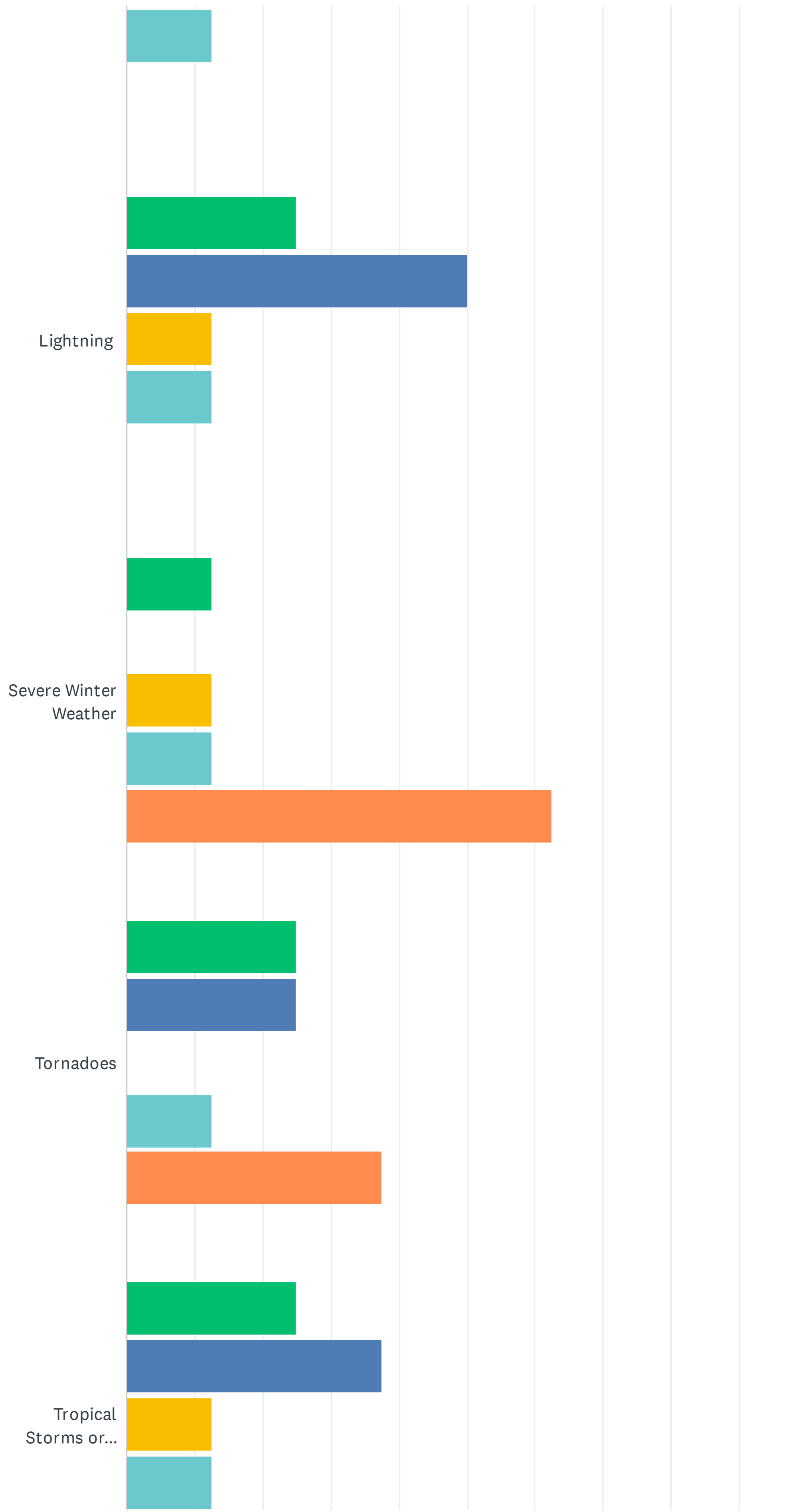


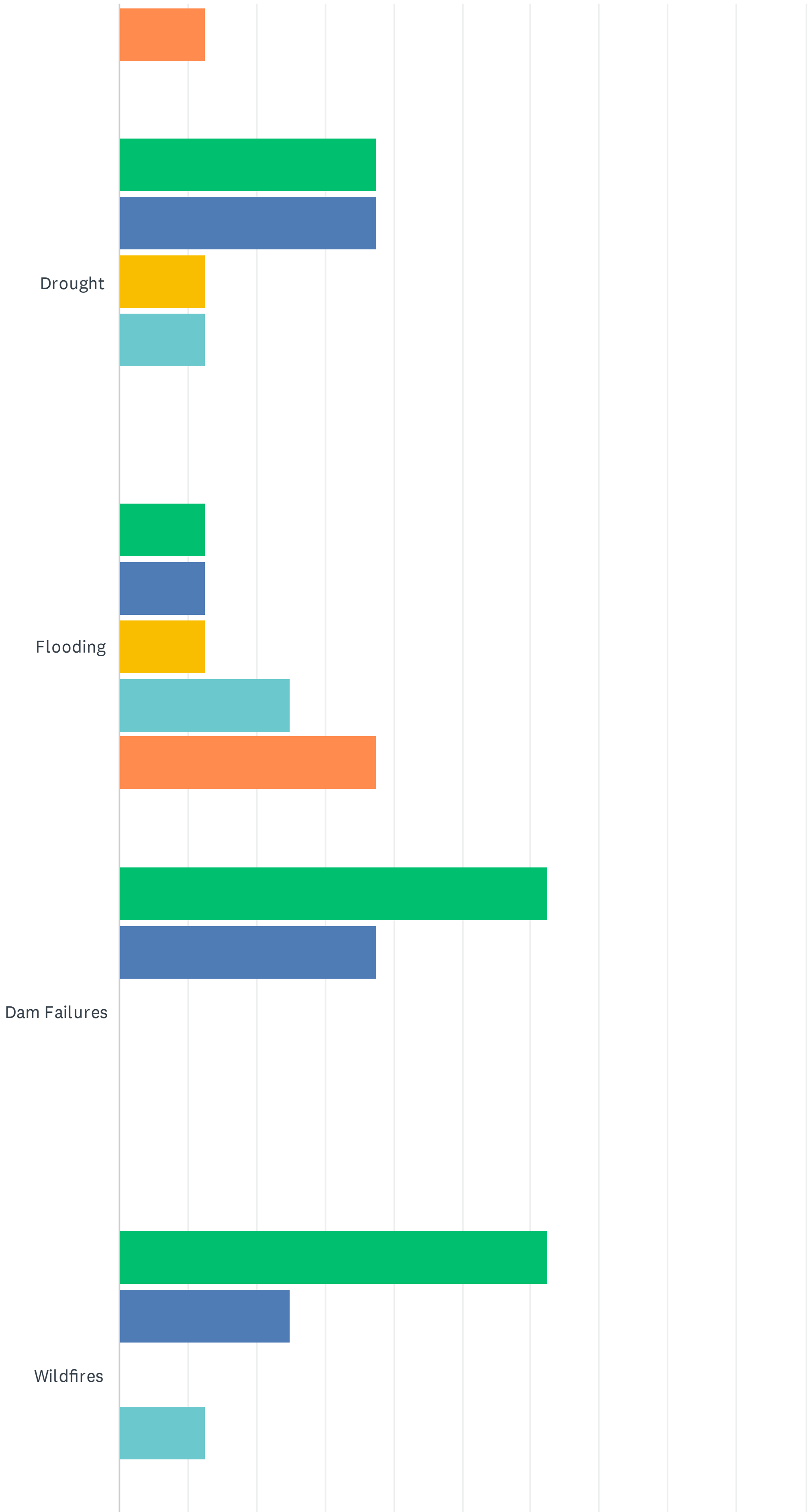
ANSWER CHOICES	RESPONSES	
Yes	71.43%	5
No	28.57%	2
TOTAL		7

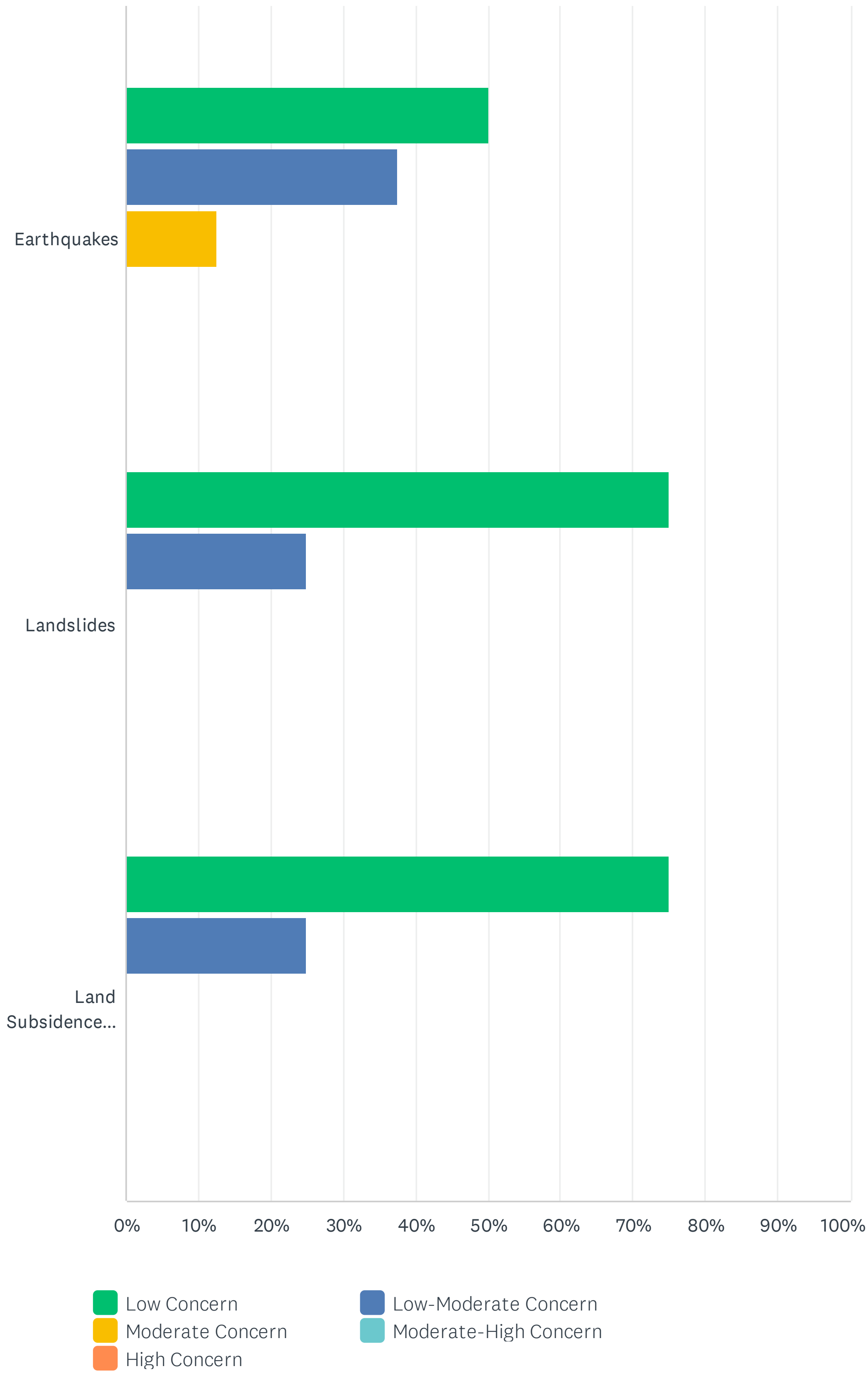
Q16 What is your level of concern for each of the following natural hazards impacting the campus?

Answered: 8 Skipped: 676




Lightning
Severe Winter Weather
Tornadoes
Tropical Storms or...


Drought
Flooding
Dam Failures
Wildfires

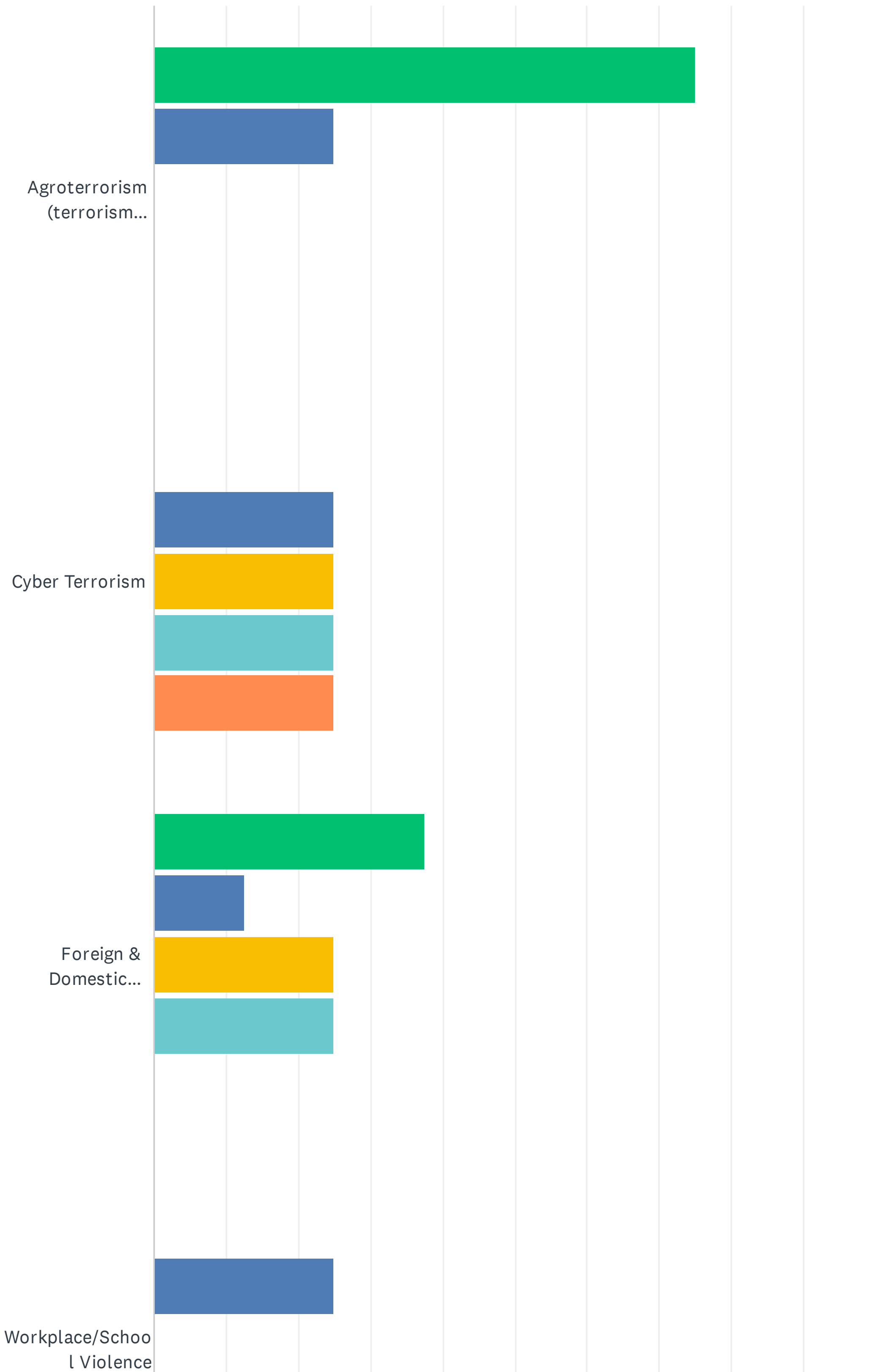

Earthquakes
Landslides
Land Subsidence...
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Low Concern
Low-Moderate Concern
Moderate Concern
Moderate-High Concern
High Concern

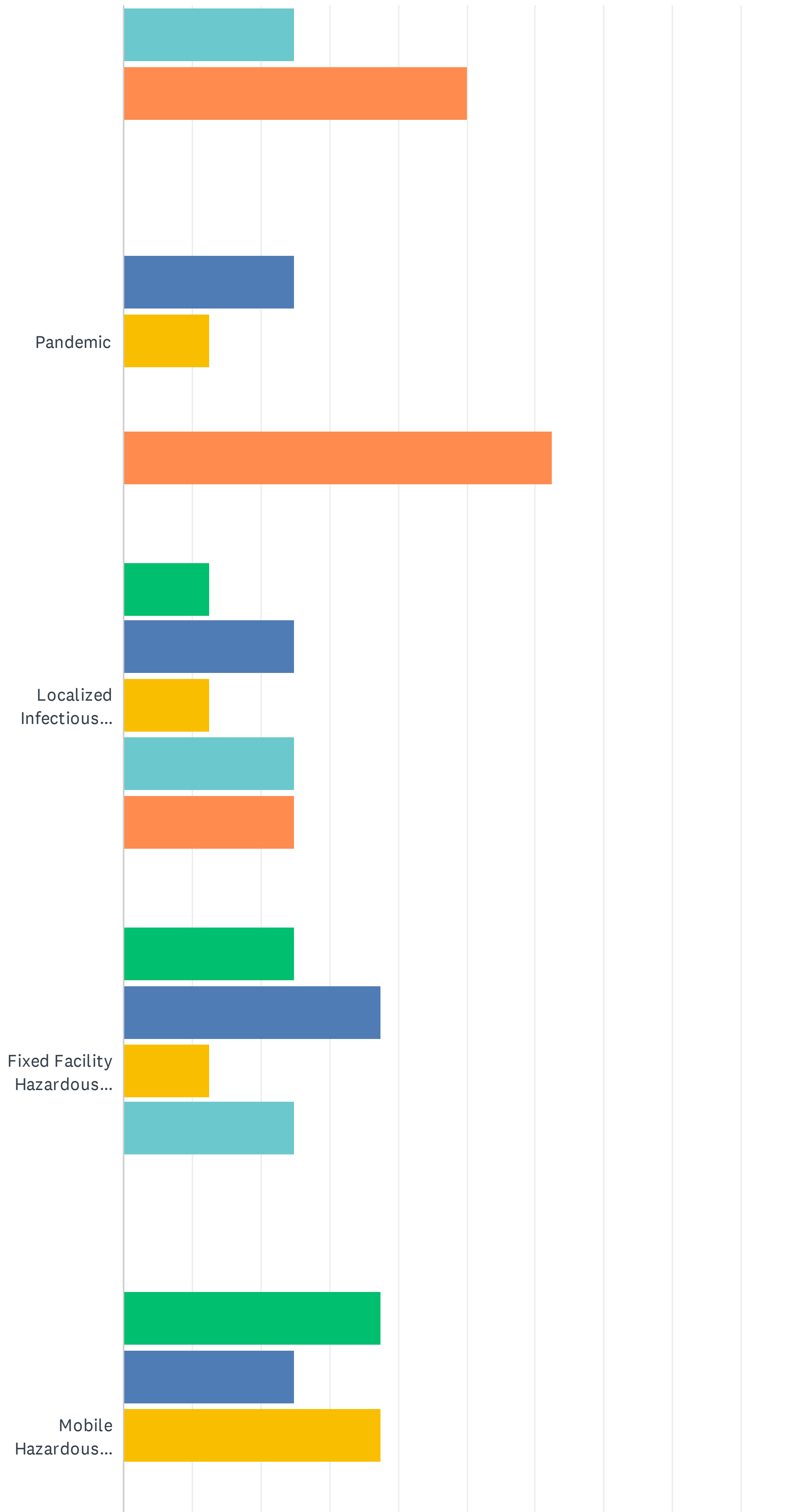
Frederick County Hazard Mitigation Survey (2021)

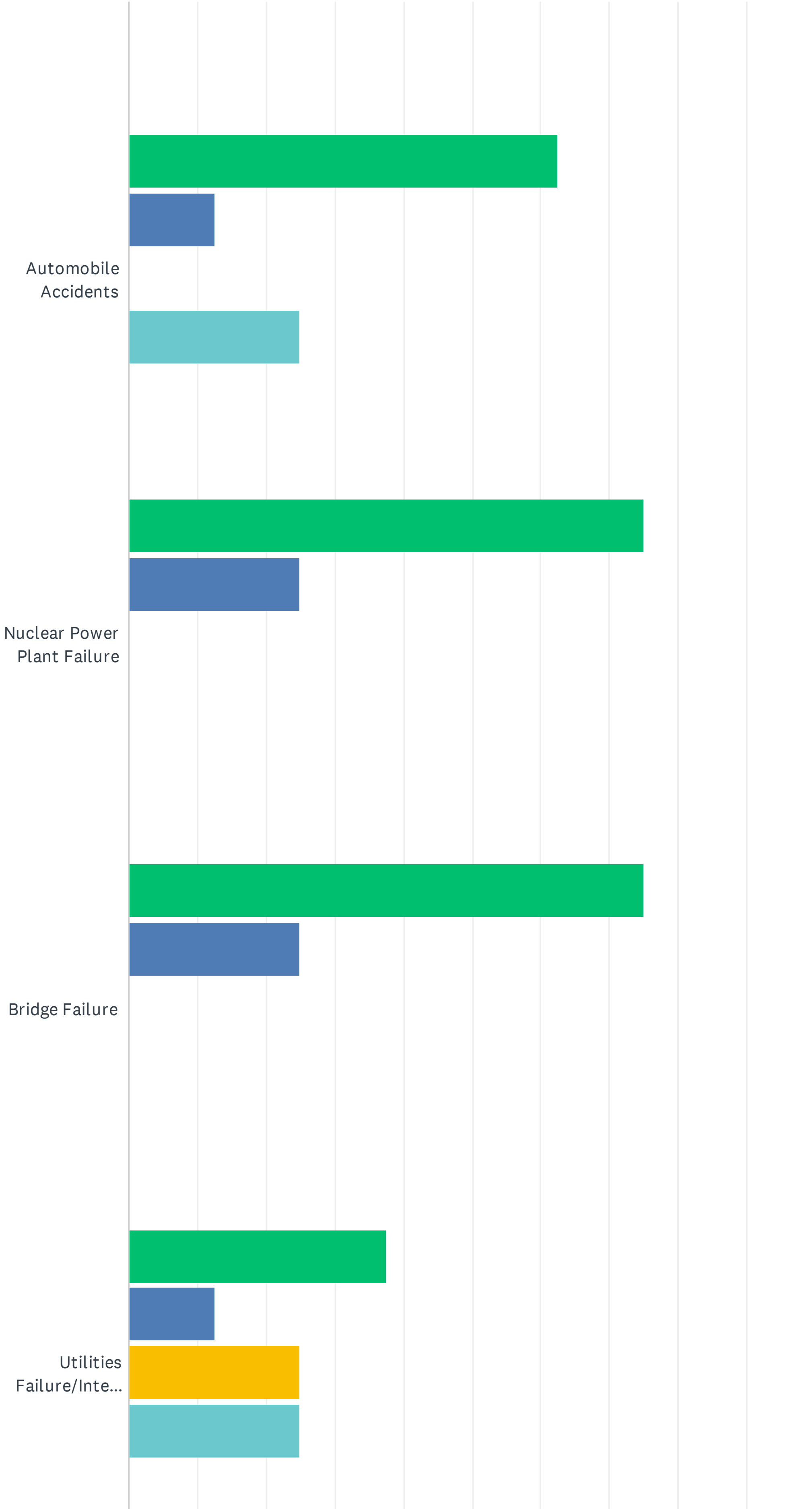
	LOW CONCERN	LOW-MODERATE CONCERN	MODERATE CONCERN	MODERATE-HIGH CONCERN	HIGH CONCERN	TOTAL
Extreme Heat	50.00% 4	25.00% 2	12.50% 1	12.50% 1	0.00% 0	8
Thunderstorms	25.00% 2	50.00% 4	0.00% 0	12.50% 1	12.50% 1	8
Extreme Wind	37.50% 3	25.00% 2	25.00% 2	12.50% 1	0.00% 0	8
Hailstorms	37.50% 3	37.50% 3	12.50% 1	12.50% 1	0.00% 0	8
Lightning	25.00% 2	50.00% 4	12.50% 1	12.50% 1	0.00% 0	8
Severe Winter Weather	12.50% 1	0.00% 0	12.50% 1	12.50% 1	62.50% 5	8
Tornadoes	25.00% 2	25.00% 2	0.00% 0	12.50% 1	37.50% 3	8
Tropical Storms or Hurricanes	25.00% 2	37.50% 3	12.50% 1	12.50% 1	12.50% 1	8
Drought	37.50% 3	37.50% 3	12.50% 1	12.50% 1	0.00% 0	8
Flooding	12.50% 1	12.50% 1	12.50% 1	25.00% 2	37.50% 3	8
Dam Failures	62.50% 5	37.50% 3	0.00% 0	0.00% 0	0.00% 0	8
Wildfires	62.50% 5	25.00% 2	0.00% 0	12.50% 1	0.00% 0	8
Earthquakes	50.00% 4	37.50% 3	12.50% 1	0.00% 0	0.00% 0	8
Landslides	75.00% 6	25.00% 2	0.00% 0	0.00% 0	0.00% 0	8
Land Subsidence (Karst)	75.00% 6	25.00% 2	0.00% 0	0.00% 0	0.00% 0	8

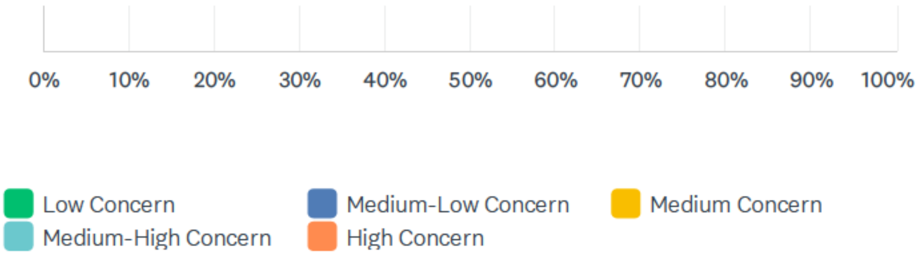
Q17 What is your level of concern for the following human-caused hazards impacting the campus?

Answered: 8 Skipped: 676




Pandemic
Localized Infectious...
Fixed Facility Hazardous...
Mobile Hazardous...


Automobile Accidents
Nuclear Power Plant Failure
Bridge Failure
Utilities Failure/Inte...



	LOW CONCERN	MEDIUM-LOW CONCERN	MEDIUM CONCERN	MEDIUM-HIGH CONCERN	HIGH CONCERN	TOTAL	WEIGHTED AVERAGE
Ag ote ro sm (te o sm effect ng c ops)	75.00% 6	25.00% 2	0.00% 0	0.00% 0	0.00% 0	8	1.25
Cyber Ter o ism	0.00% 0	25.00% 2	25.00% 2	25.00% 2	25.00% 2	8	3.50
Fo e gn & Domest c Ter o ism	37.50% 3	12.50% 1	25.00% 2	25.00% 2	0.00% 0	8	2.38
Wo kp ace/School V o ence	0.00% 0	25.00% 2	0.00% 0	25.00% 2	50.00% 4	8	4.00
Pandem c	0.00% 0	25.00% 2	12.50% 1	0.00% 0	62.50% 5	8	4.00
Loca zed Infect ous D sease Outb eak	12.50% 1	25.00% 2	12.50% 1	25.00% 2	25.00% 2	8	3.25
F xed Fac ty Haza dous Mate ia s Re ease	25.00% 2	37.50% 3	12.50% 1	25.00% 2	0.00% 0	8	2.38
Mob e Haza dous Mate ia s Re ease	37.50% 3	25.00% 2	37.50% 3	0.00% 0	0.00% 0	8	2.00
Automobi e Acc dents	62.50% 5	12.50% 1	0.00% 0	25.00% 2	0.00% 0	8	1.88
Nuc ea Power P ant Fa u e	75.00% 6	25.00% 2	0.00% 0	0.00% 0	0.00% 0	8	1.25
B dge Fa u e	75.00% 6	25.00% 2	0.00% 0	0.00% 0	0.00% 0	8	1.25
Ut t es Fa u e/Inte upt on	37.50% 3	12.50% 1	25.00% 2	25.00% 2	0.00% 0	8	2.38

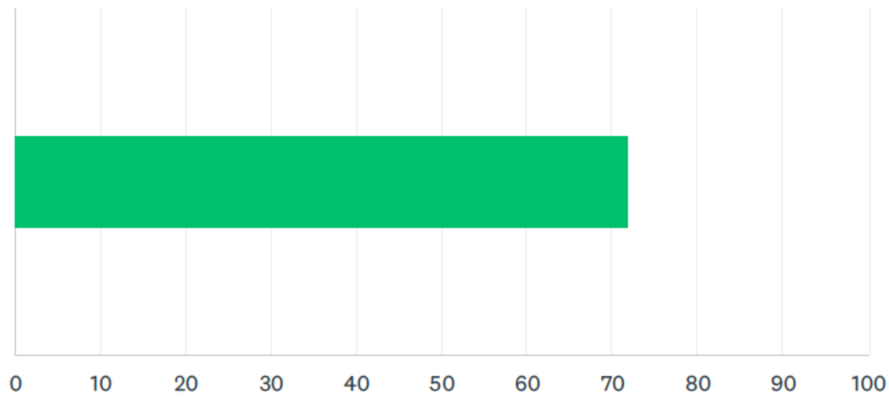
Q18 Have any recent hazard events made your more aware of the dangers of hazards on campus?

Answered: 4 Skipped: 680

#	RESPONSES	DATE
1	Yes, the recent flooding that occurred not too long ago.	10/4/2021 9:33 AM
2	no	10/1/2021 1:56 PM
3	COVID	9/29/2021 9:29 PM
4	Pandemic and flooding	9/25/2021 11:13 AM

Q19 How safe from hazards do you feel on campus?

Answered: 8 Skipped: 676



ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	72	574	8
Total Respondents: 8			

#		DATE
1	93	10/4/2021 9:33 AM
2	94	10/1/2021 1:56 PM
3	78	9/29/2021 9:29 PM
4	50	9/29/2021 2:52 PM
5	75	9/29/2021 11:00 AM
6	54	9/29/2021 10:58 AM
7	50	9/29/2021 10:35 AM
8	80	9/25/2021 11:13 AM

Q20 What area on campus is especially vulnerable to hazards? (Example: an area that often floods)Instructions: Click the area on the campus map and describe the concern in the text box below.

Answered: 3 Skipped: 681

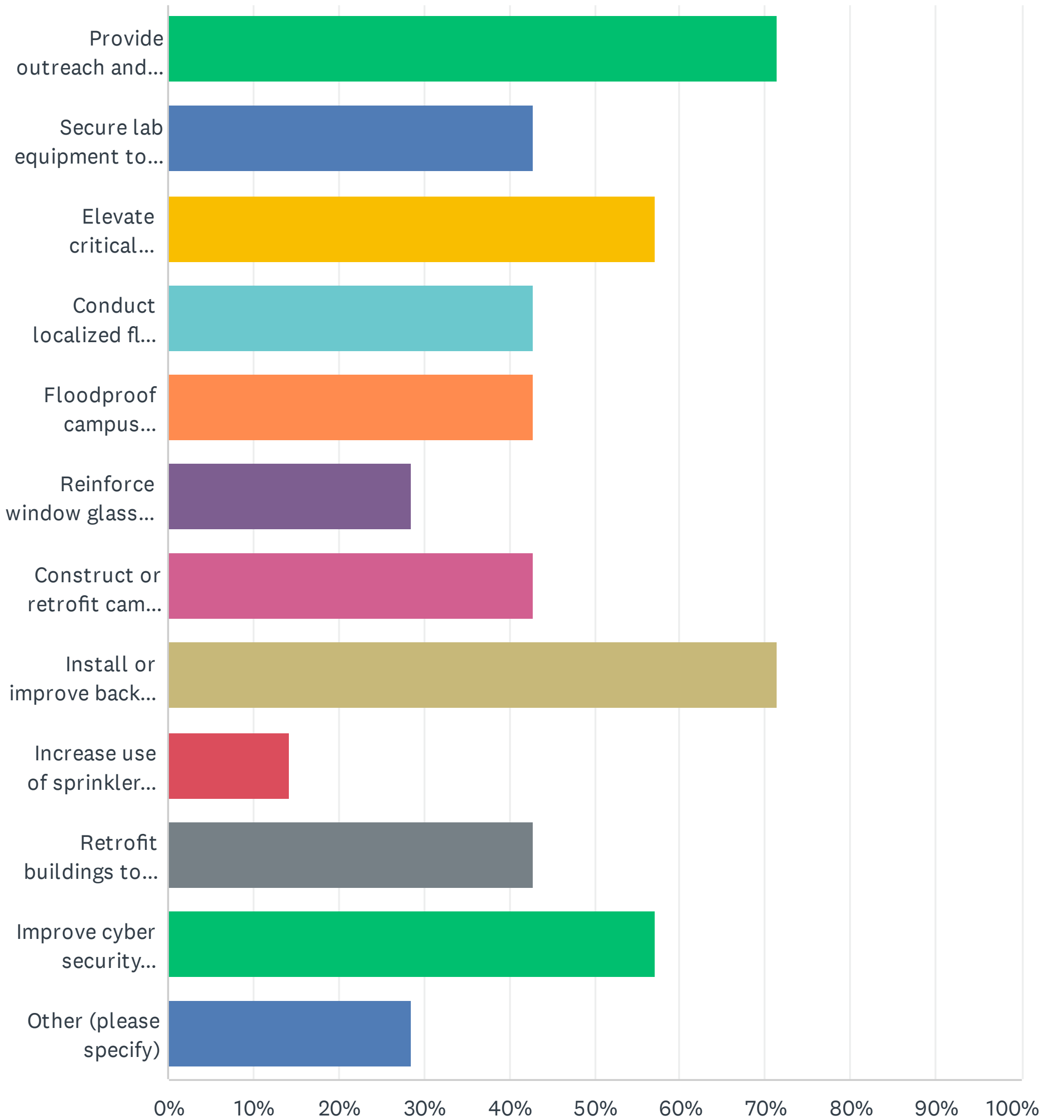
Q21 Describe the area of concern, the hazard, and why it is vulnerable:

Answered: 3 Skipped: 681

#	RESPONSES	DATE
1	flooding	10/4/2021 9:33 AM
2	Parking lot flooding vulnerable due to drainage, low areas	9/29/2021 11:00 AM
3	Flooding	9/25/2021 11:13 AM

Q22 What are the most important things that Frederick Community College can do to help mitigate hazards and become more resilient over time?

Answered: 7 Skipped: 677



ANSWER CHOICES	RESPONSES	
Provide outreach and education to students, faculty, and staff to help them understand their risks and mitigate hazards	71.43%	5
Secure lab equipment to prevent damage during an earthquake or high-wind event	42.86%	3
Elevate critical services, equipment, and/or materials to prevent damage from floodwaters (communications services, computers, books, art, etc.)	57.14%	4
Conduct localized flood risk reduction projects, such as stormwater management projects or stabilizing roads	42.86%	3
Floodproof campus buildings	42.86%	3
Reinforce window glass and frames for high-wind events	28.57%	2
Construct or retrofit campus safe rooms for hurricanes, tornadoes, etc.	42.86%	3
Install or improve backup systems such as generators, computer databases, etc.	71.43%	5
Increase use of sprinkler systems, fireproofing, and/or fire-resistant building materials	14.29%	1
Retrofit buildings to reduce future damages from erosion, high winds, earthquakes, snow, or some human-caused hazards	42.86%	3
Improve cyber security defenses	57.14%	4
Other (please specify)	28.57%	2
Total Respondents: 7		

#	OTHER (PLEASE SPECIFY)	DATE
1	Jefferson Hall 1st floor front desk staff out in open especially susceptible to active shooter	9/29/2021 11:00 AM
2	Improve critical service protection including cyber	9/25/2021 11:13 AM

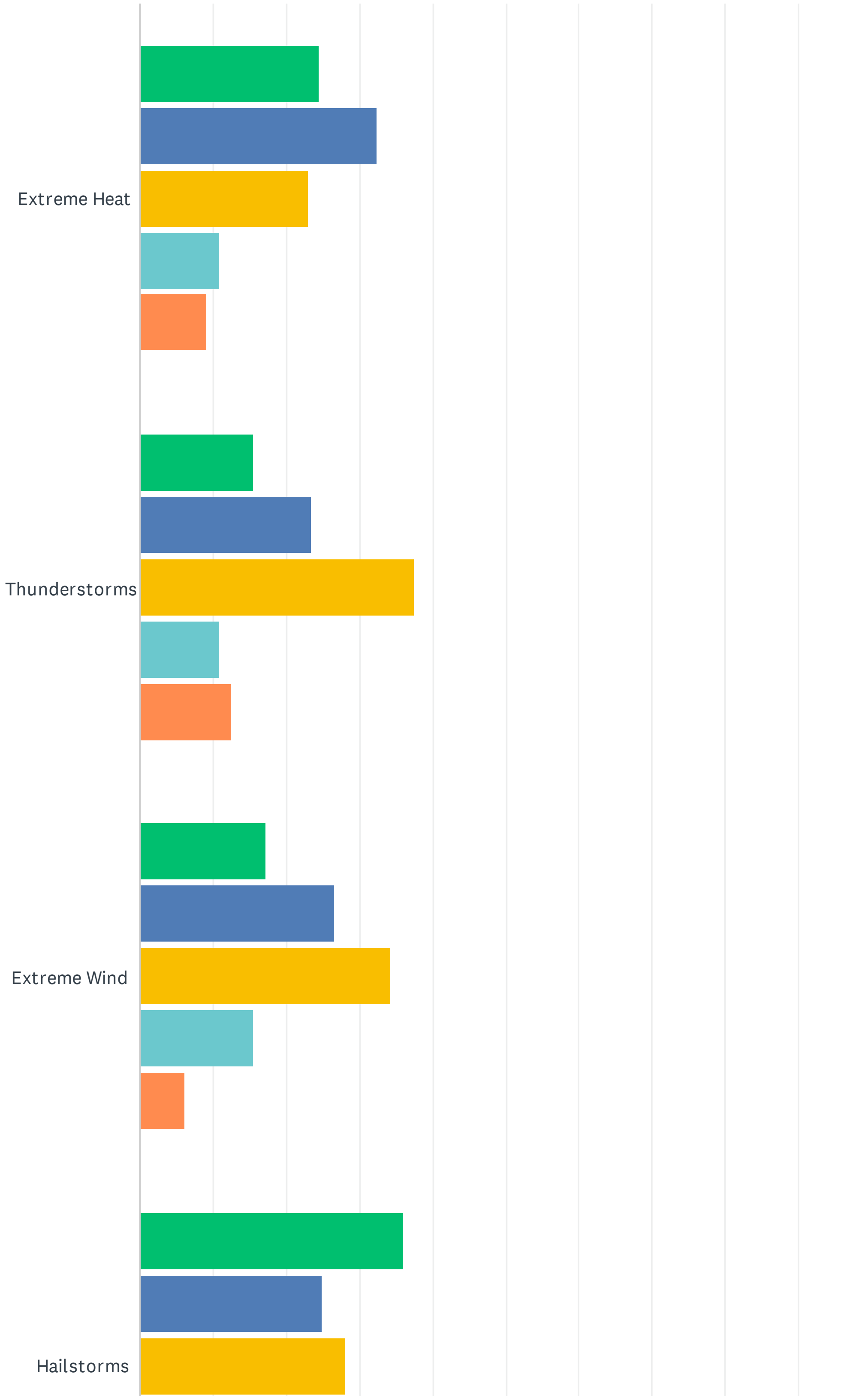
Q23 If you could choose one action that could be taken by Frederick Community College to reduce its vulnerability to hazards, what would it be?

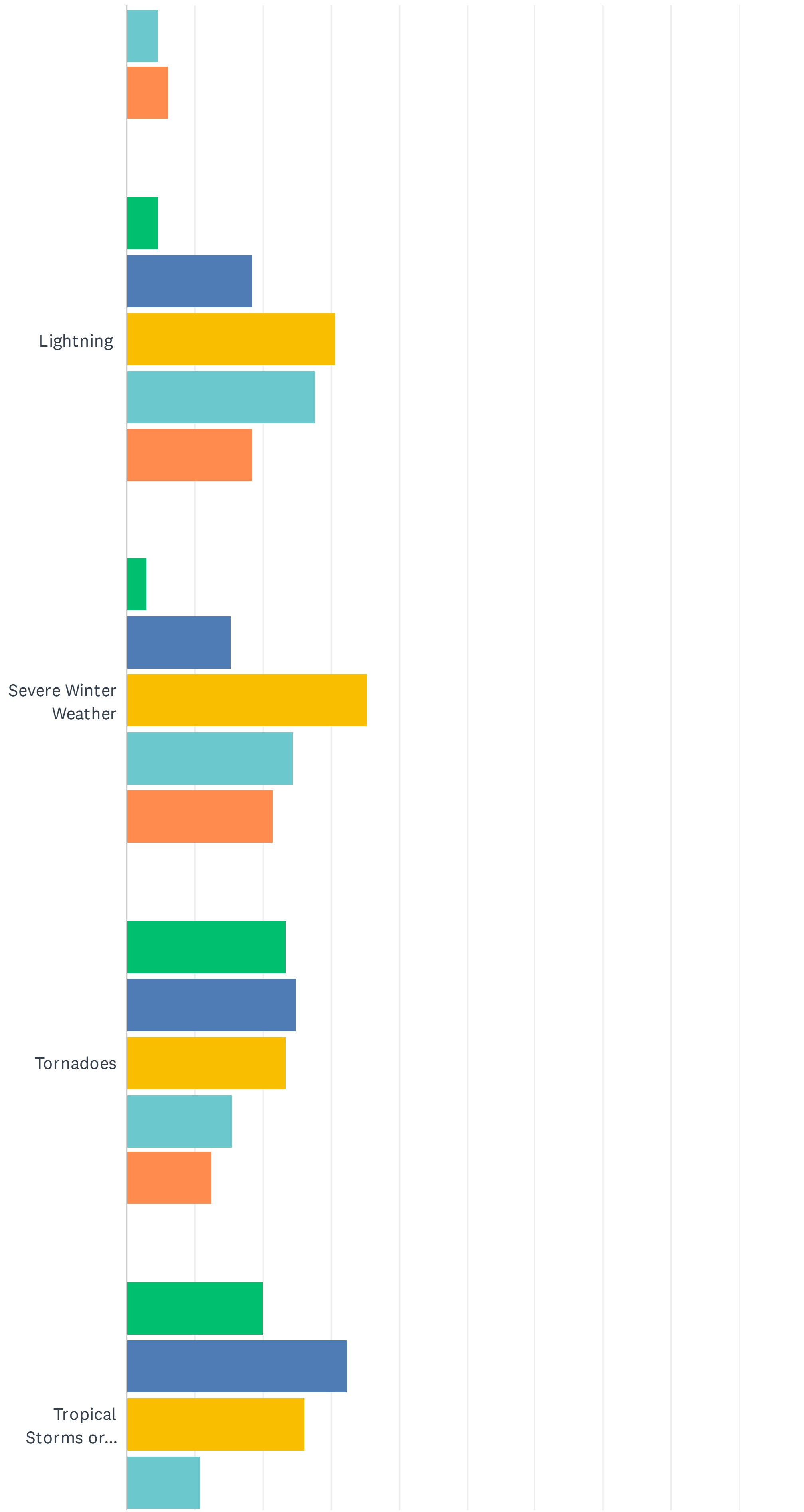
Answered: 4 Skipped: 680

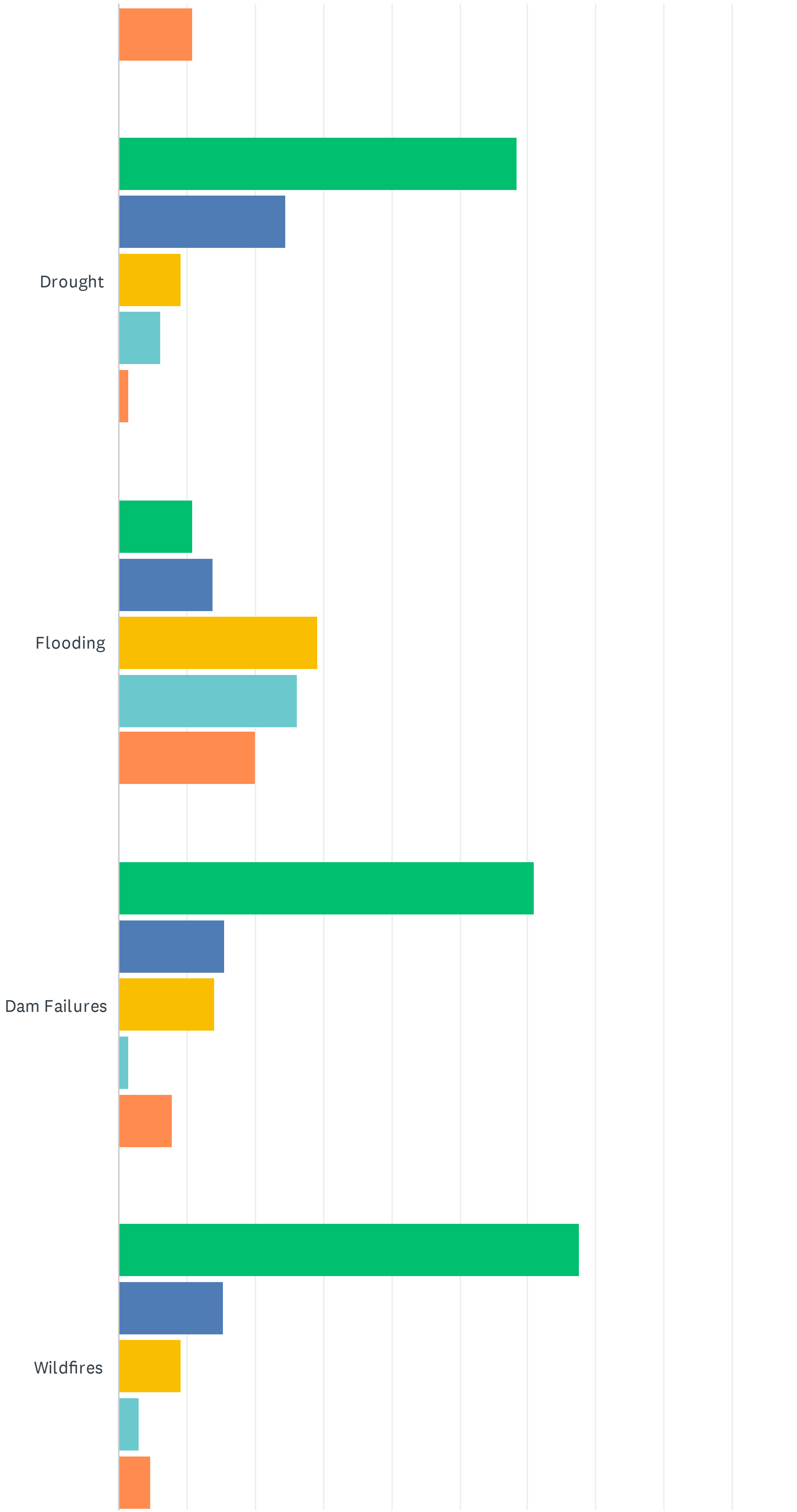
#	RESPONSES	DATE
1	Just reinforcing what is already available to withstand any hazards.	10/4/2021 9:33 AM
2	Close campus when FCPS does for snow and other emergencies.	10/1/2021 1:56 PM
3	policies that rigorously enforce public safety protocols in the event of future pandemics	9/29/2021 9:29 PM
4	Front desk(Welcome desk) staff should be in a room in Jefferson Hall with a window/blind- not an out in the open desk with no doors. Staff at that spot wouldn't stand a chance if there was an active shooter.	9/29/2021 11:00 AM

Q24 What is your level of concern for each of the following natural hazards impacting the campus?

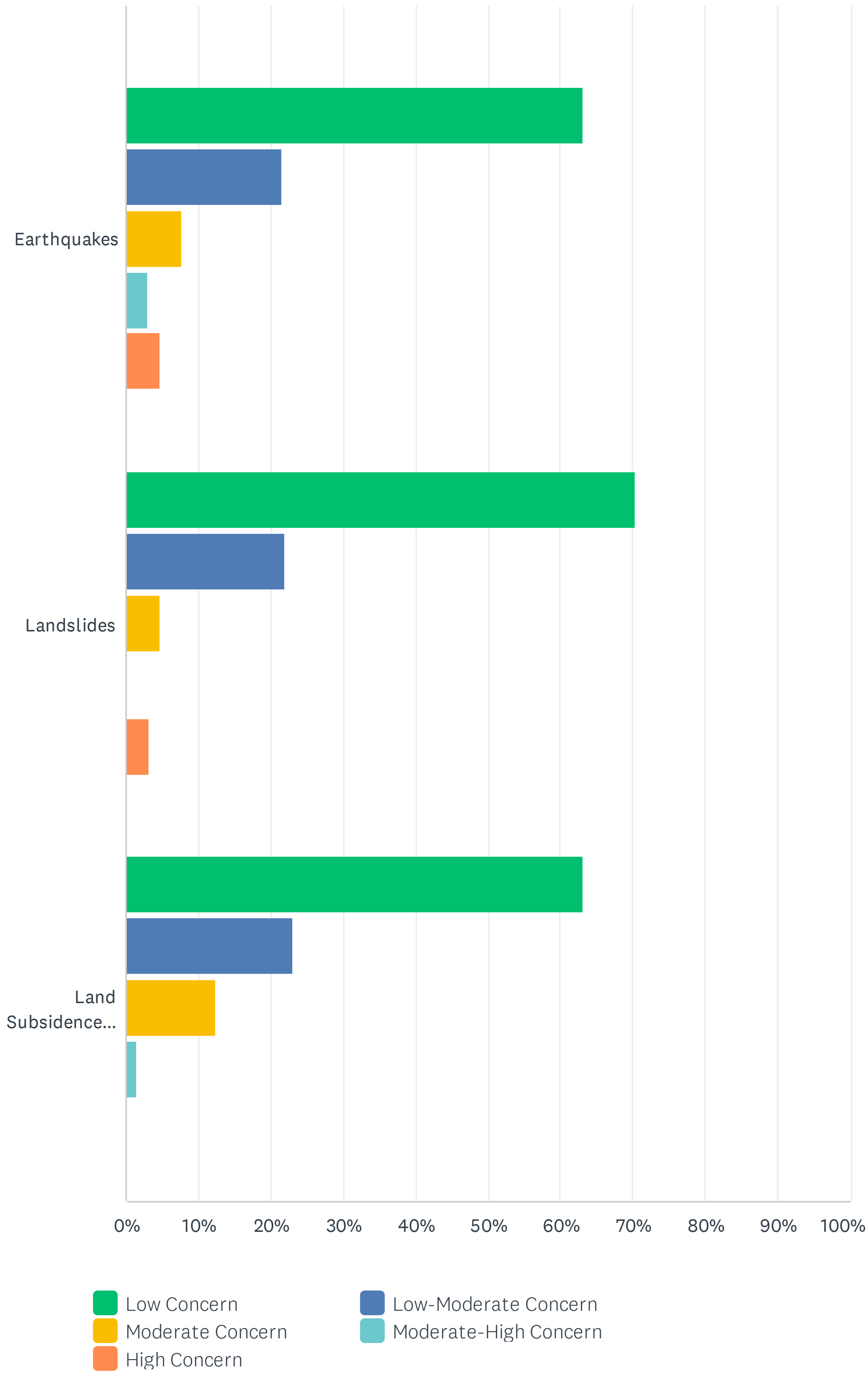
Answered: 65   Skipped: 619




Lightning
Severe Winter Weather
Tornadoes
Tropical Storms or...



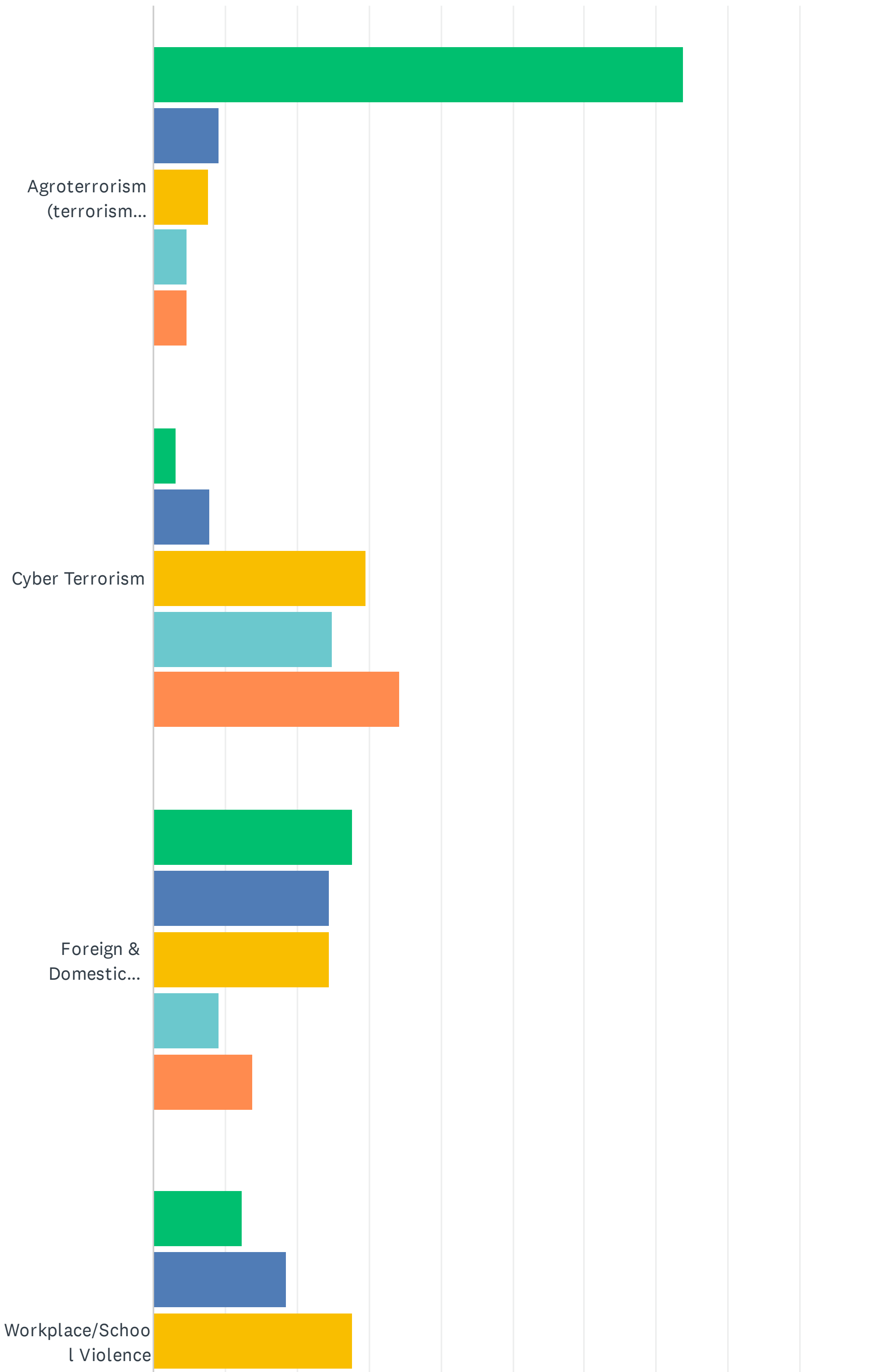
Drought
Flooding
Dam Failures
Wildfires

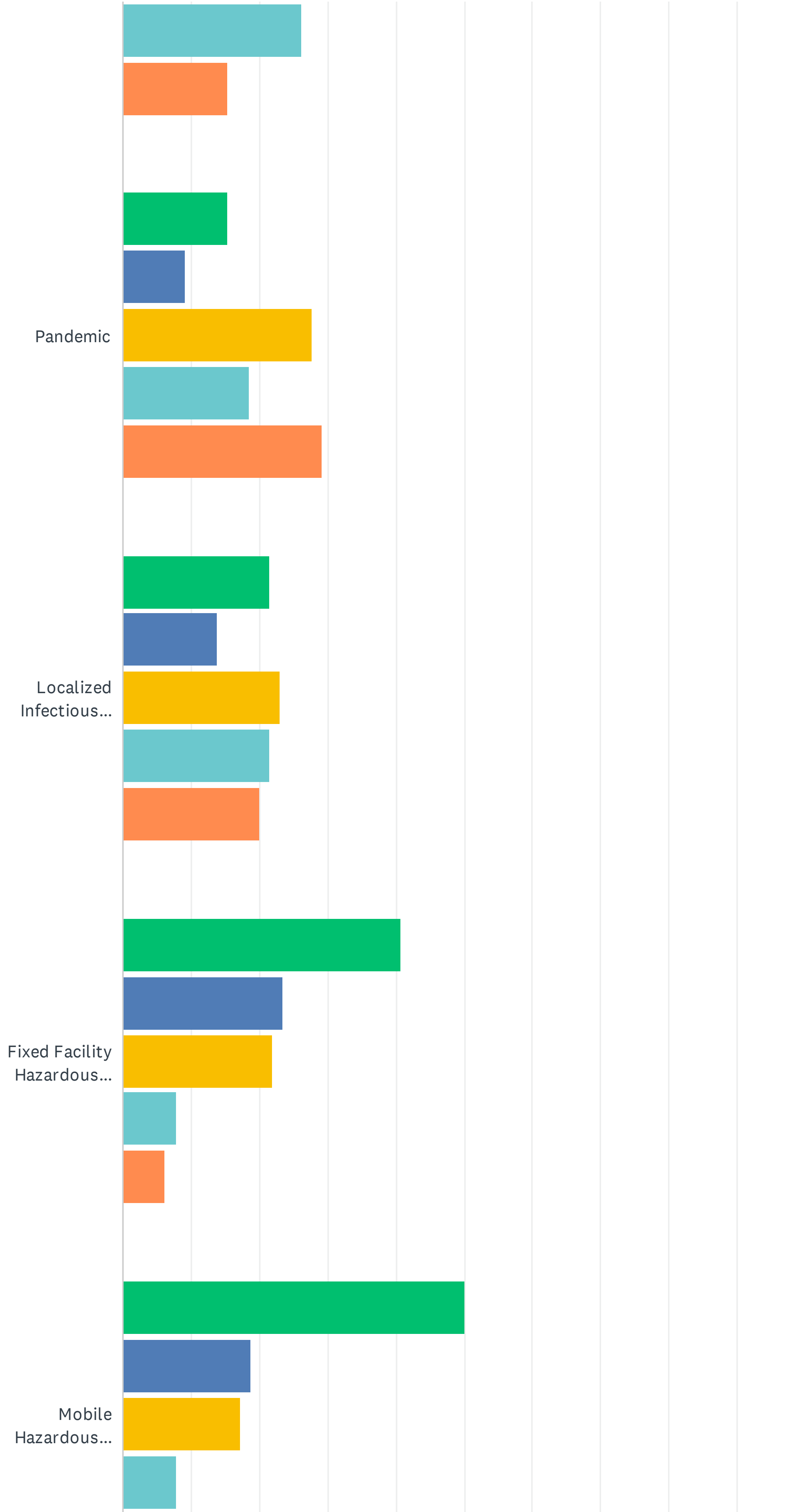

Earthquakes
Landslides
Land Subsidence...
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Low Concern
Low-Moderate Concern
Moderate Concern
Moderate-High Concern
High Concern

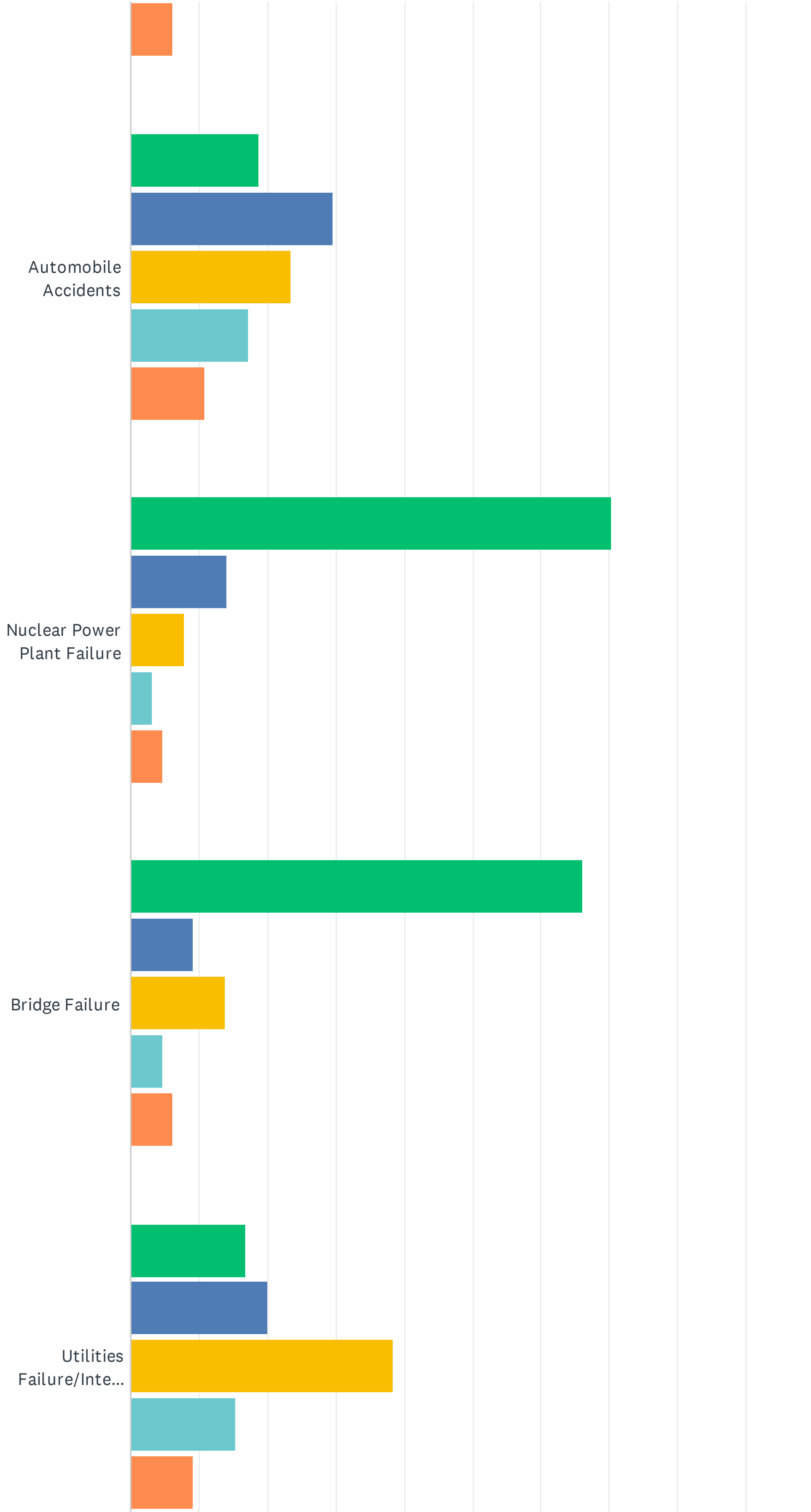
	LOW CONCERN	LOW-MODERATE CONCERN	MODERATE CONCERN	MODERATE-HIGH CONCERN	HIGH CONCERN	TOTAL
Extreme Heat	24.62% 16	32.31% 21	23.08% 15	10.77% 7	9.23% 6	65
Thunderstorms	15.63% 10	23.44% 15	37.50% 24	10.94% 7	12.50% 8	64
Extreme Wind	17.19% 11	26.56% 17	34.38% 22	15.63% 10	6.25% 4	64
Hailstorms	35.94% 23	25.00% 16	28.13% 18	4.69% 3	6.25% 4	64
Lightning	4.62% 3	18.46% 12	30.77% 20	27.69% 18	18.46% 12	65
Severe Winter Weather	3.08% 2	15.38% 10	35.38% 23	24.62% 16	21.54% 14	65
Tornadoes	23.44% 15	25.00% 16	23.44% 15	15.63% 10	12.50% 8	64
Tropical Storms or Hurricanes	20.00% 13	32.31% 21	26.15% 17	10.77% 7	10.77% 7	65
Drought	58.46% 38	24.62% 16	9.23% 6	6.15% 4	1.54% 1	65
Flooding	10.77% 7	13.85% 9	29.23% 19	26.15% 17	20.00% 13	65
Dam Failures	60.94% 39	15.63% 10	14.06% 9	1.56% 1	7.81% 5	64
Wildfires	67.69% 44	15.38% 10	9.23% 6	3.08% 2	4.62% 3	65
Earthquakes	63.08% 41	21.54% 14	7.69% 5	3.08% 2	4.62% 3	65
Landslides	70.31% 45	21.88% 14	4.69% 3	0.00% 0	3.13% 2	64
Land Subsidence (Karst)	63.08% 41	23.08% 15	12.31% 8	1.54% 1	0.00% 0	65

Q25 What is your level of concern for the following human-caused hazards impacting the campus?

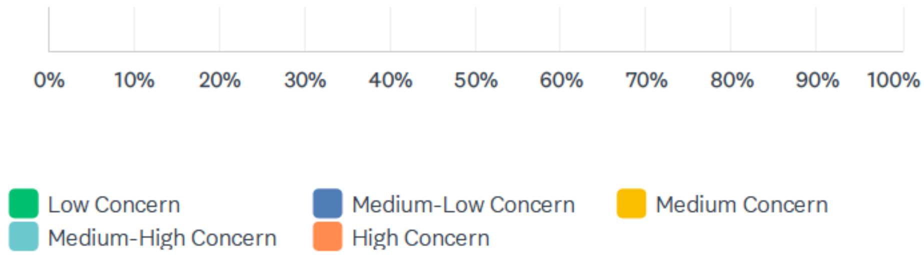
Answered: 65 Skipped: 619




Pandemic
Localized Infectious...
Fixed Facility Hazardous...
Mobile Hazardous...


Automobile Accidents
Nuclear Power Plant Failure
Bridge Failure
Utilities Failure/Inte...

Frederick County Hazard Mitigation Survey (2021)



	LOW CONCERN	MEDIUM-LOW CONCERN	MEDIUM CONCERN	MEDIUM-HIGH CONCERN	HIGH CONCERN	TOTAL	WEIGHTED AVERAGE
Ag ote ro sm (te o sm effect ng c ops)	73.85% 48	9.23% 6	7.69% 5	4.62% 3	4.62% 3	65	1.57
Cyber Ter o ism	3.13% 2	7.81% 5	29.69% 19	25.00% 16	34.38% 22	64	3.80
Fo e gn & Domest c Ter o ism	27.69% 18	24.62% 16	24.62% 16	9.23% 6	13.85% 9	65	2.57
Wo kp ace/School V o ence	12.31% 8	18.46% 12	27.69% 18	26.15% 17	15.38% 10	65	3.14
Pandem c	15.38% 10	9.23% 6	27.69% 18	18.46% 12	29.23% 19	65	3.37
Loca zed Infect ous D sease Outb eak	21.54% 14	13.85% 9	23.08% 15	21.54% 14	20.00% 13	65	3.05
F xed Fac ty Haza dous Mate ia s Re ease	40.63% 26	23.44% 15	21.88% 14	7.81% 5	6.25% 4	64	2.16
Mob e Haza dous Mate ia s Re ease	50.00% 32	18.75% 12	17.19% 11	7.81% 5	6.25% 4	64	2.02
Automobi e Acc dents	18.75% 12	29.69% 19	23.44% 15	17.19% 11	10.94% 7	64	2.72
Nuc ea Power P ant Fa u e	70.31% 45	14.06% 9	7.81% 5	3.13% 2	4.69% 3	64	1.58
B dge Fa u e	66.15% 43	9.23% 6	13.85% 9	4.62% 3	6.15% 4	65	1.75
Ut t es Fa u e/Inte upt on	16.92% 11	20.00% 13	38.46% 25	15.38% 10	9.23% 6	65	2.80

Q26 Have any recent hazard events made your more aware of the dangers of hazards on campus?

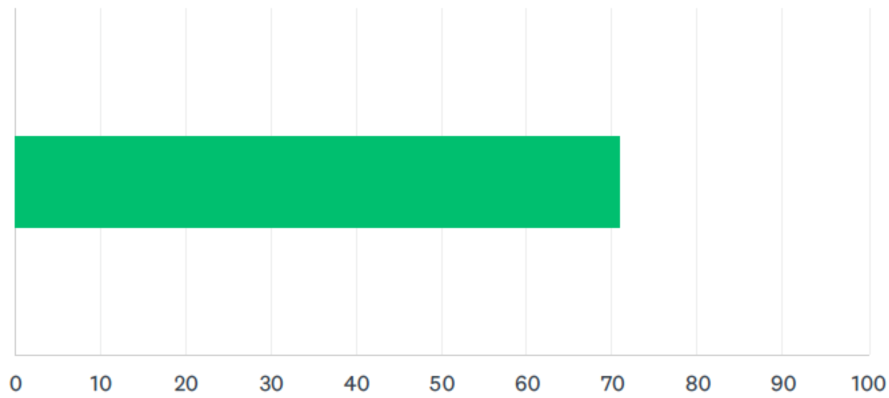
Answered: 47 Skipped: 637

#	RESPONSES	DATE
1	We had a fire on campus due to lightning which brought awareness of the vulnerability that exists, even when there are no ways to actively prevent a situation.	10/22/2021 11:06 AM
2	Lightning strike caused Brodbeck Hall Fire and Washington Adventist University experienced a ransomware attack in October this year.	10/21/2021 9:55 AM
3	The music hall on campus was struck by lightning and caught the building on fire.	10/20/2021 8:25 PM
4	A recent fire was caused by lightening striking Brodbeck Hall. Also, the ongoing pandemic increases the risk to everyone who needs to interact with others.	10/20/2021 4:56 PM
5	The lightning striking Brodbeck Hall and causing a fire	10/20/2021 4:43 PM
6	Brodbeck being struck by lightning, flooding events in Downtown Frederick, stalking and harassment of a friend	10/20/2021 3:55 PM
7	no	10/20/2021 3:50 PM
8	the fire in Brodbeck Hall made me more aware of the impact of lightning. There also have been times that our office has had to go into the basement of our building due to tornados.	10/20/2021 3:39 PM
9	No	10/20/2021 2:43 PM
10	Heavy rains in recent years that caused city flooding and water issues in some campus buildings. Lightning strike and fire at Brodbeck Music Hall. Ongoing coronavirus pandemic.	10/20/2021 1:44 PM
11	Lightening strike causing a fire in our Music Building.	10/20/2021 1:32 PM
12	Yes; the recent passing of hurricane Ida and a lightning strike that ignited a fire in one campus building	10/20/2021 1:06 PM
13	No.	10/20/2021 12:58 PM
14	Yes, on the evening of September 8, there was a thunderstorm with lightening that struck one of the buildings. My dorm building also experienced leaks in multiple students' rooms.	10/20/2021 12:51 PM
15	no	10/20/2021 12:27 PM
16	Yes. Hood College's Music Hall catching fire because of lightning striking it has me extremely concerned.	10/20/2021 12:26 PM
17	Hurricane and lightning	10/20/2021 12:22 PM
18	Lightning fire at Brodbeck hall	10/20/2021 12:21 PM
19	Fire in building caused by lightning. Residents and non-residence lurking in buildings.	10/20/2021 12:20 PM
20	The Broadbeck fire was a surprise, but I think that was the building most at risk for that.	10/20/2021 12:19 PM
21	Lightning	10/20/2021 12:18 PM
22	Lightning hit our music hall and it caught on fire	10/20/2021 11:56 AM
23	lightning that caused fire to a building recently	10/20/2021 11:54 AM
24	Some of the lower levels of certain buildings flood when there is a lot of rain.	10/18/2021 9:35 AM
25	the lightening strike on the music building and the hurricane and flooding that we had.	10/17/2021 2:20 PM
26	COVID-19 pandemic, white supremacy stickers / flyers posted on campus. I am concerned about domestic terrorist activity from white nationalists/ white supremacy groups or individuals.	10/17/2021 9:58 AM

27	COVID 19 pandemic and the poor air circulation as well as my windowless office in Tatem Art Center on Hood campus.	10/15/2021 6:55 PM
28	COVID-19, cyber attacks to local government in Maryland, power outages	10/15/2021 3:09 PM
29	The flooding from the recent hurricane	10/15/2021 1:28 PM
30	The lightning strike and consequent fire at Brodbeck hall has made me worry more about lightning. Recent heavy rainstorms that turned the local roads into rivers have made me worry about flooding.	10/15/2021 1:00 PM
31	Flooding in my classroom and the fire at the building where I teach.	10/15/2021 12:57 PM
32	Lightning involved fire on campus.	10/15/2021 12:37 PM
33	Fire at Brodbeck Hall due to lightning	10/15/2021 12:30 PM
34	Lightning striking a building on campus and starting a fire, constant email phishing scams	10/15/2021 12:12 PM
35	the pandemic	10/15/2021 11:59 AM
36	A prowler on campus, gaining access to school buildings; a situation that bordered on stalking.	10/15/2021 11:57 AM
37	Unknown person in campus residence buildings (in women's bathroom)	10/15/2021 11:57 AM
38	Fire in Brodbeck due to lightening	10/15/2021 11:54 AM
39	The current pandemic	10/15/2021 11:53 AM
40	Lightning struck the Brodbeck Music Hall.	10/15/2021 11:52 AM
41	Lightning strike and fire in Brodbeck Hall	10/15/2021 11:47 AM
42	Flooding	10/15/2021 11:46 AM
43	COVID-19 and germs/illnesses on a college campus.	10/15/2021 11:46 AM
44	Lightning strike, Cyber attack	10/14/2021 10:50 AM
45	lightning strike Brodbeck	10/14/2021 10:26 AM
46	fire	10/14/2021 10:24 AM
47	The virus going around has . That you need to be more careful and wash your hands and keep things clean so people are safe and healthy . No matter what their health is .	9/29/2021 2:13 PM

Q27 How safe from hazards do you feel on campus?

Answered: 65 Skipped: 619



ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	71	4,613	65
Total Respondents: 65			

#		DATE
1	83	10/22/2021 11:06 AM
2	85	10/21/2021 9:55 AM
3	85	10/21/2021 12:16 AM
4	85	10/20/2021 8:25 PM
5	63	10/20/2021 7:19 PM
6	85	10/20/2021 4:56 PM
7	85	10/20/2021 4:43 PM
8	35	10/20/2021 3:55 PM
9	90	10/20/2021 3:50 PM
10	70	10/20/2021 3:39 PM
11	0	10/20/2021 2:43 PM
12	70	10/20/2021 1:44 PM
13	90	10/20/2021 1:32 PM
14	96	10/20/2021 1:09 PM
15	64	10/20/2021 1:06 PM
16	89	10/20/2021 12:58 PM
17	90	10/20/2021 12:51 PM
18	72	10/20/2021 12:27 PM
19	17	10/20/2021 12:26 PM
20	80	10/20/2021 12:22 PM

21	60	10/20/2021 12:21 PM
22	50	10/20/2021 12:20 PM
23	85	10/20/2021 12:19 PM
24	55	10/20/2021 12:18 PM
25	82	10/20/2021 12:03 PM
26	80	10/20/2021 11:59 AM
27	84	10/20/2021 11:56 AM
28	90	10/20/2021 11:54 AM
29	85	10/20/2021 11:52 AM
30	56	10/18/2021 4:24 PM
31	84	10/18/2021 9:59 AM
32	92	10/18/2021 9:35 AM
33	80	10/17/2021 2:20 PM
34	75	10/17/2021 9:58 AM
35	22	10/15/2021 6:55 PM
36	70	10/15/2021 4:41 PM
37	75	10/15/2021 3:54 PM
38	75	10/15/2021 3:09 PM
39	84	10/15/2021 1:40 PM
40	79	10/15/2021 1:28 PM
41	91	10/15/2021 1:00 PM
42	34	10/15/2021 12:59 PM
43	37	10/15/2021 12:57 PM
44	50	10/15/2021 12:51 PM
45	63	10/15/2021 12:37 PM
46	71	10/15/2021 12:30 PM
47	90	10/15/2021 12:27 PM
48	69	10/15/2021 12:12 PM
49	61	10/15/2021 12:04 PM
50	69	10/15/2021 12:01 PM
51	60	10/15/2021 11:59 AM
52	84	10/15/2021 11:57 AM
53	80	10/15/2021 11:57 AM
54	70	10/15/2021 11:54 AM
55	94	10/15/2021 11:53 AM
56	59	10/15/2021 11:52 AM
57	80	10/15/2021 11:47 AM
58	90	10/15/2021 11:46 AM

59	15	10/15/2021 11:46 AM
60	52	10/15/2021 11:46 AM
61	75	10/14/2021 4:02 PM
62	100	10/14/2021 10:50 AM
63	90	10/14/2021 10:26 AM
64	85	10/14/2021 10:24 AM
65	47	9/29/2021 2:13 PM

Q28 What area on campus is especially vulnerable to hazards? (Example: an area that often floods)Instructions: Click the area on the campus map and describe the concern in the text box below.

Answered: 36 Skipped: 648

Q29 Describe the area of concern, the hazard, and why it is vulnerable:

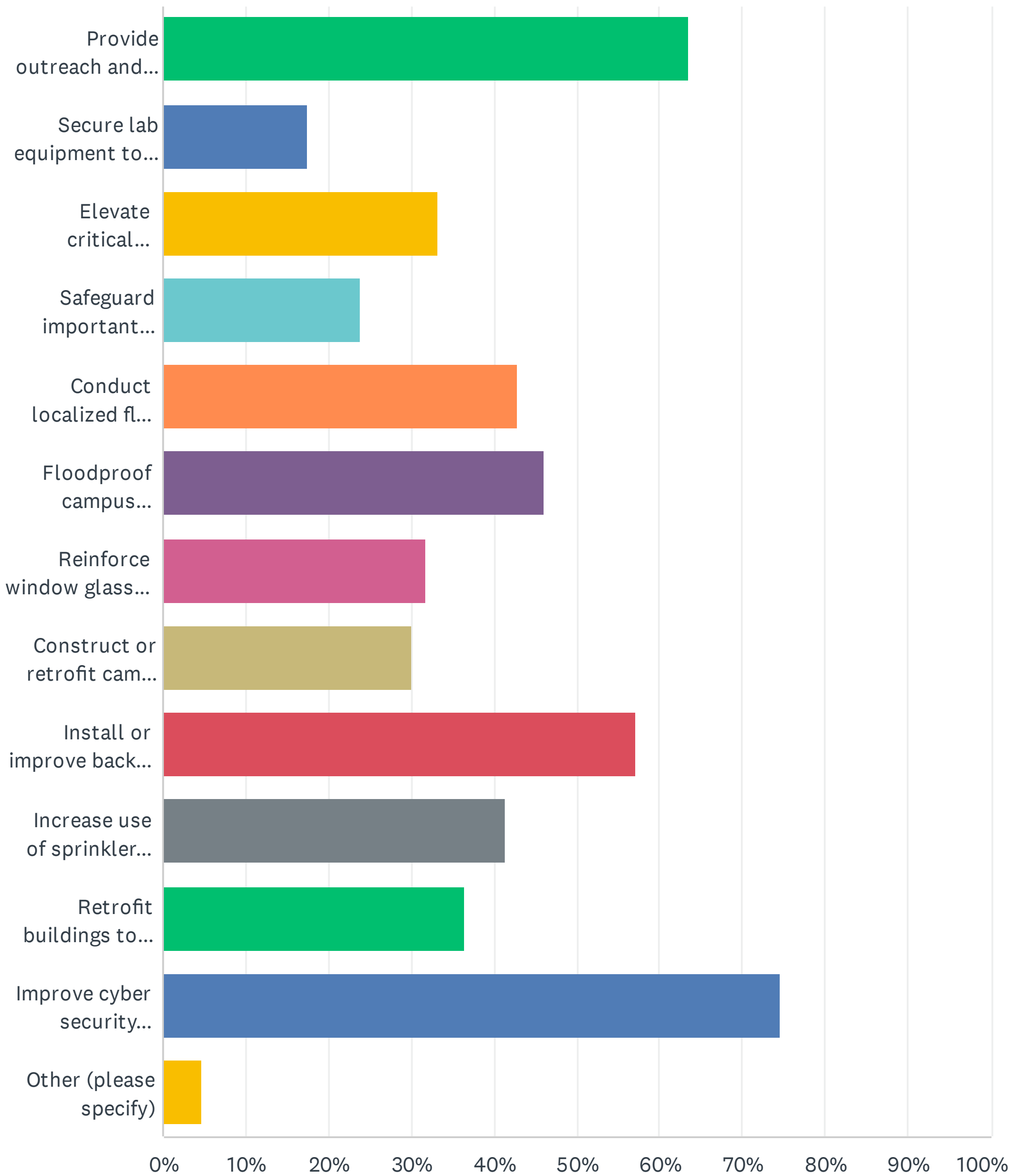
Answered: 41 Skipped: 643

#	RESPONSES	DATE
1	Biggest concern is the campus center as this is where violence is most likely to occur in large groups, or where disease can spread most rapidly due to the increased numbers of individuals in this area.	10/22/2021 11:06 AM
2	Sidewalks - especially the pergola - flood whenever it rains.	10/20/2021 7:19 PM
3	This area of campus is poorly lit at night and has dark areas where someone could perform illicit activities	10/20/2021 4:56 PM
4	I would not say the parking lots are the areas that flood most frequently. It is often the sidewalks and especially the pergola where I notice the most flooding	10/20/2021 4:43 PM
5	The parking lot in that location frequently floods because of the incline of the land and impervious surfaces above it, which can cause property damage to the cars parked in that lot and make it impossible for the owners to drive their cars during the flooding events.	10/20/2021 3:55 PM
6	campuses are always at risk because they are open and anyone can come to campus, they may not access building necessarily (but they can), but there is a lot of ability to move about.	10/20/2021 3:50 PM
7	The basement of Alumnae House floods during heavy rainstorms.	10/20/2021 3:39 PM
8	Open campus	10/20/2021 2:43 PM
9	I work in Alumnae House and we have poor gutters and drainage in instances of heavy rain which cause our basement to flood, presenting hazards to our staff in walking on wet floors with electrical equipment nearby, plus the threat to important files kept in our basement.	10/20/2021 1:44 PM
10	This is the location of our primary data center for the college. Environmental hazards could affect campus operations should the building be impacted.	10/20/2021 1:32 PM
11	It floods there a lot.	10/20/2021 1:09 PM
12	This general area is of lower elevation and thus might be more susceptible to flooding	10/20/2021 1:06 PM
13	College Drive is closer to a Main Street and the hazard could be flooding.	10/20/2021 12:58 PM
14	The pergola flooded with at least 3 inches of rain. A stronger storm could make it nearly impossible to walk through.	10/20/2021 12:51 PM
15	I clicked on the Music Hall because that was where it caught fire.	10/20/2021 12:26 PM
16	Low areas that flood easily	10/20/2021 12:22 PM
17	Rosenstock basement floods, labs down there with sensitive electronics Parkinglot outside fills up with snow in winter	10/20/2021 12:21 PM
18	Angles in street resulting in flooding across road between Hodson Technology and Whitaker. Also flooding on road between Alumni Hall and Tatum.	10/20/2021 12:20 PM
19	The lots behind Blazer and Shriner halls slope downhill but at least it's away from the buildings. The Pergola doesn't drain very well and I walked through two inches of standing water there earlier this semester. Usually only from flash floods I think.	10/20/2021 12:19 PM
20	Alumnae House basement floods on a regular basis.	10/20/2021 12:18 PM
21	That parking lot floods pretty bad	10/20/2021 11:56 AM
22	The basement of Rosenstock Hall floods when there is a lot of rain.	10/18/2021 9:35 AM
23	We have old buildings that may need repairs.	10/17/2021 9:58 AM
24	Prone to flooding, hazardous materials used in studio art in a building with poor ventilation.	10/15/2021 6:55 PM

25	Memorial Hall has trouble with flooding in the basement when it thunderstorms.	10/15/2021 4:41 PM
26	Outdoor sports in weather (heat, lightning, snow)	10/15/2021 3:54 PM
27	do not have a specific areas	10/15/2021 3:09 PM
28	I am worried about flooding on neighborhood streets. The corner of Magnolia and Evergreen was under fairly deep water during storms in September.	10/15/2021 1:00 PM
29	Flooding in and around the chapel and possible lightening strikes	10/15/2021 12:57 PM
30	poorly lit at night	10/15/2021 12:37 PM
31	Low lying, flooded before	10/15/2021 12:30 PM
32	Street flooding	10/15/2021 12:12 PM
33	Williams Observatory routinely floods in the basement. Martha Church Dr. had some sight line issues for pedestrians.	10/15/2021 11:57 AM
34	Dark parking lot, open to the street	10/15/2021 11:57 AM
35	Brodbeck caught on fire due to lightening	10/15/2021 11:54 AM
36	Brodbeck, it needs renovations, fire and lighting threats need to be mitigated	10/15/2021 11:53 AM
37	flooding	10/15/2021 11:46 AM
38	It flooded pretty significantly during the last big rainstorm.	10/15/2021 11:46 AM
39	flooding on campus from water line backing up from the city -- this happened in May 2018 (flooded Rosenstock Hall basement, Alumnae Hall basement)	10/14/2021 10:26 AM
40	Black lot, low grade, prone to flooding in heavy rain	10/14/2021 10:24 AM
41	Biology annex - there is always a pill of some chemicals happening or something going wrong and someone getting sick	9/29/2021 2:13 PM

Q30 What are the most important things that Hood College can do to help mitigate hazards and become more resilient over time?

Answered: 63 Skipped: 621



ANSWER CHOICES	RESPONSES	
Provide outreach and education to students, faculty, and staff to help them understand their risks and mitigate hazards	63.49%	40
Secure lab equipment to prevent damage during an earthquake or high-wind event	17.46%	11
Elevate critical services, equipment, and/or materials to prevent damage from floodwaters (communications services, computers, books, art, etc.)	33.33%	21
Safeguard important research documents and specimens and make duplicate copies of reports and store them separately from the originals	23.81%	15
Conduct localized flood risk reduction projects, such as stormwater management projects or stabilizing roads	42.86%	27
Floodproof campus buildings	46.03%	29
Reinforce window glass and frames for high-wind events	31.75%	20
Construct or retrofit campus safe rooms for hurricanes, tornadoes, etc.	30.16%	19
Install or improve backup systems such as generators, computer databases, etc.	57.14%	36
Increase use of sprinkler systems, fireproofing, and/or fire-resistant building materials	41.27%	26
Retrofit buildings to reduce future damages from erosion, high winds, earthquakes, snow, or some human-caused hazards	36.51%	23
Improve cyber security defenses	74.60%	47
Other (please specify)	4.76%	3
Total Respondents: 63		

#	OTHER (PLEASE SPECIFY)	DATE
1	Digitizing majority of the duplicate copies of important research documents instead of creating more paper documents for potential future damages by fire or sprinkler systems.	10/21/2021 9:55 AM
2	Keep up with repairs/updates to crumbling infrastructure	10/15/2021 12:57 PM
3	Green Infrastructure	10/15/2021 12:27 PM

Q31 If you could choose one action that could be taken by Hood College to reduce its vulnerability to hazards, what would it be?

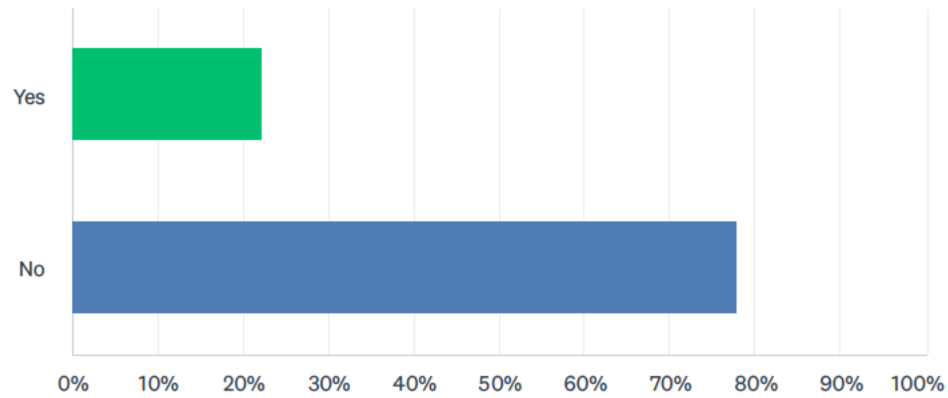
Answered: 43 Skipped: 641

#	RESPONSES	DATE
1	Outreach and education or cyber security defenses.	10/22/2021 11:06 AM
2	Reassess evacuation strategies and plans for each campus building.	10/21/2021 9:55 AM
3	Improve Cybersecurity - There are numerous scam emails and hacked accounts every year.	10/20/2021 7:19 PM
4	Improved cybersecurity	10/20/2021 4:56 PM
5	Better drainage / storm water management systems to prevent sidewalk flooding	10/20/2021 4:43 PM
6	For reports to campus safety (of literally any kind!) to be taken seriously and be dealt with expediently	10/20/2021 3:55 PM
7	Increase campus safety--hire more staff	10/20/2021 3:50 PM
8	From the list above, I think the cybersecurity issue is paramount - strengthening our defenses and having a recovery plan in place.	10/20/2021 1:44 PM
9	Better cyber security	10/20/2021 1:09 PM
10	I don't know	10/20/2021 1:06 PM
11	Conduct localized flood risk reduction projects	10/20/2021 12:58 PM
12	Protecting buildings (especially dorm buildings) from damages caused by hazards	10/20/2021 12:51 PM
13	improve cyber-security	10/20/2021 12:27 PM
14	N/A	10/20/2021 12:26 PM
15	Have backup systems for power outage	10/20/2021 12:22 PM
16	floodproof	10/20/2021 12:21 PM
17	Proofing buildings from natural disasters including tornados, hurricanes, thunderstorms, lightning, wind, rain, and flooding.	10/20/2021 12:20 PM
18	Send out a single email at the beginning of the semester going over what to do and safe areas in each building from tornadoes/hurricanes.	10/20/2021 12:19 PM
19	educate and be prepared	10/20/2021 12:18 PM
20	N/A	10/20/2021 11:56 AM
21	conduct a risk management study on the various hazards and examine current protocols	10/20/2021 11:54 AM
22	more eyes on foot. hore more security staff. Visible presence is always good deterrent.	10/18/2021 4:24 PM
23	Flood proof buildings.	10/18/2021 9:35 AM
24	Cyber security.	10/15/2021 6:55 PM
25	Purchase apps for more staff members from the national weather service to predict the future forecast.	10/15/2021 3:54 PM
26	mentally prepare students, faculty, and staff that any of these things are possible at anytime	10/15/2021 3:09 PM
27	I would suggest that Hood continue to strengthen its defenses against online attacks. A disruption to Hood's computer systems would seriously disrupt classes and other college operations.	10/15/2021 1:00 PM

28	Repair and update existing infrastructure.	10/15/2021 12:57 PM
29	Education, training and drills.	10/15/2021 12:30 PM
30	Develop a Climate Action Plan for prioritizing resiliency projects.	10/15/2021 12:27 PM
31	flood prevention	10/15/2021 12:12 PM
32	remove windows from all classroom, office, and lab doors in case someone comes in with a gun	10/15/2021 11:59 AM
33	Hire more campus security officers.	10/15/2021 11:57 AM
34	Keeping students and staff better informed and updated when it comes to risks and suspicious activity	10/15/2021 11:57 AM
35	Retrofit buildings	10/15/2021 11:54 AM
36	Set aside a hazard fund, and provide education about any and all hazard plans	10/15/2021 11:53 AM
37	Prepare for armed assailants by ensuring all doors can be locked and windows can be opened.	10/15/2021 11:46 AM
38	Close campus in a timely manner BEFORE these hazards strike	10/15/2021 11:46 AM
39	Backup systems and cyber security	10/15/2021 11:46 AM
40	IT security	10/14/2021 4:02 PM
41	Awareness. Education	10/14/2021 10:50 AM
42	Education/awareness	10/14/2021 10:24 AM
43	Provide outreach and education to students , faculty to help them understand the flood risks and maybe make a plan set in place for when these type of things happen students and staff know what to do and don't panic . That way they are safe and are knowledgeable and up to date .	9/29/2021 2:13 PM

Q32 Do you own a home in Frederick County?

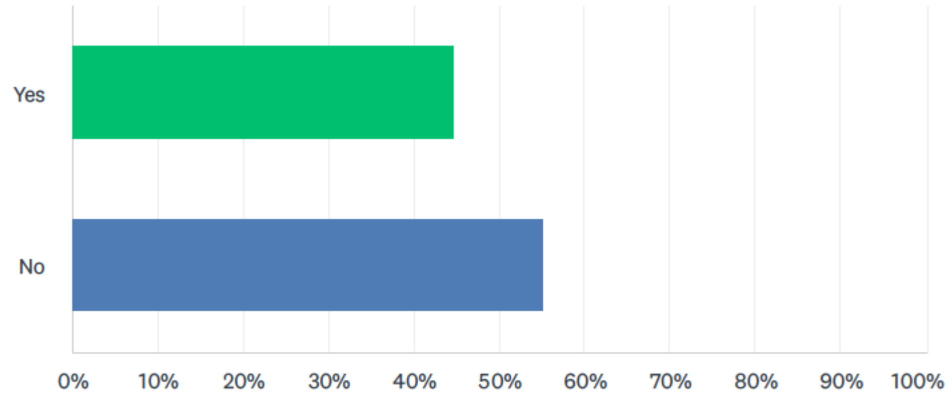
Answered: 211 Skipped: 473



ANSWER CHOICES	RESPONSES	
Yes	22.27%	47
No	77.73%	164
TOTAL		211

Q33 Are you aware that Frederick County maintains a hazard mitigation plan?

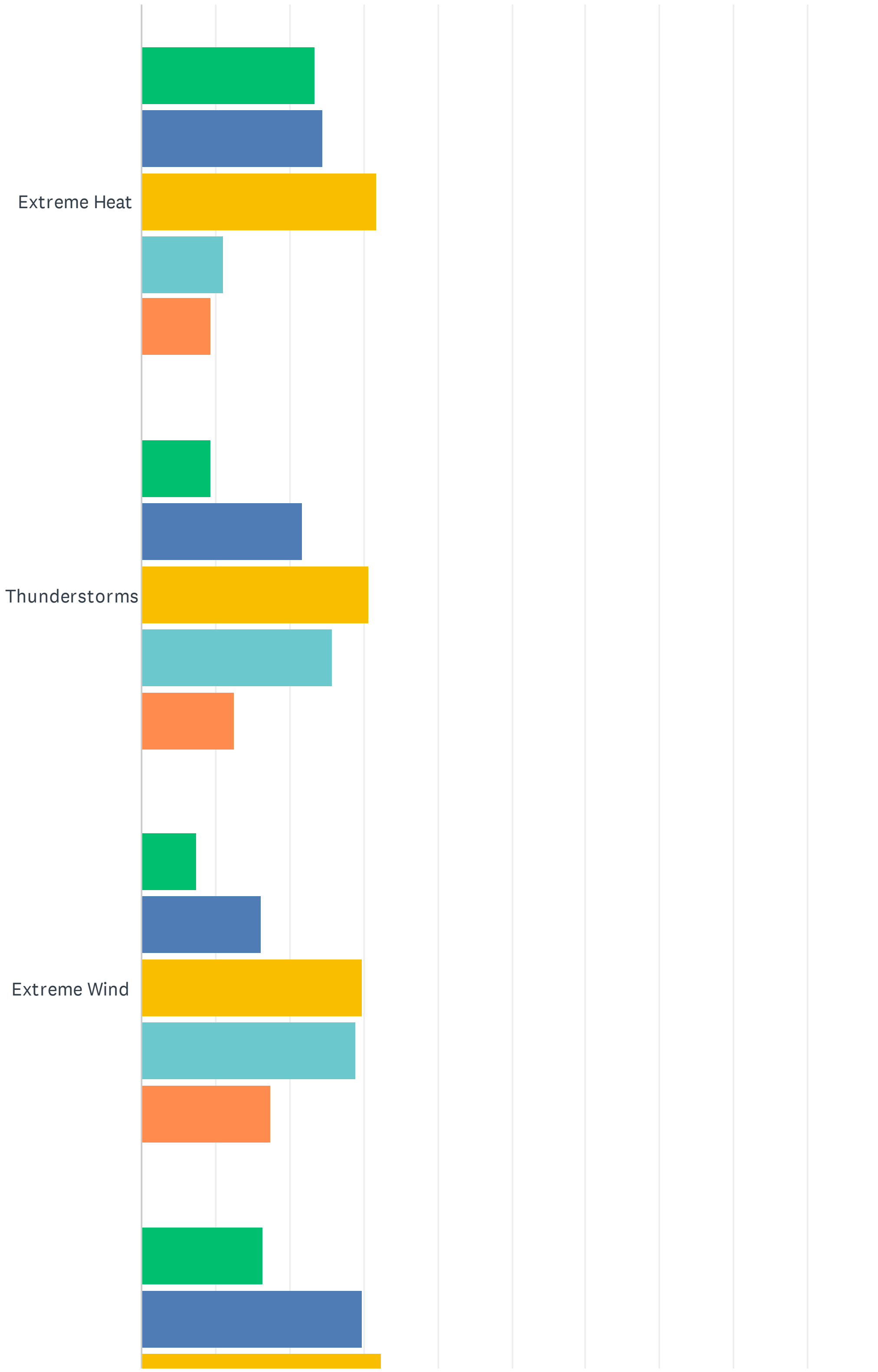
Answered: 368   Skipped: 316

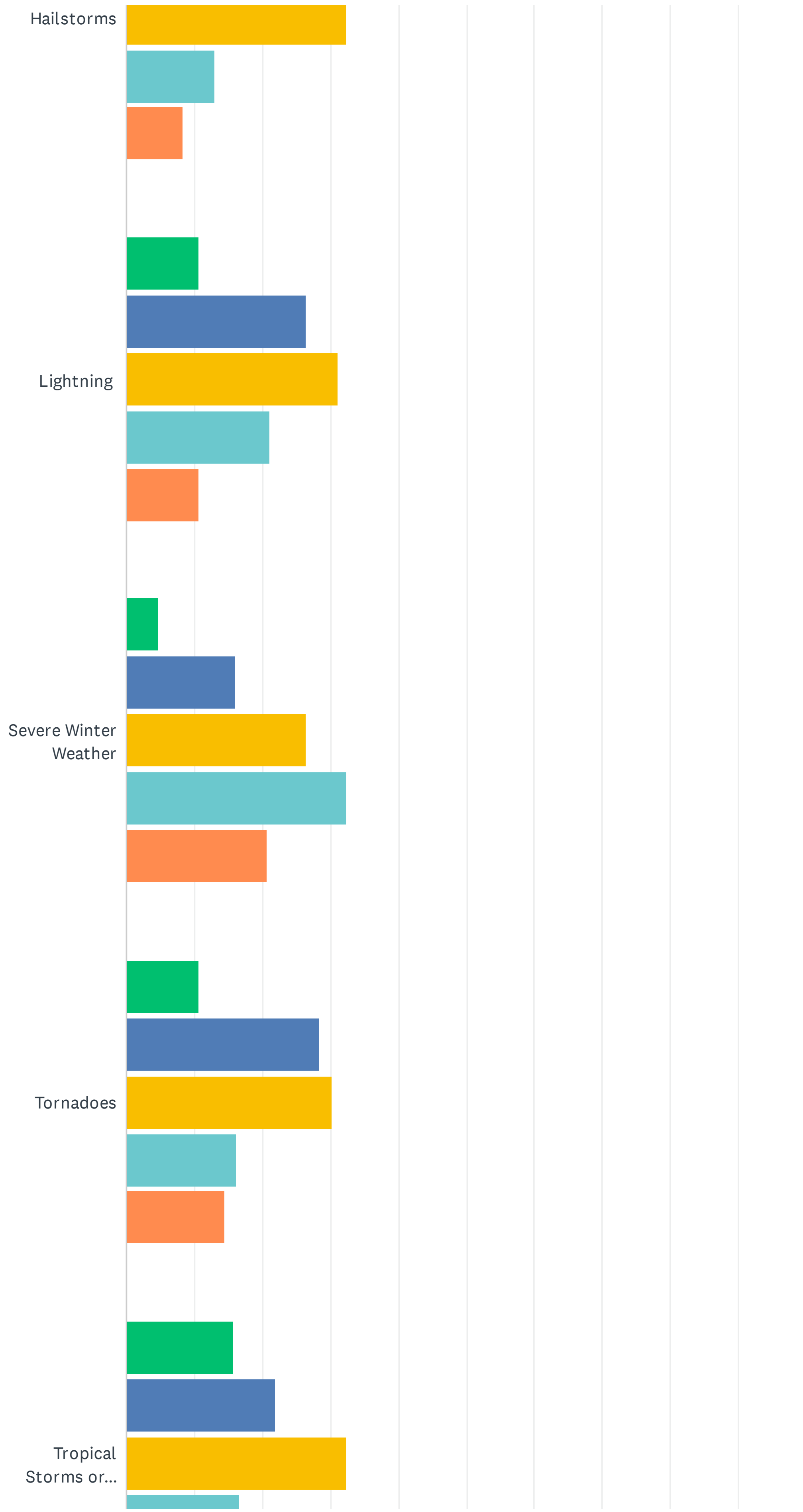


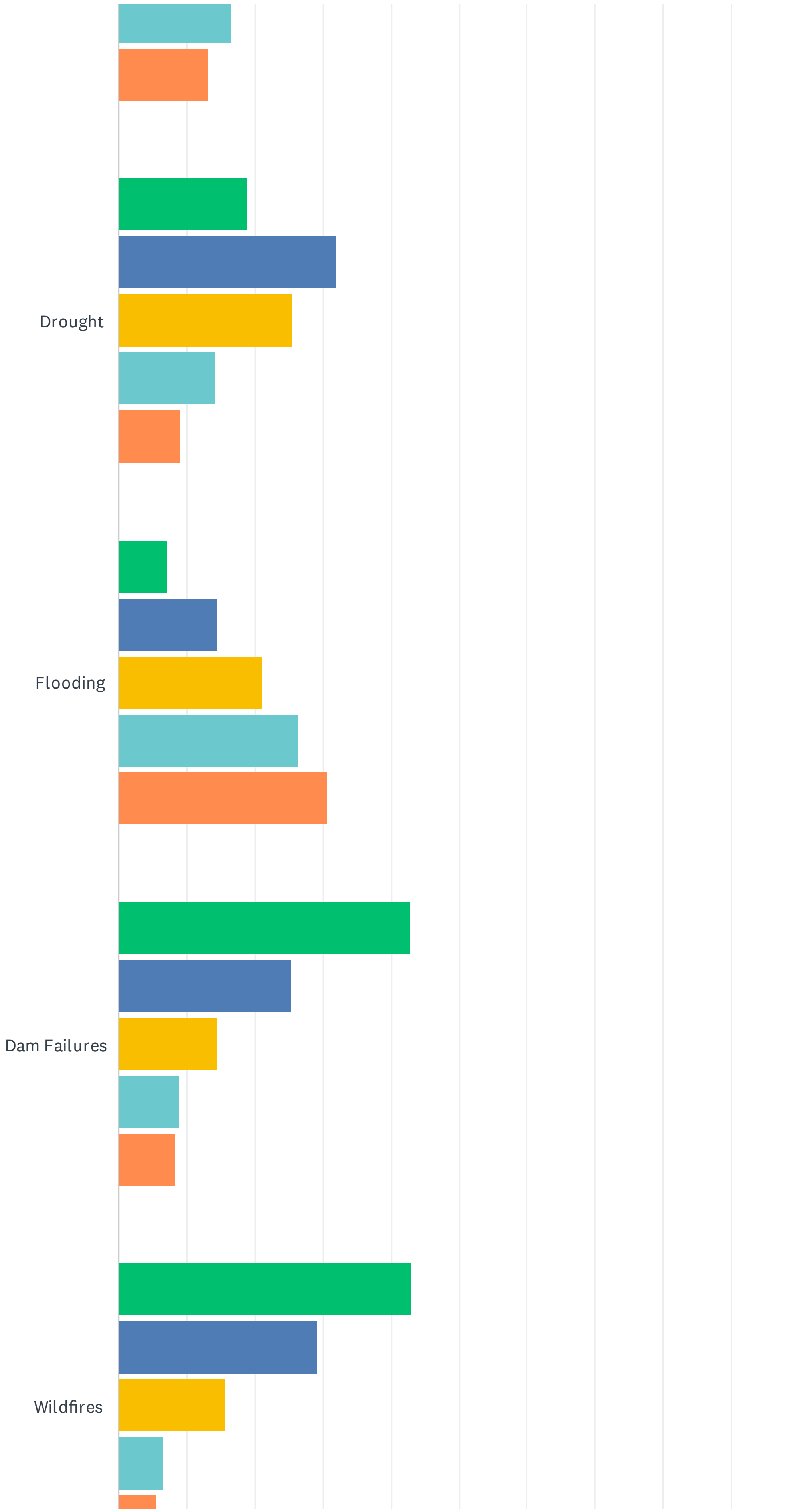
ANSWER CHOICES	RESPONSES	
Yes	44.84%	165
No	55.16%	203
TOTAL		368

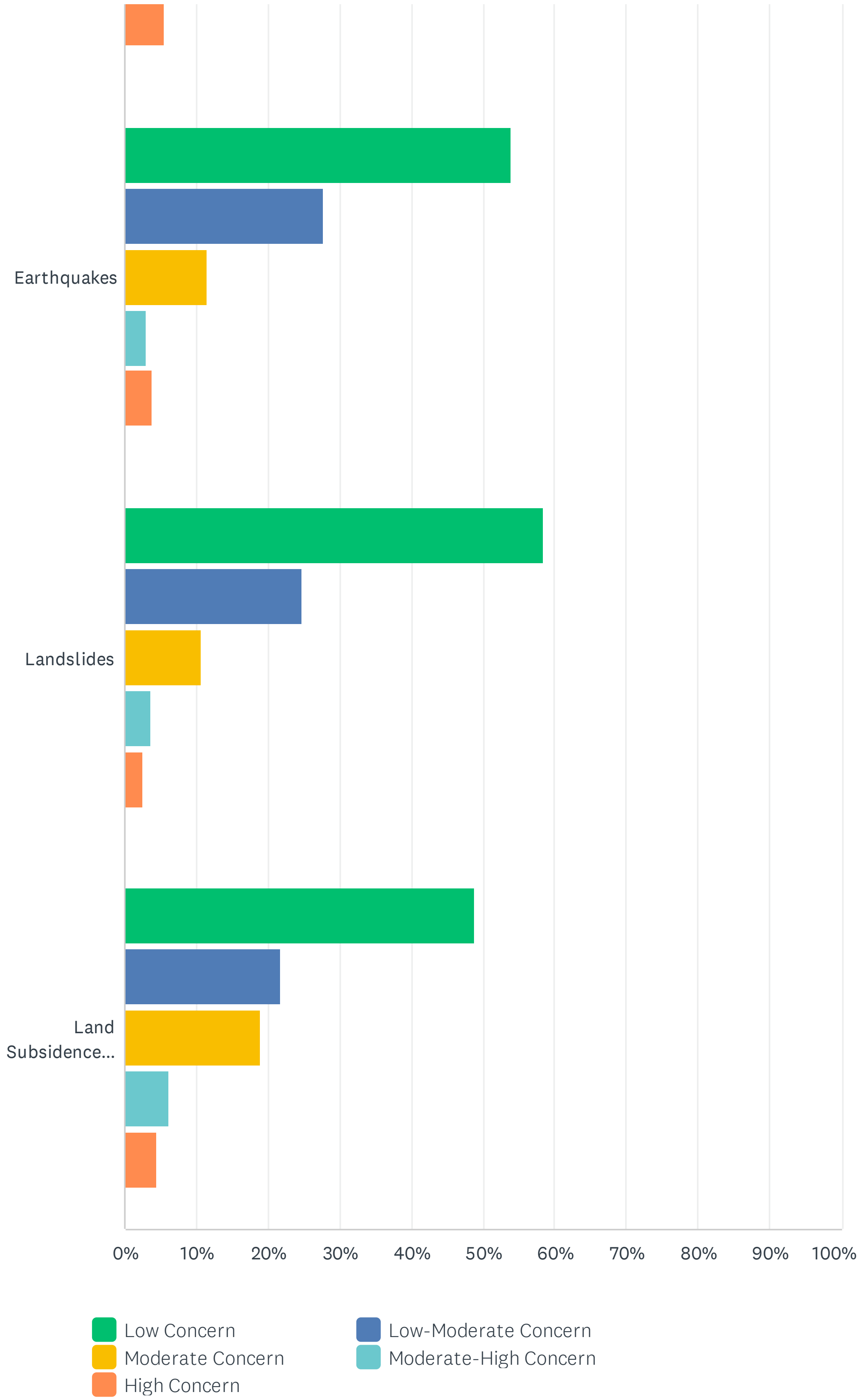
Q34 How concerned are you about each of the following hazards impacting your home, business, community, college/university, or organization?

Answered: 369 Skipped: 315




Hailstorms
Lightning
Severe Winter Weather
Tornadoes
Tropical Storms or...


Drought
Flooding
Dam Failures
Wildfires



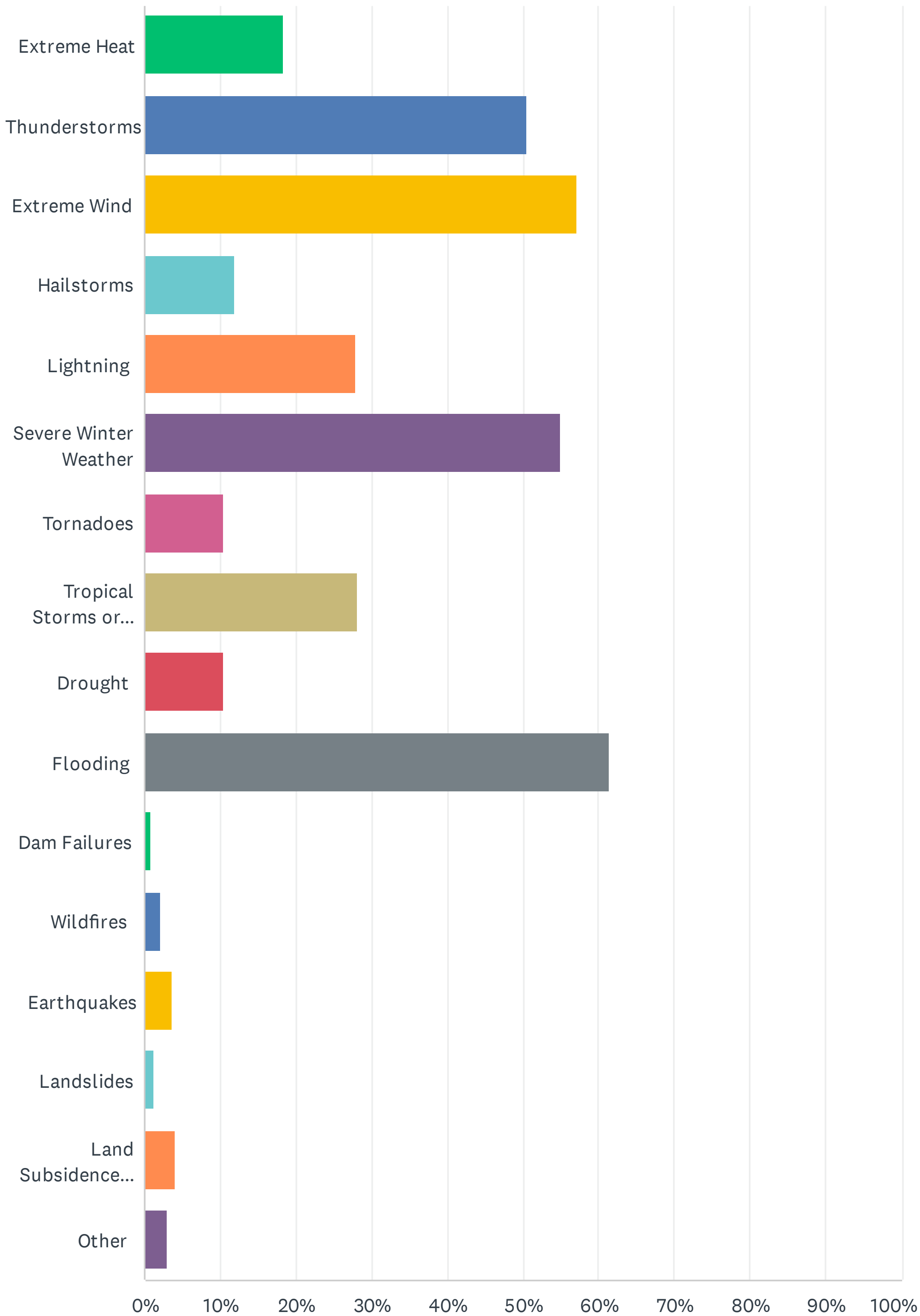
Earthquakes
Landslides
Land
Subsidence...
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Low Concern
Low-Moderate Concern
Moderate Concern
Moderate-High Concern
High Concern

Frederick County Hazard Mitigation Survey (2021)

	LOW CONCERN	LOW-MODERATE CONCERN	MODERATE CONCERN	MODERATE-HIGH CONCERN	HIGH CONCERN	TOTAL
Extreme Heat	23.35% 85	24.45% 89	31.87% 116	10.99% 40	9.34% 34	364
Thunderstorms	9.32% 34	21.64% 79	30.68% 112	25.75% 94	12.60% 46	365
Extreme Wind	7.46% 27	16.30% 59	29.83% 108	29.01% 105	17.40% 63	362
Hailstorms	16.34% 59	29.92% 108	32.41% 117	13.02% 47	8.31% 30	361
Lightning	10.71% 39	26.37% 96	31.04% 113	21.15% 77	10.71% 39	364
Severe Winter Weather	4.62% 17	16.03% 59	26.36% 97	32.34% 119	20.65% 76	368
Tornadoes	10.66% 39	28.42% 104	30.33% 111	16.12% 59	14.48% 53	366
Tropical Storms or Hurricanes	15.70% 57	22.04% 80	32.51% 118	16.53% 60	13.22% 48	363
Drought	19.01% 69	31.96% 116	25.62% 93	14.33% 52	9.09% 33	363
Flooding	7.34% 27	14.40% 53	21.20% 78	26.36% 97	30.71% 113	368
Dam Failures	42.90% 154	25.35% 91	14.48% 52	8.91% 32	8.36% 30	359
Wildfires	42.98% 156	29.20% 106	15.70% 57	6.61% 24	5.51% 20	363
Earthquakes	53.85% 196	27.75% 101	11.54% 42	3.02% 11	3.85% 14	364
Landslides	58.52% 213	24.73% 90	10.71% 39	3.57% 13	2.47% 9	364
Land Subsidence (Karst)	48.75% 175	21.73% 78	18.94% 68	6.13% 22	4.46% 16	359

Q35 Please select any hazards that have affected your home, business, community, college/university, or organization.

Answered: 327 Skipped: 357



ANSWER CHOICES	RESPONSES	
Extreme Heat	18.35%	60
Thunderstorms	50.46%	165
Extreme Wind	57.19%	187
Hailstorms	11.93%	39
Lightning	27.83%	91
Severe Winter Weather	55.05%	180
Tornadoes	10.40%	34
Tropical Storms or Hurricanes	28.13%	92
Drought	10.40%	34
Flooding	61.47%	201
Dam Failures	0.92%	3
Wildfires	2.14%	7
Earthquakes	3.67%	12
Landslides	1.22%	4
Land Subsidence (Karst)	3.98%	13
Other	3.06%	10
Total Respondents: 327		

#	OTHER	DATE
1	Burst pipe due to extremely cold temperatures	10/19/2021 6:40 AM
2	sustained power outages	10/6/2021 4:38 PM
3	Large trees falling	10/4/2021 8:26 PM
4	Racism	10/3/2021 12:13 PM
5	Democrats	10/2/2021 6:54 AM
6	contaminated water tables and well water	9/29/2021 10:33 AM
7	Many specimen trees lost and removal AND cracked foundation due to extreme storms and water runoff erosion	9/29/2021 7:31 AM
8	Government	9/29/2021 5:03 AM
9	none	9/28/2021 8:06 PM
10	Crime	9/28/2021 5:55 PM

Q36 Have any recent events made you more aware of the danger of hazards?

Answered: 230 Skipped: 454

#	RESPONSES	DATE
1	the building that caught on fire on Hood Campus	10/25/2021 11:03 AM
2	Town flooding, town water system is affected by environment—have had discolored water	10/21/2021 1:23 PM
3	No	10/21/2021 12:06 PM
4	no	10/21/2021 11:49 AM
5	Yes…locally, regionally and nationwide.	10/21/2021 8:09 AM
6	No. The most severe hazard we've experienced recently was flooding, which caused the inconvenience of closed roadways for roughly one day.	10/20/2021 9:32 PM
7	no	10/20/2021 6:48 PM
8	being a farmer - drought is a major issue for us since we don't access to other income.	10/20/2021 4:14 PM
9	Increased Extreme Weather	10/20/2021 4:05 PM
10	The extreme heat this summer caused health problems for members of my family, particularly when our air conditioning failed.	10/20/2021 4:00 PM
11	Climate change is happening more rapidly than forecasted and there are no local priorities to shift how we are working and living. I experienced two 100 year floods working at the YMCA and lost my car to the flood. The same event filled my basement with water. Insurance helped but did not cover the full damage. Frederick City infrastructure needs to be updated to accommodate the development growth. My parents live in Frederick County. As summers get hotter I am concerned about their well sustaining through the summer. My in-laws also live in Frederick County and during the winter they have to buy water because their well is directly impacted by the brine treatment road runoff. As the climate continues to shift its going to be hotter and dryer and our largely agricultural community is going to economically, socially and environmentally impact to a severe degree. The plan should not just be focused on what to happen in the face of an immediate hazard but how to mitigate the effects of long-term hazard to reduce the communal harm. At some point the cards will fall and Frederick County does not have to be reactionary.	10/20/2021 1:18 PM
12	Yes, Brodbeck Hall fire caused by lightning	10/20/2021 12:11 PM
13	Of course they have!!	10/20/2021 12:02 PM
14	No	10/20/2021 11:53 AM
15	Yes, the floods	10/20/2021 11:50 AM
16	Brodbeck Hall, on Hood College's campus, caught on fire due to a lightning strike.	10/20/2021 11:50 AM
17	I had to have my roof replaced recently because of the wind damage during a storm this summer. The same storm blew down my neighbor's tree, which knocked out the power lines for several hours. Also, a few months ago, extreme wind felled a tree that hit the power lines and started a huge fire directly across the street of my house. I had to evacuate and was worried my house was going to burn down because of how giant the fire was and how quickly it was spreading in the June heat, but luckily the fire was put out in time to preserve our homes.	10/19/2021 8:09 PM
18	None to mention.	10/19/2021 8:23 AM
19	The flash flooding on campus during the recent hurricane.	10/19/2021 6:40 AM
20	The large amount of rain has caused some extreme flooding recently.	10/18/2021 9:32 AM

21	Recent floods on 1st of September 2021 highlighted the vulnerability of many areas to flood damage and flash flooding.	10/18/2021 3:25 AM
22	Yes	10/17/2021 5:29 PM
23	No	10/16/2021 9:28 AM
24	Flooding	10/15/2021 8:55 PM
25	I work in climate change and adaptation, the latest IPCC report makes more aware of danger. Also a lot of trees have lost branches and been severely damaged (trucks split) by recent extreme rain, wind events.	10/15/2021 12:30 PM
26	A lot of rain, thunderstorms	10/15/2021 12:13 PM
27	Recent heavy rain.	10/15/2021 11:45 AM
28	yes	10/11/2021 3:37 PM
29	Flooding on my college campus	10/11/2021 12:50 PM
30	Yes, the extreme weather across the country in the last few years.	10/8/2021 7:26 AM
31	No	10/7/2021 4:07 PM
32	Rain	10/7/2021 8:29 AM
33	none	10/6/2021 4:38 PM
34	Heavy rains	10/6/2021 11:09 AM
35	yes the flooding in Frederick County recently due to the Hurricane IDA	10/5/2021 8:30 PM
36	tropical storms and floods	10/5/2021 4:25 PM
37	No	10/5/2021 4:06 PM
38	Flooding	10/5/2021 2:40 PM
39	no	10/5/2021 12:35 PM
40	No	10/5/2021 9:08 AM
41	Heavy rain causing Heavy rain this summer causing basement flooding & streets to become rivers	10/4/2021 8:26 PM
42	recent earthquakes in the south	10/4/2021 2:19 PM
43	Yes	10/4/2021 2:09 PM
44	So much rain	10/4/2021 1:35 PM
45	N/A	10/4/2021 11:33 AM
46	No	10/4/2021 9:47 AM
47	not really	10/4/2021 8:49 AM
48	Hurricane Ida remnants caused flooding of Ballenger Creek and my nearly encroached on my home and neighborhood.	10/4/2021 8:34 AM
49	Flooding is worse than ever; schools closing because of RAIN now	10/3/2021 12:13 PM
50	yes	10/3/2021 11:05 AM
51	Yes, recent flooding	10/3/2021 8:11 AM
52	No	10/3/2021 7:47 AM
53	The increased number of extreme weather events has definitely also increased my concern and awareness	10/2/2021 4:41 PM
54	yes	10/2/2021 11:04 AM
55	Wildfires in the Carolinas. I worry about the brush along Route 355 & I270.	10/2/2021 11:01 AM

56	Tropical storms creating flash flooding or flood warnings.	10/1/2021 6:25 PM
57	Hurricane flooding	10/1/2021 5:46 PM
58	Not due to any event in particular however, I am more aware of geostorms and solar flares that may cause disruptions to GPS and the grid.	10/1/2021 2:57 PM
59	No	10/1/2021 1:39 PM
60	Yes. Last hurricane.	10/1/2021 1:23 PM
61	The response to COVID 19 by the county was overall excellent. I saw there organization work hard and professionally.	10/1/2021 1:03 PM
62	no	10/1/2021 10:48 AM
63	Yes, the power outages in Gulf states resulting from weather events, the increased likelihood of a long-term large-scale power outage from a cyber attack on the power grid, weather event or other source.	10/1/2021 9:19 AM
64	FCPS bus that was stuck in rising water after a torrential rain storm.	10/1/2021 12:06 AM
65	No	9/30/2021 9:37 PM
66	Closure of Route 355 for road repairs after a 24 hour rainfall event. New bridge where Ijamsville Road meets Mussetter Road had water not more than 1' from the bottom. Bridge on Ijamsville Road near Route 355 had higher water still. New bridge in Hyattstown had huge flow with 1' chop heading towards the bridge and with the water closer still to the bottom of the bridge.	9/30/2021 7:05 PM
67	Flooding in our home. Lighting that effected our Hvac unit	9/30/2021 6:09 PM
68	Yes, recent flooding and 2 incidences of lightning strikes in Frederick (Hood College and the house in Ijamsville where the firefighter was killed).	9/30/2021 11:17 AM
69	no	9/30/2021 10:46 AM
70	No.	9/30/2021 10:26 AM
71	Yes	9/30/2021 9:23 AM
72	Yes, flooding.	9/30/2021 9:21 AM
73	The hurricane that came through recently	9/30/2021 8:44 AM
74	Yes, the recent heavy rains causing flooding and making it almost impossible to travel, especially in woodsboro because there are not many routes out of town that don't flood.	9/30/2021 8:33 AM
75	We had a tornado sweep through our neighborhood and the only warning came from an app I purchase.	9/30/2021 8:14 AM
76	Sept. 1, 2021 heavy rains and flash flooding.	9/30/2021 8:06 AM
77	Flooding	9/30/2021 8:05 AM
78	No	9/30/2021 8:05 AM
79	No	9/30/2021 7:54 AM
80	No	9/29/2021 11:46 PM
81	Yes last hurricane	9/29/2021 10:12 PM
82	Hurricane Wildfires Tornadoes	9/29/2021 9:58 PM
83	Yes. More sever storms of late (it seems)	9/29/2021 8:44 PM
84	Massive amounts of rain from the past two hurricanes	9/29/2021 6:58 PM
85	Yes	9/29/2021 6:50 PM
86	Heavy rain causing flooding	9/29/2021 6:18 PM
87	Recent thunderstorms and extreme winds which brought down major tree limbs in my neighborhood	9/29/2021 4:37 PM

88	Yes, Hurricane/tropical storm/depression Ida.	9/29/2021 4:21 PM
89	no	9/29/2021 3:31 PM
90	No	9/29/2021 3:22 PM
91	yes	9/29/2021 3:09 PM
92	yes	9/29/2021 3:01 PM
93	Yes	9/29/2021 2:58 PM
94	Yes	9/29/2021 2:26 PM
95	Flooding around Frederick City and County	9/29/2021 2:19 PM
96	yes, the recent floods throughout frederick county	9/29/2021 1:57 PM
97	Recent flash flooding in Frederick County, MD due to tropical depression.	9/29/2021 1:44 PM
98	No	9/29/2021 1:43 PM
99	Flooding due to recent heavy rains including Hurricane Ida and losing a large tree limb in a thunderstorm with high winds.	9/29/2021 1:14 PM
100	recent tropical storms / hurricanes and flooding in Eastern US	9/29/2021 1:11 PM
101	No	9/29/2021 1:09 PM
102	Severe thunderstorms, trees down etc.	9/29/2021 12:26 PM
103	Fires in California.	9/29/2021 12:22 PM
104	Nothing stands out.	9/29/2021 12:16 PM
105	Recent significant rainfall.	9/29/2021 12:15 PM
106	The increased 'frequency' has been cause for more concern, but I've always been aware and have prepared accordingly.	9/29/2021 12:15 PM
107	yes the last 2 hurricanes.	9/29/2021 12:12 PM
108	The increasing number of road closures do to flooding.	9/29/2021 12:10 PM
109	Yes	9/29/2021 12:04 PM
110	High winds	9/29/2021 12:04 PM
111	Ida	9/29/2021 11:45 AM
112	News about extreme weather globally. The 2017 flood affected me and my neighbors.	9/29/2021 11:34 AM
113	Yes the flooding from Ida. A large sinkhole opened up in the backyard of the building I rent an apt in.	9/29/2021 11:19 AM
114	Ida and the flooding was not handled properly by many Frederick county businesses. FCPS was not handled well at all.	9/29/2021 11:09 AM
115	heavy rain events this summer	9/29/2021 11:00 AM
116	The recent flash floodings have me concerned. This year is the first time since I have lived and worked in the county that a heavy storm lead to flash flooding that caused work (FCC campus) to shut down early. Also, watching the extreme heat waves that hit the est coast this summer -especially the one that melted power lines somewhere in the Pacific Northwest - has me very worried for my general comfort and quality of life in the future. I am worried about what daily life will be like on a much hotter planet.	9/29/2021 10:59 AM
117	Recent rainfall has brought up hazard concerns of flooding.	9/29/2021 10:55 AM
118	Climate change and its effects (wildfires, droughts, etc)	9/29/2021 10:48 AM
119	flooding, extreme rain	9/29/2021 10:43 AM
120	no	9/29/2021 10:39 AM

121	no	9/29/2021 10:37 AM
122	no	9/29/2021 10:35 AM
123	Severe thunderstorms from hurricanes with winds and flooding, severe ice storms/snow storms, wells drying up and/or becoming contaminated do to Ft Detrick and other companies	9/29/2021 10:33 AM
124	Recent flooding	9/29/2021 10:31 AM
125	Yes	9/29/2021 10:24 AM
126	This summer brought very high temperatures and severe weather.	9/29/2021 10:04 AM
127	No	9/29/2021 10:04 AM
128	Yes - tropical storm Ida and the recent 2-3 years of hurricane and tropical storm weather	9/29/2021 10:02 AM
129	Flooding	9/29/2021 9:58 AM
130	No	9/29/2021 9:44 AM
131	yes	9/29/2021 9:41 AM
132	Yes	9/29/2021 9:34 AM
133	No	9/29/2021 9:29 AM
134	The recent flooding in our area	9/29/2021 9:18 AM
135	yes	9/29/2021 9:17 AM
136	yes	9/29/2021 9:15 AM
137	Yes	9/29/2021 9:14 AM
138	Looding	9/29/2021 9:10 AM
139	Flooding in magnolia several years ago	9/29/2021 9:08 AM
140	No	9/29/2021 9:07 AM
141	Recent flooding in September, 2021 that closed dozens of county roads and stranded school buses.	9/29/2021 9:01 AM
142	No	9/29/2021 9:00 AM
143	Climate change in general	9/29/2021 8:59 AM
144	yes	9/29/2021 8:56 AM
145	New from around the world and re earcher tating that our wor ening weather i only going to get more extreme. We are not ready for it.	9/29/2021 8 55 AM
146	The remnants of Hurricane Ida passing through did.	9/29/2021 8:55 AM
147	Power outages due to the above events noted in #6. Flooding concerns which prevent me from using roads in my area.	9/29/2021 8:52 AM
148	yes	9/29/2021 8:51 AM
149	None	9/29/2021 8:49 AM
150	Yes. 1. Severe winter weather. Extremely difficult and dangerous to drive. 2. Thunderstorms with heavy rain causing roads closed due flooding and fallen trees make drive to work/home extremely dangerous.	9/29/2021 8:47 AM
151	Ida	9/29/2021 8:40 AM
152	Hurricane Bill	9/29/2021 8:36 AM
153	House continually floods due to the severe rain storms that have been occurring in the last 3-4years.	9/29/2021 8:32 AM
154	Flooding from Ida	9/29/2021 8:29 AM

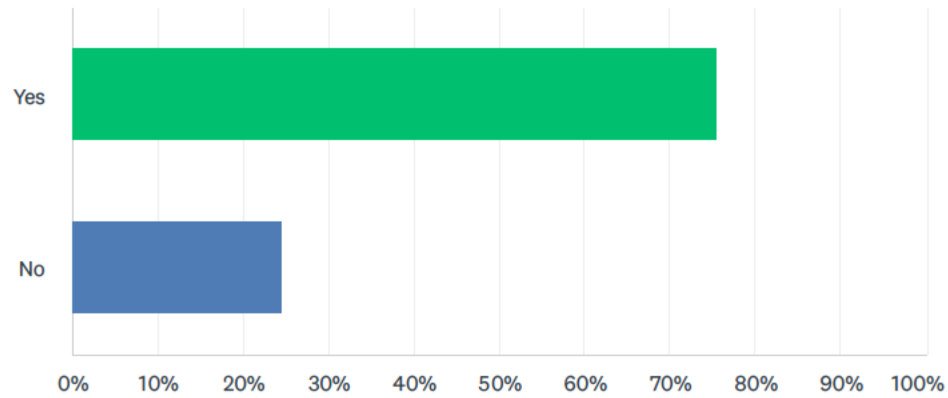
155	Climate change is driving a lot of severe weather changes all over the planet.	9/29/2021 8:20 AM
156	yes, the more extreme weather	9/29/2021 8:18 AM
157	2018 & 2020 Tornadoes	9/29/2021 8:13 AM
158	No	9/29/2021 8:06 AM
159	Recent large rainfall events that lead to stormwater facilities being full and overtopping that had not previously filled anywhere near capacity in the 12 years we have been here.	9/29/2021 7:53 AM
160	Tropical storms, other high intensity rain events.	9/29/2021 7:51 AM
161	yes	9/29/2021 7:49 AM
162	Monocacy River flooding (which is getting worse with time); exponential growth of Urbana; lack of disaster preparedness and proper planning regarding Landsdale.	9/29/2021 7:45 AM
163	Ida and the flooding it caused	9/29/2021 7:44 AM
164	no	9/29/2021 7:41 AM
165	no	9/29/2021 7:39 AM
166	The most recent rainstorms that were within a week or two of each other and brought a massive amount of rainfall. I have not seen it rain like that outside of a tropical system before at my house and I experienced minor basement flooding from the rain.	9/29/2021 7:35 AM
167	YES	9/29/2021 7:31 AM
168	NO	9/29/2021 7:28 AM
169	The flooding from the past few tropical storms we have had	9/29/2021 7:21 AM
170	Yes, the last 2 events of flooding in the county. Roads flooded out near my home that have NEVER flooded out and it made it difficult for me to get home and I had to miss time at work due to both of these.	9/29/2021 7:06 AM
171	Yes, flooding along with a mudslide. took me 5 hrs to get home. five roads leading to my home were flooded	9/29/2021 6:50 AM
172	Hurricanes causing rain/flash flooding here	9/29/2021 6:40 AM
173	No	9/29/2021 5:48 AM
174	2020 Presidential Election	9/29/2021 5:03 AM
175	Multiple flooding events	9/28/2021 10:54 PM
176	No	9/28/2021 10:43 PM
177	Hurricane IDA rains.	9/28/2021 10:32 PM
178	Recent flooding in our area and across the state. Watching the devastation to the western states due to the wild fires.	9/28/2021 8:43 PM
179	multiple floods in downtown and around local schools; roads washed away	9/28/2021 8:35 PM
180	Somewhat	9/28/2021 8:06 PM
181	Increased rainfall and local flooding	9/28/2021 8:02 PM
182	No	9/28/2021 7:31 PM
183	No	9/28/2021 7:22 PM
184	recent flooding	9/28/2021 7:00 PM
185	no	9/28/2021 6:54 PM
186	Yes, flooding	9/28/2021 6:53 PM
187	No	9/28/2021 6:43 PM
188	No	9/28/2021 5:55 PM

189	Yes	9/28/2021 5:30 PM
190	Recent flooding from Hurricane Ida	9/28/2021 5:29 PM
191	Flooding at North Seton ave and Provincial parkway	9/28/2021 5:23 PM
192	Flooding near our facilities (schools) and along Frederick county roads. Hurricane Ida.	9/28/2021 5:11 PM
193	no	9/28/2021 5:06 PM
194	All of the recent heavy rains and extreme flooding in the area.	9/28/2021 5:06 PM
195	YES	9/28/2021 4:57 PM
196	Yes	9/28/2021 4:42 PM
197	Extreme weather and heavy rain events which the ground simply cannot handle. Flooding occurs because the water simply has no where to go and the ground becomes saturated.	9/28/2021 4:39 PM
198	Recent high flooding, record high summer temps	9/28/2021 4:37 PM
199	No	9/28/2021 4:37 PM
200	The big rain from the Hurricane caused substantial flooding. Seasonal poor road conditions due to snow and ice.	9/28/2021 4:35 PM
201	Hurricane Ida damage flooding caused mold in the basement where i used to work and i had to quit because it made me sick recent development on 16th st near northampton manor/banner school -there is chronic land subsidence ever since they stated work on that. there is a dip in the road that they constantly have to repave. the amount of development is really ridiculous, and now messing up the land in that area has caused a constant subsidence problem , not to mention the danger caused by removing trees that were cleaning the air, providing shelter for wildlife and soaking up carbon	9/28/2021 4:32 PM
202	No	9/28/2021 4:30 PM
203	Recent hurricane caused me to not be able to drive home from work - all roads flooded.	9/28/2021 4:28 PM
204	The recent flooding from hurricane Ida	9/28/2021 4:26 PM
205	Storms from several years ago made it apparent that flood waters cannot be mitigated as hoped. Recent rains have cause flooding within the city. The city/county needs to look at areas along Carroll Creek and assess how to better prevent the flood waters rising exponentially higher than they have in the past. Crews need to clear obstructions along the creek annually and assess after any major rain events	9/28/2021 4:26 PM
206	Yes	9/28/2021 4:25 PM
207	No	9/28/2021 4:24 PM
208	No	9/28/2021 4:24 PM
209	yes	9/28/2021 2:42 PM
210	Continued drought in Western US; wildfires and wildfire smoke brought to East Coast; hurricane remnants with wind and rain. Rain saturation, weakening plant/tree hold in soil	9/28/2021 10:17 AM
211	No.	9/28/2021 9:01 AM
212	flashflood and high wind	9/28/2021 8:53 AM
213	the torrential rains we have had from hurricane remnants	9/28/2021 8:45 AM
214	No	9/28/2021 8:29 AM
215	yes	9/28/2021 8:24 AM
216	increasing frequency of hurricanes; global warming	9/28/2021 8:16 AM
217	Recent flooding due storm rain	9/28/2021 8:11 AM
218	Yes	9/28/2021 8:07 AM

219	Yes - hurricanes causing flooding	9/28/2021 8:07 AM
220	Yes, flood damage from Hurricane Ida.	9/28/2021 8:06 AM
221	Extreme weather events over past year coupled with Covid	9/25/2021 3:55 PM
222	Yes	9/25/2021 2:42 PM
223	Frederick County flooding that has occurred in recent years.	9/24/2021 12:46 PM
224	flooding	9/24/2021 9:25 AM
225	The recent flooding has seemed to cause a big impact.	9/24/2021 8:48 AM
226	Changing of the climate from extreme heat in the summers to extreme cold in the winter. The seasons in between shortening.	9/24/2021 8:47 AM
227	The durecho a few years ago that knocked out power for days.	9/24/2021 8:30 AM
228	Tropical storm Ida	9/24/2021 7:59 AM
229	Flooding during May 2018	9/14/2021 8:12 AM
230	Flooding in 2018	8/30/2021 10:53 AM

Q37 Do you own a home in Frederick County?

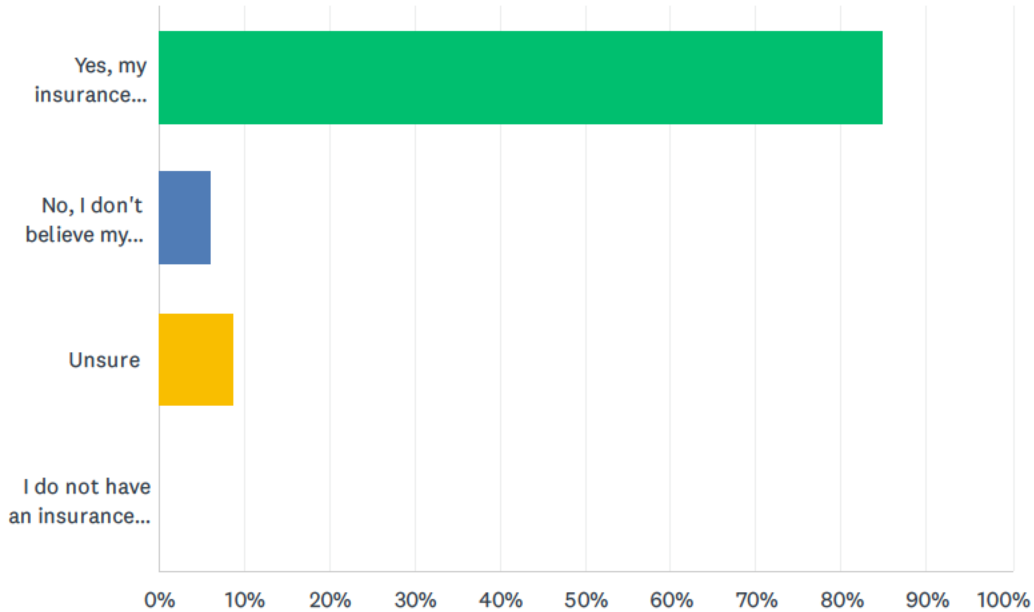
Answered: 371 Skipped: 313



ANSWER CHOICES	RESPONSES	
Yes	75.47%	280
No	24.53%	91
TOTAL		371

Q38 Do you have adequate basic homeowners insurance to cover the hazards that could impact your home?

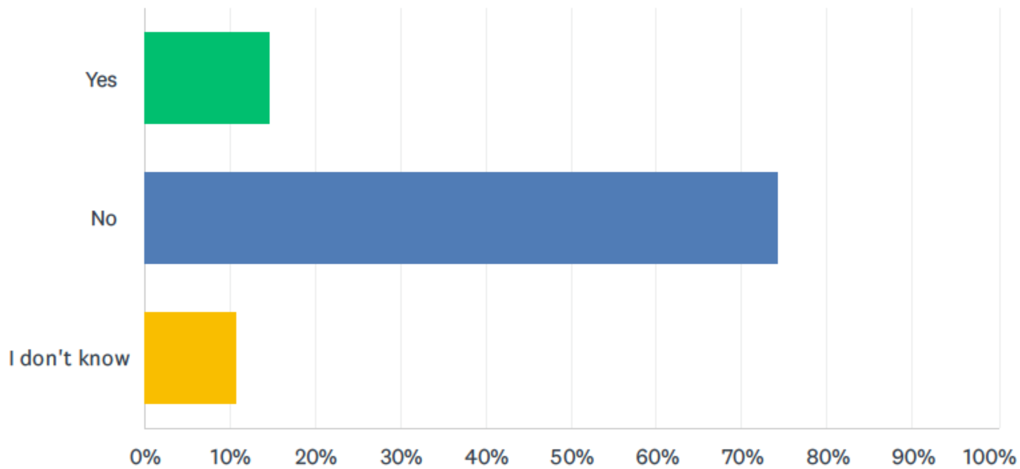
Answered: 319 Skipped: 365



ANSWER CHOICES	RESPONSES	
Yes, my nsu ance coverage shou d be adequate.	84.95%	271
No, I don't bel eve my nsu ance cove age wou d be adequate fo a major d saster.	6.27%	20
Unsu e	8.78%	28
I do not have an nsu ance po cy	0.00%	0
TOTAL		319

Q39 Do you have any other insurance? (e.g., flood, subsidence, etc.)

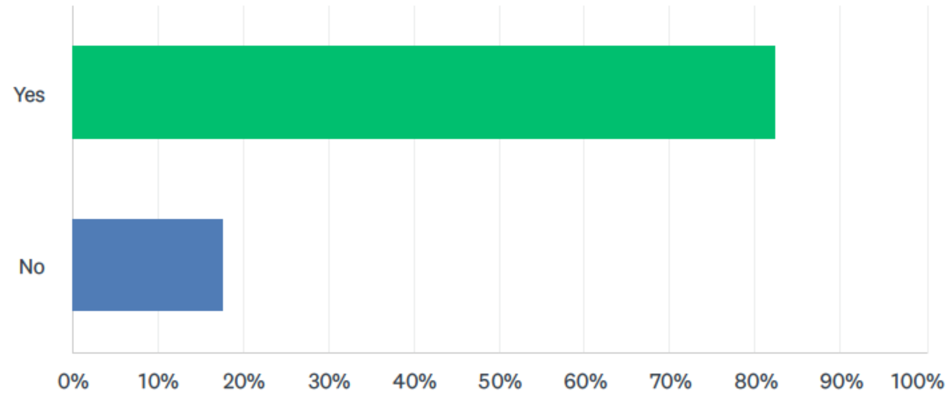
Answered: 319   Skipped: 365



ANSWER CHOICES	RESPONSES	
Yes	14.73%	47
No	74.29%	237
I don't know	10.97%	35
TOTAL		319

Q40 Did you know that most standard homeowner's insurance policies do not cover rising water (flooding) orminor subsidence (sinkhole)?

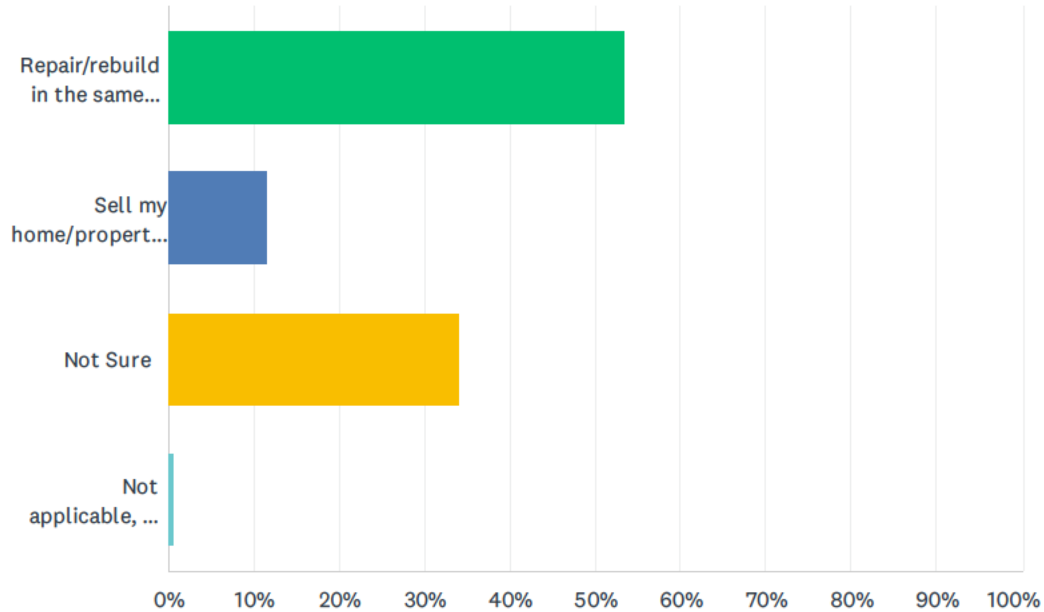
Answered: 318 Skipped: 366



ANSWER CHOICES	RESPONSES	
Yes	82.39%	262
No	17.61%	56
TOTAL		318

Q41 If disaster substantially damaged your home, which of the following wouldbe the most likely option you would pursue?

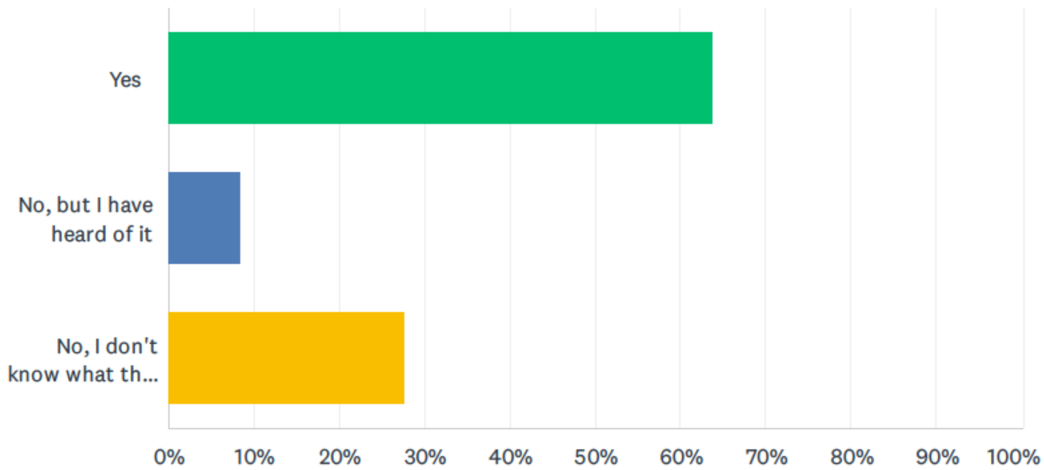
Answered: 319 Skipped: 365



ANSWER CHOICES	RESPONSES	
Repai / ebu d n the same ocat on to cu ent bu d ng code standards	53.61%	171
Se my home/p ope ty and elocate	11.60%	37
Not Su e	34.17%	109
Not app cab e, I ent my cu ent es dence	0.63%	2
TOTAL		319

Q42 Have you signed up for the Alert FC emergency notification system?

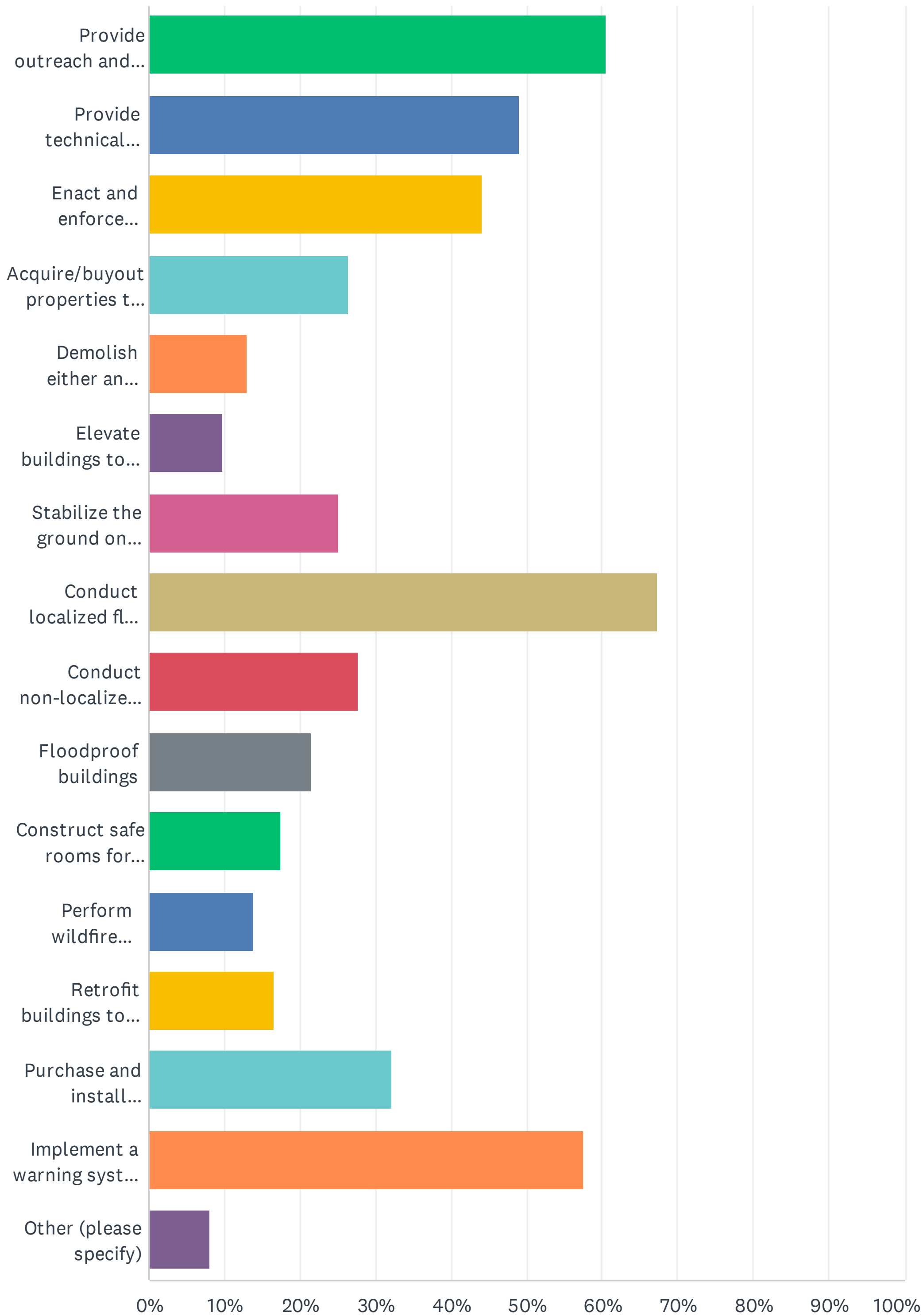
Answered: 390   Skipped: 294



ANSWER CHOICES	RESPONSES	
Yes	63.85%	249
No, but I have hea d of t	8.46%	33
No, I don't know what that s	27.69%	108
TOTAL		390

Q43 What are the most important things that your community can do to help mitigate hazards and become more resilient over time?

Answered: 385   Skipped: 299



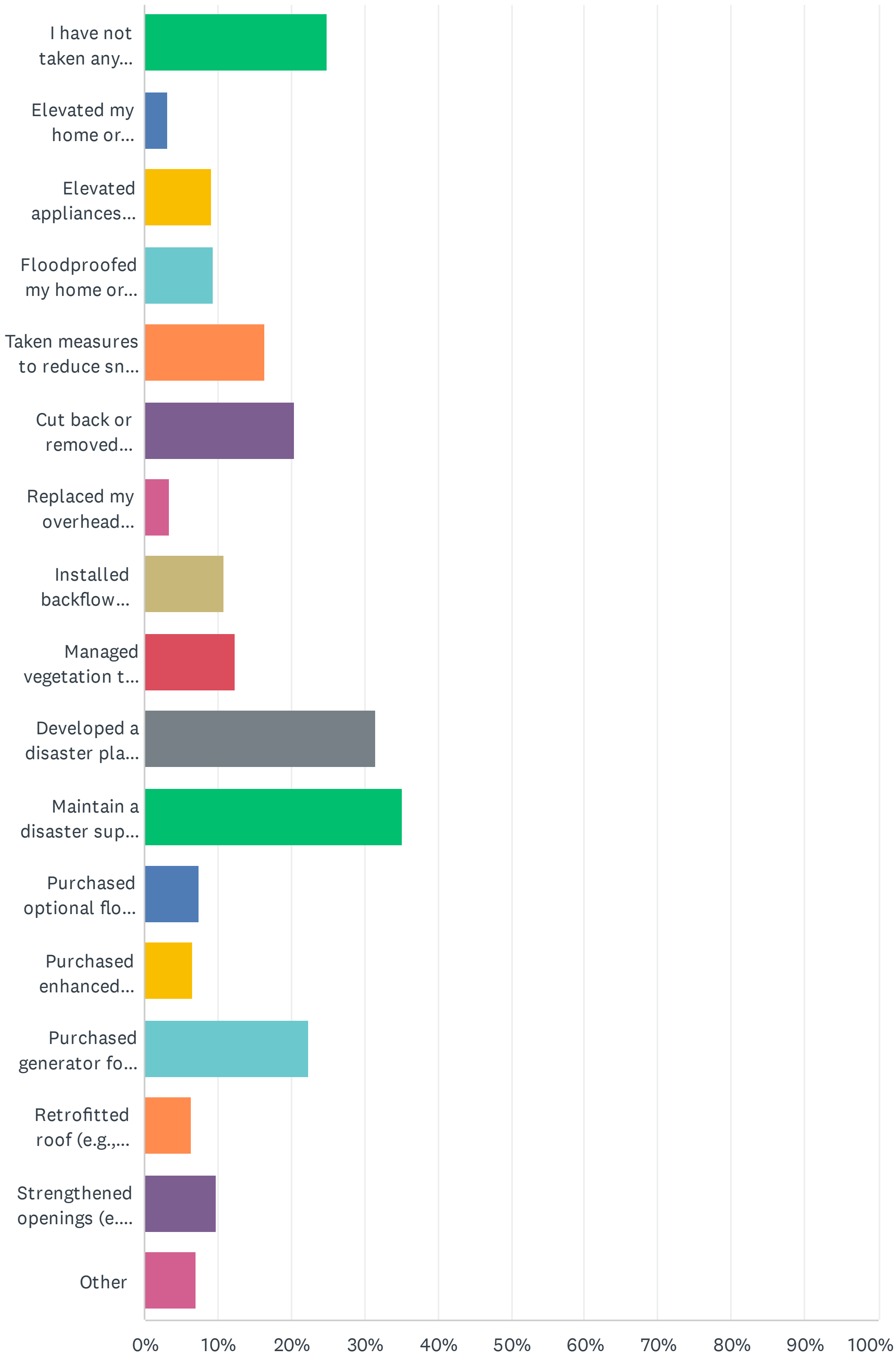
ANSWER CHOICES	RESPONSES	
Provide outreach and education to residents, business, jurisdictions, and organizations to help them understand risks and mitigate hazards	60.52%	233
Provide technical assistance to residents, businesses, jurisdictions, and organizations to help them preform hazard mitigation projects	49.09%	189
Enact and enforce regulations, codes and ordinances, such as zoning regulations and building codes	44.16%	170
Acquire/buyout properties to create open space and reduce flooding	26.49%	102
Demolish either an entire building or part of a building in order to rebuild it in a way that mitigates it from flooding	12.99%	50
Elevate buildings to avoid potential floodwaters	9.87%	38
Stabilize the ground on slopes to prevent slope failures/landslides	25.19%	97
Conduct localized flood risk reduction projects, such as stormwater management projects or stabilizing roads/bridges	67.27%	259
Conduct non-localized flood risk reduction projects, such as rehabilitating dams and levees	27.79%	107
Floodproof buildings	21.56%	83
Construct safe rooms for hurricanes, tornadoes, etc.	17.40%	67
Perform wildfire mitigation projects, such as creating defensible space, retrofitting buildings with ignition-resistant building materials, or vegetation management	13.77%	53
Retrofit buildings to reduce future damages from erosion, high winds, earthquakes, or snow.	16.62%	64
Purchase and install generators	32.21%	124
Implement a warning system to alert the public of impending hazards	57.66%	222
Other (please specify)	8.05%	31
Total Respondents: 385		

#	OTHER (PLEASE SPECIFY)	DATE
1	Build building to code for earthquakes	10/21/2021 11:34 AM
2	Public Shelters	10/21/2021 8:15 AM
3	Less reliance on fossil fuel energy; decentralize energy grid w/ renewable sources	10/20/2021 4:09 PM
4	Continue recording data and identifying trends then enforce change either in transportation, agriculture, property rights that will increase public responsibility and is enforceable.	10/20/2021 1:34 PM
5	enact climate change mitigation laws and initiatives	10/18/2021 4:19 PM
6	Slow down new construction	10/15/2021 12:32 PM
7	Less development near lakes and waterways, erosion control and deforestation are large issues	10/11/2021 12:56 PM
8	Get the developers out of the decision loop for sustainable infrastructure in town	10/4/2021 8:42 PM
9	County must stop spraying herbicides at all guard rails so that vegetation can hold the soil when heavy rain events hit. I have lost more soil from the County's spraying the ground near our guard rails over our stream than I have in my farm fields! Because of the soil lost over the last month and half near our stream I am very concerned that the bridge might sink in a coming rain event.	10/4/2021 12:58 PM
10	Provide additional data and testing for the downstream hazards from extreme weather (mold, structural analysis, data publicly available to analyze and prove the problems that exist.	10/4/2021 8:45 AM

11	All of these ideas sound good, but I'm not sure what needs to be done as I'm not an engineer or planner.	10/4/2021 8:36 AM
12	bury power lines underground.	10/3/2021 12:16 PM
13	No Democrats	10/2/2021 6:58 AM
14	Become less dependent on the national power grid in an emergency and move toward more solar and micro grids	10/1/2021 9:25 AM
15	plan for short, medium and long term power outages	9/30/2021 7:18 PM
16	Stop overdevelopment and fund infrastructure projects needed.	9/30/2021 9:26 AM
17	Fix zoning so the building of new neighborhoods does not create more flooding of our parks.	9/30/2021 8:30 AM
18	Stop the urban sprawl and building that is disturbing the ground and causing runoff.	9/30/2021 8:10 AM
19	Maintain open streets in Downtown Frederick- very concerned about the impact on snow and other emergency if they are restricted	9/29/2021 1:08 PM
20	Plant trees to help reduces temps and therefore extreme weather	9/29/2021 12:24 PM
21	Stop overbuilding in areas where farmland and woodland exist. By creating parking lots and homes it decreases the groundspace for water absorption, increases overall temps in summer and decreases overall temps in winter, changes weather patterns in the area and increases floods due to runoff from cement and blacktop into roads and homes	9/29/2021 10:46 AM
22	STOP BUILDING!!!!!	9/29/2021 10:04 AM
23	plant trees to create wind breaks and prevent soil erosion	9/29/2021 8:00 AM
24	Address improper stormwater management at the top of slopes first then work the way downward to the edge of streambanks	9/29/2021 7:43 AM
25	Stop building! Period.	9/29/2021 7:08 AM
26	Remove current Democrats from office	9/29/2021 5:06 AM
27	more fire rescue special operations staff	9/28/2021 7:07 PM
28	Continue to monitor hazards in Carroll Creek that cause significant flooding even with relatively insignificant rainfall. Any major rain event causes major flooding along the creek and it is most likely due to tunnels under RT 15 being clogged, as well as other blockages along the creek causing water to rise	9/28/2021 4:30 PM
29	Financial Assistance for Flooding	9/28/2021 4:30 PM
30	our current alert system is woefully behind counties such as Montgomery County Alert system. We don't get alerts that effect us through Frederick County; I get them from MEMA. Send on cell phones!	9/28/2021 10:26 AM
31	Far greater implementation of renewable energy sources; slow & halt the accumulation of GHGs. Fix the problem - not minimize the impacts.	9/28/2021 8:51 AM

Q44 Have you taken any actions to reduce the risk or vulnerability from hazards of your family, home, business, or organization?

Answered: 380   Skipped: 304


I have not taken any...
Elevated my home or...
Elevated appliances...
Floodproofed my home or...
Taken measures to reduce sn...
Cut back or removed...
Replaced my overhead...
Installed backflow...
Managed vegetation t...
Developed a disaster pla...
Maintain a disaster sup...
Purchased optional flo...
Purchased enhanced...
Purchased generator fo...
Retrofitted roof (e.g.,...
Strengthened openings (e....
Other
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

ANSWER CHOICES	RESPONSES	
I have not taken any actions	25.00%	95
Elevated my home or business to reduce flood damage	3.16%	12
Elevated appliances (e.g., hot water heater) or mechanical systems (i.e., air conditioning)	9.21%	35
Floodproofed my home or business to reduce flood damage	9.47%	36
Taken measures to reduce snow build-up on my roof	16.32%	62
Cut back or removed vegetation from my overhead utility lines or roof	20.53%	78
Replaced my overhead utility lines with underground lines	3.42%	13
Installed backflow prevention device(s) (to prevent sewer back-ups)	10.79%	41
Managed vegetation to reduce risk of wildfire reaching my home or business	12.37%	47
Developed a disaster plan for my family, home, or business	31.58%	120
Maintain a disaster supply kit for my family, home, or business	35.26%	134
Purchased optional flood insurance	7.37%	28
Purchased enhanced homeowner insurance coverage (e.g., sinkhole, additional wind coverage)	6.58%	25
Purchased generator for home	22.37%	85
Retrofitted roof (e.g., fire resistant shingles, hurricane brackets, etc)	6.32%	24
Strengthened openings (e.g., doors, windows, and/or garage door to reduce high-hazard wind risk)	9.74%	37
Other	7.11%	27
Total Respondents: 380		

#	OTHER	DATE
1	Education and Training	10/21/2021 8:15 AM
2	I have a new home so I'm assuming it's up to code on everything.	10/14/2021 8:52 PM
3	purchase sewer back up insurance, replaced roof/gutters	10/14/2021 10:29 AM
4	Planted more trees and plants to reduce erosion and voted against clearcutting developments	10/11/2021 12:56 PM
5	I sold my generator because it is a real hassle to bring it out, test it, fuel it and run it. I'm sure I'll regret this but I would love to have solar back up. When batteries are up to that task, I'll do it.	10/6/2021 4:41 PM
6	bought pumps	10/5/2021 4:29 PM
7	Voted against democrats	10/2/2021 6:58 AM
8	Replaced my roof to withhold wind and rain damage	9/29/2021 12:42 PM
9	Installed sub-roof under my second floor balcony, so water does not pool in my sunken patio beneath. Works wonderfully! Installed downspout extensions to direct rainwater further away from my house. Getting rid of grass lawn and putting in plants that soak up water and prevent runoff.	9/29/2021 12:24 PM
10	Having larger gutters installed on my home to manage torrential rainfall. Also creating a cover for outside basement steps to prevent water in my basement.	9/29/2021 11:39 AM
11	Installed french drain in basement	9/29/2021 10:46 AM
12	Battery backup for sump pump.	9/29/2021 10:06 AM

13	No	9/29/2021 9:11 AM
14	provided time and ideas and suggestions for emergency preparedness to private and government identities	9/29/2021 8:53 AM
15	Attempted to grade the property and install a drain to catch the street run off. It has helped a little, but due to the significant run off from the street, it is not enough.	9/29/2021 8:36 AM
16	As a wastewater utility, there are many instances of sewer backups into basements that would have been prevented by backflow devices which resulted in claims against the County. Appreciate this being a survey item.	9/29/2021 7:56 AM
17	Removed and continue to remove dead and dying trees from storm damage and plant seedlings. Repaired foundation installed an elastomer to the outside foundation wall to prevent infiltration. Have blocked road water runoff to my property and continue to create hardscape and landscaping to divert flows away from my dwelling.	9/29/2021 7:43 AM
18	Sump pump install	9/29/2021 6:18 AM
19	Clean gutters monthly to avoid backups that flood basement in bad weather. Retrofitted gutters to perform better.	9/28/2021 4:32 PM
20	Better sump pump to keep up when we have hurricane/ tropical storms that produce a bunch of rain.	9/28/2021 4:31 PM
21	French drains installed in basement	9/28/2021 4:30 PM
22	restructured landscaping to channel water away from home	9/28/2021 10:26 AM
23	Earthquake insurance.	9/28/2021 9:13 AM
24	Home has solar hot water heater, insulated basement walls, sun shades. Monitoring water accumulation into crawlspace / basement during major storm events.	9/28/2021 8:51 AM
25	put in french drains to redirect the flow of water and help alleviated ground saturation	9/28/2021 8:48 AM
26	I am not a home owner	9/28/2021 8:16 AM
27	Tree removal	9/24/2021 8:34 AM

Q45 If you could choose one action that could be taken in Frederick County to reduce its vulnerability to hazards, what would it be?

Answered: 195   Skipped: 489

#	RESPONSES	DATE
1	Improve flood control for areas that routinely flood	10/21/2021 1:27 PM
2	Educate the Public.	10/21/2021 8:15 AM
3	This area is not that vulnerable to disasters. That's one nice thing about the region - extreme weather is rare. The actions I've seen taken in Frederick County in the past ie flood control projects have not proven to be very effective. A recent example is Woodsboro Park - 2 years of construction resulted in an ugly marsh area where there used to be a peaceful stream, which still severely flooded in the recent tropical storm.	10/20/2021 9:39 PM
4	Ensure back up, renewable sources of energy if a natural disaster affects the grid	10/20/2021 4:09 PM
5	Deal with the fickle electricity sources around here. Power outages in summer and winter can be deadly.	10/20/2021 4:03 PM
6	It would be great if the county would pay for the installation of backflow prevention devices because that is an expensive process. In the event of an imminent hazard having a solid communication system that does not require electricity in the event that we cannot access electricity is vital to the logistical organization of people, resources and mitigating social anxiety which leads to unrest.	10/20/2021 1:34 PM
7	Flooding	10/20/2021 11:52 AM
8	Subsidize retrofitting of buildings	10/19/2021 8:13 PM
9	Identify specific geographic areas of risk.	10/19/2021 8:27 AM
10	Take action to reduce flooding risk on frequently flooded roadways.	10/19/2021 6:47 AM
11	Assist homeowners with alternative energy solutions on site to make them independent of public electric utility	10/16/2021 9:34 AM
12	fix the road tilting on Magnolia ave at Rosemont ave. The water runs towards the west side of the road, which floods basements on that side of the street.	10/15/2021 8:30 PM
13	creek flooding	10/15/2021 5:22 PM
14	mentally prepare people that hazardous conditions can occur at anytime	10/15/2021 3:10 PM
15	Conduct localized flood-risk reduction projects. There are known areas in Frederick County that floor regularly. The county should address flooding in those areas and provide alternative travel routes to bypass flooded roads.	10/15/2021 1:04 PM
16	have important locations, fire stations, hospitals, police stations, winchester hall etc. retrofitted to have microgrids and be independent of the existing electrical infrastructure	10/15/2021 12:33 PM
17	Flood control	10/15/2021 12:32 PM
18	Provide outreach, education and provide technical assistance	10/15/2021 12:18 PM
19	stabilize the ground	10/15/2021 12:01 PM
20	Stop building on new land; use land that's been developed already which needs new infrastructure.	10/15/2021 12:00 PM
21	Conduct localized flood risk reduction projects.	10/15/2021 11:47 AM
22	Provide flood mitigation to all areas of Frederick County that are high risk to flooding or near a body of water.	10/14/2021 2:31 PM

23	education	10/14/2021 10:29 AM
24	n/a	10/11/2021 3:39 PM
25	Reduce urban sprawl and development without environmental considerations. Clearcutting lots, removing old forests, and building massive houses with no trees kept on the lawns degrade the environment and significantly increase the risk of flooding and polluting our waterways. Rainwater management and serious environmental consultation need to be prioritized when zoning new neighborhoods rather than economic gain and job revenue. Protect the wildlife and there will be less hazards that threaten human health!	10/11/2021 12:56 PM
26	I think Frederick County does a great job in keeping the citizens informed and providing services as needed to recover/prevent damage from these hazards	10/8/2021 10:14 AM
27	Conduct localized flood risk reduction projects	10/7/2021 4:10 PM
28	Allow solar energy storage by individuals.	10/6/2021 4:41 PM
29	Education of public with an offer of assistance assisting possible hazards in and around the home	10/6/2021 11:15 AM
30	Enhance the reporting system, you can piggyback on the Ft. Detrick identification system and get the information out to the public. identify a risk management system for the county for these natural disasters Educate the public in protecting themselves.	10/5/2021 8:34 PM
31	more storm drains	10/5/2021 4:29 PM
32	Education	10/5/2021 2:43 PM
33	Keep trees trimmed away from roads. Not allow citizens to plant trees near roads.	10/5/2021 12:41 PM
34	Require new or repaving of all parking lots to be absorbent type or porous to assist in less run off of rain water into the storm water systems to help prevent flooding.	10/5/2021 9:31 AM
35	Provide assistance to low-income families to reduce risk of hazards	10/5/2021 9:28 AM
36	Purchase optional flood insurance.	10/5/2021 9:21 AM
37	Since we have not been too heavily impacted by any natural disaster, it's hard for me to say, but I have known more that have suffered loss from storm water damage than any of the others listed.	10/5/2021 9:18 AM
38	Stop cementing so much open ground. Make all new developments pay into a special mitigation fund	10/4/2021 8:42 PM
39	Unsure	10/4/2021 2:33 PM
40	Education on how to mitigate these issues for low to no cost.	10/4/2021 2:12 PM
41	Flood proofing	10/4/2021 12:58 PM
42	Stop spraying herbicides.	10/4/2021 12:58 PM
43	provide a generator to homeowners at a low cost	10/4/2021 11:46 AM
44	Anything to help with flooding	10/4/2021 9:36 AM
45	Help with Monocacy flooding.	10/4/2021 8:53 AM
46	Help manage climate change.	10/4/2021 8:36 AM
47	Rely less on masts and put more power lines under ground.	10/3/2021 12:16 PM
48	the roads get awful every time it rains really bad, i would like if the roads could be reinforced so that doesn't happen as much	10/3/2021 11:06 AM
49	Localized flood reduction projects	10/3/2021 10:59 AM
50	Flood mitigation projects	10/3/2021 10:20 AM
51	Flood mitigation actions	10/3/2021 8:16 AM
52	Strengthen emergency response operations	10/3/2021 7:50 AM

53	Encourage strong communities that are resilient through education, preparation, and communication.	10/2/2021 4:44 PM
54	Vote against democrats	10/2/2021 6:58 AM
55	Flooding hazard is a major vulnerability in Frederick County. So, mitigation strategies could include updating the sewage system to prevent combined sewage overflows during heavy rains or flooding events.	10/1/2021 6:25 PM
56	Flood control	10/1/2021 5:49 PM
57	I would rest better knowing that ALL emergency responders were equipped to handle these types of emergencies in addition to their daily responses.	10/1/2021 3:02 PM
58	Localized flood reduction plans, either purchasing open land or buying buildings to demo	10/1/2021 1:42 PM
59	More resources.	10/1/2021 1:26 PM
60	Education and outreach	10/1/2021 9:25 AM
61	Improve drainage to remove water that flls the streets around Baker Park and areas in the county.	10/1/2021 12:14 AM
62	Not sure	9/30/2021 9:39 PM
63	High density residential and commercial areas lack adequate parking and clearances to allow emergency apparatus to access them in optimal conditions. In the event of extreme weather they are impassable and emergency units cannot mitigate emergencies that cannot reach.	9/30/2021 7:27 PM
64	education	9/30/2021 7:18 PM
65	Not sure but need to help homeowners access help	9/30/2021 6:13 PM
66	Actively manage and repair flood remediation infrastructure. For example, we have swales to direct water in front of our home that were heavily damaged a few years back. They could have easily been repaired when our road was repaved.	9/30/2021 3:30 PM
67	flood mitigation	9/30/2021 10:48 AM
68	We need to be more proactive about saving the earth. There need to more recycling bins/containers available in the public area- particularly in open spaces like parks. And there needs to be a better system for recycling. The what can/cannot be recycled is too complicated for people to remember.	9/30/2021 10:29 AM
69	Measures to address flooding due to increased heavy rains.	9/30/2021 9:26 AM
70	Continue to maintain the flood plan in Frederick city/ baker park.	9/30/2021 9:26 AM
71	something to fix the flooding on the roads since this seems like it may become a more common issue.	9/30/2021 8:37 AM
72	stop allowing building of new neighborhoods which are changing the flood zones due to lack of water absorption and other factors beyond my understanding.	9/30/2021 8:30 AM
73	outreach	9/30/2021 6:21 AM
74	Fire Alban. She put our children at risk.	9/29/2021 10:15 PM
75	Early warning systems	9/29/2021 10:00 PM
76	Not sure	9/29/2021 8:46 PM
77	Generators	9/29/2021 6:53 PM
78	Educate residents about appropriate safety precautions for severe weather. Inform the public about personal responsibility so that people know what their role in protecting their lives/property/families are and what the appropriate role of government and other agencies are. Let others know about important resources that are not limited to overloading 911/emergency responders so that emergency responders can address true emergencies. (E.G. : Red Cross, FEMA, local nonprofits, shelters, 211, etc)	9/29/2021 6:22 PM
79	Strengthen openings	9/29/2021 6:10 PM

80	Electrical lines underground, instead of overhead	9/29/2021 4:40 PM
81	Bury power transmission lines.	9/29/2021 4:25 PM
82	storm water management with consideration of French drains	9/29/2021 3:30 PM
83	Educate public so persons can make better decisions during a crisis	9/29/2021 3:12 PM
84	Alerts and education on flood insurance	9/29/2021 3:00 PM
85	Maintain storm drainage systems	9/29/2021 1:53 PM
86	Flood mitigation	9/29/2021 1:46 PM
87	Flood mitigation management, such as storm water management and repair/maintenance of infrastructure	9/29/2021 1:17 PM
88	Please help the city see that closing Downtown streets (even going to one lane of traffic) will put us at a dramatic risk in the event of an emergency	9/29/2021 1:08 PM
89	City and County needs to do a better job of removing debris from drains to stop some of the flooding in the neighborhoods	9/29/2021 12:42 PM
90	We need more renewable energy and less fossil fuel to reduce the global temperature and stop these extreme weather events.	9/29/2021 12:24 PM
91	Outreach and Education.	9/29/2021 12:18 PM
92	Improve storm water drainage	9/29/2021 12:12 PM
93	Better stormdrains in Downtown	9/29/2021 11:46 AM
94	Improve storm water management.	9/29/2021 11:39 AM
95	Stop overbuilding. The flooding will only get worse if there is no open space or trees to absorb floodwaters.	9/29/2021 11:21 AM
96	Limit development, put permeable surface requirements in place for developers and county civil projects.	9/29/2021 11:13 AM
97	educate the people making decisions about safety- nature will win-water especially is harmful	9/29/2021 11:12 AM
98	Better disseminate information when there are road closures due to weather(flooding, snow). School and College closures- err on the side of safety and close for weather events. I'd rather folks be safe at home and have nothing happen than be stuck somewhere if something does happen.. People do not go home on their own unless an official call is made.	9/29/2021 11:08 AM
99	Set up evacuation centers or something like that where residents can stay for a while after a disaster. Not everyone has the skills or money to take preparedness action, so facing that reality and being ready to take in those people who will not be able to protect themselves from disasters would be much appreciated by me.	9/29/2021 11:05 AM
100	Make sure stormdrains are cleared of debris, slow down on construction of new homes or make sure the deversion of water flow towards drains or stormwater ponds instead of roadways or buildings.	9/29/2021 11:00 AM
101	Flood management	9/29/2021 10:50 AM
102	flood mitigation	9/29/2021 10:46 AM
103	Stop overbuilding in areas of farmland and woodland	9/29/2021 10:46 AM
104	Prep for flood control since that seems to be our biggest threat Or Disaster preparation plan & drills	9/29/2021 10:46 AM
105	Stock the county with disaster supply kits.	9/29/2021 10:38 AM
106	Stop over development and clear cutting.	9/29/2021 10:17 AM
107	Increase open green space and areas (farms, parks) and update storm water infrastructure for flood waters to collect	9/29/2021 10:06 AM
108	STOP BUILDING!!!!	9/29/2021 10:04 AM

109	Enact and enforce regulations, codes and ordinances, such as zoning regulations and building codes	9/29/2021 9:58 AM
110	Stop allowing large over crowded subdivisions to be built before the infrastructure to support them has been developed.	9/29/2021 9:49 AM
111	Cut back or removed vegetation from back-roads and ensure roads/bridges and damns are in a good condition, and elevated enough to reduce its vulnerability to hazards.	9/29/2021 9:41 AM
112	?	9/29/2021 9:32 AM
113	Existing homes need to be able to improve and better control water runoff, education and possible grants or tax breaks for when improvements are completed	9/29/2021 9:23 AM
114	manage flooding risks	9/29/2021 9:20 AM
115	Better flood prevention	9/29/2021 9:13 AM
116	Decrease slant on magnolia at Rosemont and magnolia	9/29/2021 9:11 AM
117	Stop approving housing and commercial developments. We are destroying our forrest and farm lands in the county.	9/29/2021 9:11 AM
118	Implement early warning system	9/29/2021 9:06 AM
119	Control development sprawl; mitigate the act of clear cutting trees for development.	9/29/2021 9:05 AM
120	address stormwater management issues	9/29/2021 8:58 AM
121	install solar panels and require electric vehicles of all county and state institutions	9/29/2021 8:58 AM
122	Assistance/grant funding for generators. Alert system to notify residents which roads are closed/impassable in Myersville area.	9/29/2021 8:56 AM
123	Add additional zoning requirements that reduce FEMA impacts	9/29/2021 8:55 AM
124	More education to general public for all hazards	9/29/2021 8:53 AM
125	Provide outreach and education	9/29/2021 8:44 AM
126	Floodproofing home	9/29/2021 8:41 AM
127	More city/county professionally done drains on public streets to divert and maintain the severe rain waters.	9/29/2021 8:36 AM
128	Whatever projects are necessary to mitigate the flooding that occurs in the SAME places EVERY single time there is heavy rain. We all know the bad areas, let's fix them.	9/29/2021 8:32 AM
129	Flood mitigation due to increased rainfall amounts in short times. I see flooding as our major issue.	9/29/2021 8:27 AM
130	Replace overhead utility lines.	9/29/2021 8:25 AM
131	Manage construction to reduce flooding? But I am not an expert. for instance, Rt. 40 never used to be covered in water... even in the heavy rains of the 70's & 80's to my memory, but now it floods - seems there is no where for the water to go, or to be absorbed? But not an expert.	9/29/2021 8:21 AM
132	Assistance to lower flooding in downtown Frederick	9/29/2021 8:16 AM
133	Reduce building in flood plains.	9/29/2021 8:10 AM
134	Completely stop Urbana and Monrovia from growing any more.	9/29/2021 7:47 AM
135	Find a way to address flooding issues in troubled areas.	9/29/2021 7:46 AM
136	educate local businesses and farms on preparedness	9/29/2021 7:44 AM
137	ADDRESS STORMWATER MANAGEMENT AT THE TOP OF SLOPES AND THEN WORK DOWNWARD. Little things can be implemented more cost effectively at the top of slopes that would greatly help reduce impacts downstream. Trying to address stormwater at the bottom of a slope is futile.	9/29/2021 7:43 AM

138	alerts	9/29/2021 7:40 AM
139	Develop overflow paths for rivers and creeks to help divert water to prevent excessive flooding that can damage homes and infrastructure.	9/29/2021 7:37 AM
140	FLOODING IS AN ONGOING ISSUE IN THE COUNTY	9/29/2021 7:31 AM
141	Reduce new housing being built in Fredrick County to maintain our resources.	9/29/2021 7:09 AM
142	STOP BUILDING!	9/29/2021 7:08 AM
143	Be proactive, pay attention to what other counties are doing in hazard situations and follow suit. Don't wait until it's too late! No children should be put in danger because of one ego head adult.	9/29/2021 6:58 AM
144	Conduct localized flood risk reduction projects, such as stormwater management projects or stabilizing roads/bridges	9/29/2021 6:45 AM
145	Redesign the entrance to my subdivision so it would stop flooding	9/29/2021 6:18 AM
146	Relocated to a less restrictive state	9/29/2021 5:06 AM
147	Do not approve *any* new development in flood plains.	9/28/2021 11:01 PM
148	Stop building and causing water to build upon places it does not go naturally	9/28/2021 10:46 PM
149	Work more on pre event activities, education so people understand how to stay safe.	9/28/2021 10:35 PM
150	Improve drainage systems to mitigate flooding during rainstorms	9/28/2021 8:38 PM
151	Better education and notification about tornados. Most don't know the difference between a watch and a warning.	9/28/2021 8:15 PM
152	close businesses and county buildings when necessary	9/28/2021 7:34 PM
153	increase Emergency management department/increase fire rescue special operations to help mitigate hazards. to prevent loss of life.	9/28/2021 7:07 PM
154	Educate the community and provide funds to help homeowners make their homes safer	9/28/2021 7:06 PM
155	Coordinate education to assure citizens are aware of options	9/28/2021 7:03 PM
156	Make others aware of the phone numbers to find help without calling 911	9/28/2021 6:45 PM
157	Conduct localized flood risk reduction projects.	9/28/2021 5:38 PM
158	Stop building so much.	9/28/2021 5:23 PM
159	Improve infrastructure (roadways) to reduce flooding.	9/28/2021 5:15 PM
160	Offer monetary incentives to home owners for building better, stronger, more resilient homes.	9/28/2021 5:12 PM
161	emergency alerts	9/28/2021 5:01 PM
162	Address long standing issues related to flooding in outlying areas from downtown/Baker Park. Work more aggressively to resolve the issues in areas already identified and obtaining assistance from the Army Corps of Engineers. (I know this is Frederick City)	9/28/2021 4:42 PM
163	Improve infrastructure	9/28/2021 4:40 PM
164	Improve drainage to prevent severe floods	9/28/2021 4:39 PM
165	Create an emergency relief fund. It is impossible to plan for all eventualities but is possible to keep cash on hand to rebuild and keep business running.	9/28/2021 4:39 PM
166	People first reduction of hazards, keep people in safe spaces when needed.	9/28/2021 4:37 PM
167	Education on climate change	9/28/2021 4:35 PM
168	Figure out how to deal with substantial rain water / flooding which seems to be getting more frequent and substantial	9/28/2021 4:33 PM
169	Have active and adequately staffed Division of Emergency Management	9/28/2021 4:32 PM

170	Stop building so much and focus on maintaining watersheds and natural areas so flooding isn't as impactful	9/28/2021 4:31 PM
171	Seem to be a big problem with flooding. Although Carrol Creek project helped with this it is still an issue and may need some updates to prevent the flooding we've been seeing recently.	9/28/2021 4:31 PM
172	Continued maintenance along Carroll Creek to provide safe passage for floodwaters into already existing flood management area	9/28/2021 4:30 PM
173	Flood Proof Houses	9/28/2021 4:30 PM
174	Purchase additional insurance	9/28/2021 4:28 PM
175	Alert system	9/28/2021 2:45 PM
176	Education and communication. Use people's cell to notify; educate them, including schools and social groups. BSA already does this with an Emergency Preparedness merit badge. Make it worthwhile to engage in preparedness.	9/28/2021 10:26 AM
177	Supply generators	9/28/2021 9:13 AM
178	It seems like flooding is the main hazard issue in town. My house is not in a low-lying area, but there are houses that aren't supposed to be in flooding area but they get flooded. I believe there was a stormwater study completed by the USACE for Frederick. Implementing their recommendation would be my preferred action.	9/28/2021 9:11 AM
179	The water drainage should be fixed, with 3 inches of rain some parts of the county are already flooded.	9/28/2021 9:01 AM
180	Invest heavily in renewable energies and energy efficiency. (Not just city & county buildings or schools - but for all residents & businesses.) With regards to energy efficiency - the last apartment I rented in Frederick was relying upon 40 year old HVAC units - was NOT efficient. Nice place but inefficient. Why - because renter pays the energy, they pay the capital cost of new equipment.	9/28/2021 8:51 AM
181	identify and review plans to manage water run off	9/28/2021 8:48 AM
182	One action could be to look at bridges vulnerability (width/ height versus ground level) when it comes to flash flooding and and heavy rain fall. Thought process of how fast the bridge is no longer able to be used when heavy rainfall hits.	9/28/2021 8:42 AM
183	Genuinely focus on the issues and mitigation strategies for the good of the people versus making everything political.	9/28/2021 8:35 AM
184	Reduce construction of new homes to reduce impervious surfaces that increase flooding and temperatures.	9/28/2021 8:33 AM
185	unknown	9/28/2021 8:13 AM
186	Make sure that residents with flooding issues have a way to egress from their street when creek flooding occurs. Being trapped and flooded is never a happy day. Especially when it comes with water quality issues (bacteria in the wells)	9/28/2021 8:10 AM
187	Safe rooms	9/28/2021 8:09 AM
188	Improve electrical grid	9/25/2021 11:16 AM
189	Education of residents and business owners regarding largest potential threats and provide assistance with mitigation efforts.	9/24/2021 12:51 PM
190	clean ditches along county side roads better to prep before storms	9/24/2021 9:28 AM
191	flood risk reduction measures	9/24/2021 9:18 AM
192	There are some areas near where we live where the roads often have flooding even with minimal rain (which can cause issues also in the winter). I would like to see the roads be taken care of (whether that be fixing the sloping or whatever it may take).	9/24/2021 8:52 AM
193	Ensure that codes for construction on new homes are strict.	9/24/2021 8:49 AM
194	Planning for disasters	9/24/2021 8:34 AM

195	Implement an emergency alert system for the City of Frederick.	9/24/2021 8:16 AM

Q46 Please provide any additional comments or questions to be addressed as Frederick County and your community update our hazard mitigation plan.

Answered: 68 Skipped: 616

#	RESPONSES	DATE
1	Emmitsburg needs help with their water infrastructure—frequent issues with town water being discolored (possibly from theft—which also brings up the question of how easily it could be contaminated) and recent flooding of roads, sewers, and homes in town have brought to light more public safety issues not being addressed.	10/21/2021 1:34 PM
2	Provide Community presentations of the updated/finished plan, begin in each Municipality and then larger Communities (Urbana etc.). Present the Plan in each High School and College, as a one day curriculum topic requirement, Send the Plan (link to a website) to each Alert subscriber in Frederick County. Provide the URL web address to the Plan in the Frederick County Tax Bills, after all it's all about the land and developed property. Require each Fire/Rescue Station to have a copy of the plan and require each Career and Volunteer Member to review and understand the plan etc. specific to the Community they serve and the First Due area as well. Same requirement for Municipal, County and State Law Enforcement serving Frederick County. Ensure local Frederick County Red Cross Chapter has a copy and Chapter Volunteers must review and understand.	10/21/2021 8:38 AM
3	A homeowner's checklist would be very helpful, which includes information about the most likely hazard scenarios and what homeowners (or renters) can do to prepare. Funding or tax breaks for taking these steps would be even better!	10/20/2021 4:11 PM
4	I am 8th generation Frederick County. I am raising my family here. My spouse and I both work here, our children go to school here. Generations before mine are buried here. The future of this place has significant meaning to me. As the County continues to grow developers need to be held to higher environmental building standards. Emergency services need to be supported and communication systems updated and available (it is but more people need to be plugged into it). Thank you for having these conversations. This is a multi-pronged issue that requires mindful wording of the issues, inclusion of perspectives and high expectations for adaptation.	10/20/2021 1:56 PM
5	No additional comments.	10/20/2021 1:00 PM
6	N/A.	10/20/2021 12:27 PM
7	I'm really proud of how well Baker Park functioned to protect downtown during the flash flooding. Ft. Detrick is a security hazard, but as long as they're taking their mitigation plans seriously I'm not going to worry too much.	10/20/2021 12:21 PM
8	N/A	10/20/2021 11:56 AM
9	Please assist power company with burying power lines in my area. We lose power quite often. We also need an internet option as there are no internet lines to our area.	10/18/2021 4:20 PM
10	Thank you	10/15/2021 12:33 PM
11	Better resources for tenants renting and protection against environmental hazards in homes	10/15/2021 12:13 PM
12	n/a	10/11/2021 3:39 PM
13	Understand what other counties are doing so there are no conflicts in a large area event.	10/6/2021 4:41 PM
14	integration with school system (i.e. student transportation and utilization of buildings in the event of emergency)	10/5/2021 8:36 PM
15	Can't think of anything at this time.	10/5/2021 3:30 PM
16	Notify residents of meetings and education to attend so we can learn more about these hazards and what hazards affect our area of the great State of Maryland.	10/5/2021 2:46 PM

17	N/A	10/5/2021 9:18 AM
18	I've been happy to see the direction Mount St. Mary's University has been heading with hazard mitigation and disaster preparedness over the last few years. There have been some extreme events to take place during the last decade, but the university seems to be very proactive in providing safety and mitigation to potential risks.	10/4/2021 2:24 PM
19	I find it odd that farmers are not supposed to spray herbicides near streams or bodies of water, but the County is. In either case, it destroys the vegetation that holds soil during rain events causing both herbicide run off and soil run off to the Bay.	10/4/2021 1:01 PM
20	N/A	10/4/2021 11:47 AM
21	I think the Mount is doing a great job mitigating Covid-19 spread while maintaining its core mission and the quality of education. I commend the leadership for continuing to follow CDC guidelines and scientific evidence rather than popular opinion.	10/4/2021 10:03 AM
22	A couple concerns that I have that weren't listed are: hazards related to being so close to Washington D.C. (terrorism), and bio-hazards at Fort Detrick.	10/4/2021 8:38 AM
23	You are doing well so far, it is hard to mitigate flooding down a mountain so there may not be much that can be done about that situation. Thank you.	10/3/2021 1:00 PM
24	I do not feel that Mount St. Mary's University is prepared for any emergency, nor have the members of the Mount community been informed or trained to react if there is an emergency.	10/3/2021 12:59 PM
25	It is very important to communicate - if there is an emergency plan in place for some hazard or weather disaster, let people know what it is! Then when we do have something happen (such as the sudden Sept. 1 flooding), we'll have some idea of how to respond and what to do. (For example, when we had the Sept. 1 flooding, it would have been helpful to know what roads are prone to flooding, and what roads are usually safe. I ended up driving a roundabout path to get home, because I experienced unexpected road flooding in a few places)	10/3/2021 12:03 PM
26	n/a	10/3/2021 11:07 AM
27	NA	10/3/2021 8:16 AM
28	The brush along Route 355 & I270 needs to be addressed. It's a wildfire hazard.	10/2/2021 11:04 AM
29	Extreme heat, flooding, and severe weather are going to increase in intensity, duration and frequency in this region. More drastic mitigation measures may be needed.	10/1/2021 6:26 PM
30	N/A	10/1/2021 3:03 PM
31	Take seriously the possibility of a long-term large-scale power outage and see how various mitigation efforts can dovetail also exploring any areas where climate change mitigation and mitigating the effects of a wide-spread long-term power outage maybe complementary.	10/1/2021 9:30 AM
32	Keep up the great work!	9/30/2021 3:46 PM
33	The alert system is not used to its full capability. Additionally, no news stations seem to cover the weather well for our area- I'm not sure what can be done about that.	9/30/2021 3:31 PM
34	My backyard floods drastically because my neighbor build a HUGE patio which impacted the water flow of the neighborhood water swell and drainage. The city drain is in their yard. The city staff member who came out could care less. Agreed with the problem being their patio and said they will not do anything about it. I wish I could add photos here. It's unbelievable that the city will not take action. It's in Emerald Farm on Crossover Court. The water flooding almost reaches my basement steps each time we have a heavy rain.	9/30/2021 9:29 AM
35	Work with schools to better communicate these hazards.	9/29/2021 10:16 PM
36	As more severe weather events increase in quantity, will the City/County be more aggressive in trimming trees around power lines and clearing debris and obstructions within drainage swales, creeks, streams, culverts, flood plain and storm water management catch basins?	9/29/2021 4:31 PM
37	Don't allow the building of new homes in the flood plain of Carrol Parkway. Fix the sewerage treatment facility so the pumps don't fail. Look at infrastructure in Frederick City before building more homes especially in areas where traffic and flooding are already an issue.	9/29/2021 3:11 PM

38	I would like the flood plain map to be revisited as I cannot buy flood insurance as I am not technically in a flood risk area. However, my home has been flooded in the past.	9/29/2021 1:18 PM
39	Maybe there should be a community outreach program to educate people on how to protect themselves and their families regarding any type of hazard mitigation	9/29/2021 12:44 PM
40	Please keep the public updated about hazard planning tasks and timelines. Of particular interest is storm water management on N Market Street around the YMCA. I'd also like to see tree planting encouraged/supported as a way to mitigate extreme heat, particularly in residential areas.	9/29/2021 11:45 AM
41	more speed cameras would decrease accidents and increase revenue for county and city	9/29/2021 10:48 AM
42	A better system to update residents on flooded roads. One can go miles only to find a road flooded. Then, need to turn around and run into flooded road after flooded road. No wonder people risk crossing flooded roads. They have no way to know in advance of the safest route of travel. Also, the permanent flood signs do not get adjusted regularly. So one can not rely on those signs because when there isn't any flooding, the signs can be left in the position that indicates flooding.	9/29/2021 10:47 AM
43	Implement county and zip code based alert system to send alerts by text.	9/29/2021 10:07 AM
44	Snow plowing my area is one of the last to get plowed. Flooding with the last two storms all roads around us where flooded out so we where stuck, if an emergency happened we would be unable to receive help or get out.	9/29/2021 10:05 AM
45	More than provide outreach and education or technical assistance to residents, businesses, jurisdictions, and organizations and help them understand risks and mitigate hazards or perform hazard mitigation projects, I would provide and disseminate information on the location of those specific areas that have been identified as more vulnerable to risk and hazard within the county.	9/29/2021 9:43 AM
46	Ensure first responders have the tools to handle responding to emergencies that occur as a result of hazards.	9/29/2021 9:06 AM
47	More information of Fire and Life Safety for Industrial and government identities .	9/29/2021 8:55 AM
48	Flooding is our County's main "disaster" and what we should focus on. Mitigation and prevention projects should be priority, whether that is through changing the current stormwater facilities to hold more water or creating diversions around vulnerable facilities. But diversions must be done correctly so as not to focus the water on down stream properties.	9/29/2021 8:29 AM
49	Assistance with the removal of trees that pose an overhead danger to homes.	9/29/2021 8:26 AM
50	I think we need to be prepared for total system failures. It's coming, there is huge environmental disaster and Fed Gov failures coming. Food, energy and water etc. may be at risk.	9/29/2021 8:23 AM
51	There are numerous items listed in this survey that coincide with the interests of the Division of Water and Sewer Utilities which we are happy to discuss.	9/29/2021 7:58 AM
52	none	9/29/2021 7:44 AM
53	STOP BUILDING!	9/29/2021 7:08 AM
54	From a strategic perspective, the county should embrace solar and wind power installations, instead of bowing to NIMBY pressure that would rather rely on upwind coal and gas power plants.	9/28/2021 11:04 PM
55	Share the results of the survey and what action steps you are taking in response to this information.	9/28/2021 10:37 PM
56	Additional training for Emergency management and fire rescue special operations.	9/28/2021 7:09 PM
57	Review and revise, if needed, evacuation plans for residents affected by extreme weather.	9/28/2021 5:41 PM
58	Help resolve flooding of roadways around the county.	9/28/2021 5:20 PM
59	Can sinkholes be prevented in East Frederick? Can water drains be improved to avoid floods?	9/28/2021 4:41 PM
60	What programs are we initiating to address getting businesses to respond automatically with	9/28/2021 10:31 AM

	critical assets during an emergency? Do they have buy-in? Thinking about how places like Anchorage, AK has pulled together their community partners to respond immediately without an "ask" from the county during earthquakes. Example was when the asphalt companies began heating their stock immediately following one of the 2020 earthquakes; they reduced road repair to major access roads taking weeks off of the estimated times, by not delaying. Just an example, and wondering what we have established here in Frederick.	
61	Do (way) more. Why are we holding up solar farm in Walkersville? Why not add a solar farm w/ battery storage to power the New Design WWTP (via PPA & long-term agreement with adjacent chicken farmer)? These are tiny insufficient steps, but at least in needed direction.	9/28/2021 8:55 AM
62	None	9/28/2021 8:35 AM
63	Please do something about Shryock Mill Rd. Of the 5 occupied houses - all 5 had some flooding due to Ida. Our street is cracking and falling into the creek. One person's home is trashed. Our well water has been contaminated by farm run off. One home has been abandoned for years and the property is not maintained causing hazards such as flood issues (because the property is not maintained), animals living in the house, fire hazard (the house has a tree on top of it). Please help! No one listens to us. Our street is a dead end and when it floods we literally have NO ESCAPE and NO AMBULANCE can get to us.	9/28/2021 8:14 AM
64	none at this time	9/28/2021 8:13 AM
65	Be prepared and do everything possible to be successful in it.	9/28/2021 8:10 AM
66	I've like to be given the info for signing up for the hazard alerts.	9/24/2021 8:53 AM
67	Why doesn't Frederick County use their alert system for anything other than weather? It seems like Montgomery County offers more alerts and inundates their community. Frederick doesn't send out alerts for anything but weather.	9/24/2021 8:51 AM
68	Address climate change at a local level. We all need to do our part.	9/24/2021 8:35 AM

Q47 If you wish to be notified of hazard mitigation plan updates and meetings, please provide your name and email address.

Answe ed: 72 Sk pped: 612

ANSWER CHOICES	RESPONSES	
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Ema Add ess	98.61%	71

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APPENDIX H: HAZUS REPORTS

Final HAZUS-MH 4.2 results for earthquake, flood, and hurricane wind are contained on the following pages.

Earthquake

Hazus: Earthquake Global Risk Report

Region Name: FrederickMD_EQ

Earthquake Scenario: FrederickMD_EQ_Probabilistic

Print Date: August 03, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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Appendix A: County Listing for the Region

Appendix B: Regional Population and Building Value Data

General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 667.20 square miles and contains 61 census tracts. There are over 84 thousand households in the region which has a total population of 233,385 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 85 thousand buildings in the region with a total building replacement value (excluding contents) of 34,232 (millions of dollars). Approximately 91.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 3,668 and 9,893 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 85 thousand buildings in the region which have an aggregate total replacement value of 34,232 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 65% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 97 schools, 31 fire stations, 11 police stations and 2 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 34 hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 13,561.00 (millions of dollars). This inventory includes over 214.37 miles of highways, 473 bridges, 9,016.09 miles of pipes.

Table 1: Transportation System Lifeline Inventory

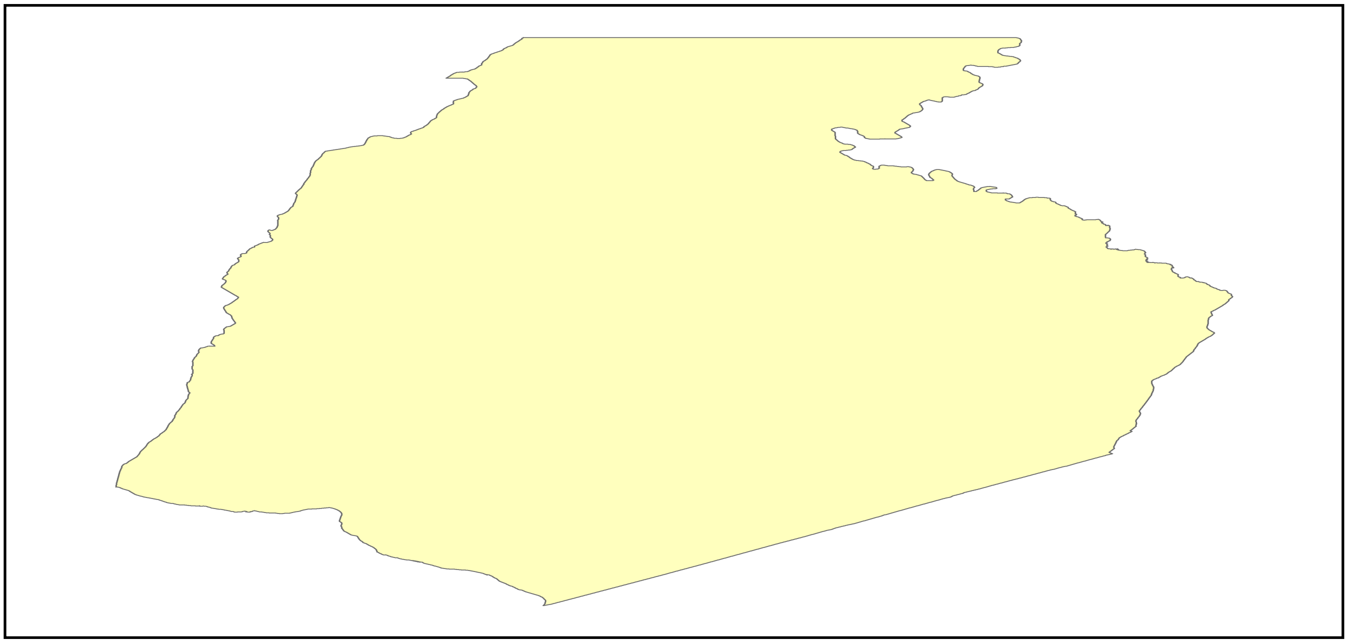
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	473	953.2185
	Segments	149	2070.0370
	Tunnels	0	0.0000
		Subtotal	**3023.2555**
Railways	Bridges	57	260.0625
	Facilities	0	0.0000
	Segments	101	209.9936
	Tunnels	0	0.0000
		Subtotal	**470.0561**
Light Rail	Bridges	0	0.0000
	Facilities	5	14.6000
	Segments	5	61.6474
	Tunnels	0	0.0000
		Subtotal	**76.2474**
Bus	Facilities	2	2.9200
		Subtotal	**2.9200**
Ferry	Facilities	0	0.0000
		Subtotal	**0.0000**
Port	Facilities	0	0.0000
		Subtotal	**0.0000**
Airport	Facilities	3	27.5575
	Runways	2	68.6473
		Subtotal	**96.2048**
		Total	**3,668.70**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	181.1197
	Facilities	2	65.9340
	Pipelines	0	0.0000
		Subtotal	**247.0537**
Waste Water	Distribution Lines	NA	108.6718
	Facilities	70	9134.1250
	Pipelines	0	0.0000
		Subtotal	**9242.7968**
Natural Gas	Distribution Lines	NA	72.4479
	Facilities	0	0.0000
	Pipelines	2	12.9284
		Subtotal	**85.3763**
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**0.0000**
Electrical Power	Facilities	2	317.5500
		Subtotal	**317.5500**
Communication	Facilities	11	1.0890
		Subtotal	**1.0890**
		Total	**9,893.90**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



Scenario Name	FrederickMD_EQ_Probabilistic
Type of Earthquake	Probabilistic
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	Annualized
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	NA
Depth (km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Direct Earthquake Damage

Building Damage

Hazus estimates that about buildings will be at least moderately damaged. This is over % of the buildings in the region. There are an estimated buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

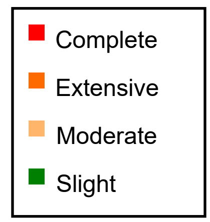


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Total										

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Total										

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 308 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	1	0	0	0
Schools	97	0	0	0
EOCs	2	0	0	0
PoliceStations	11	0	0	0
FireStations	31	0	0	0

Transportation Lifeline Damage

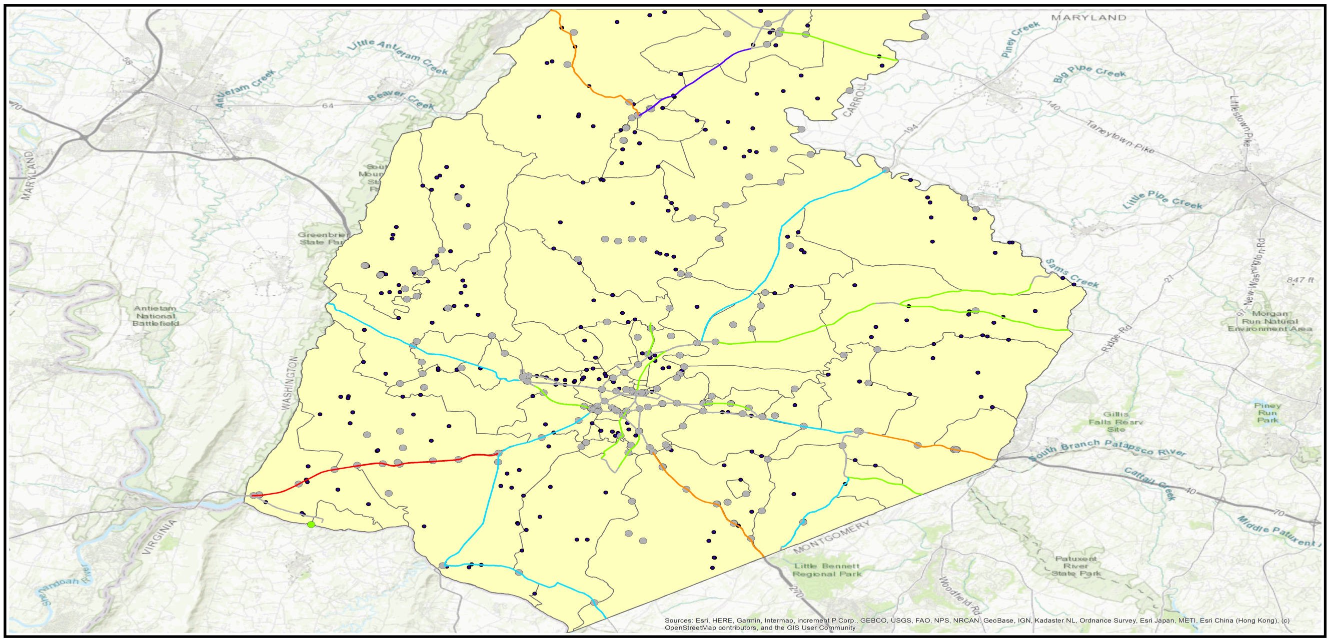


Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	149	0	0	0	0
	Bridges	473	0	0	0	0
	Tunnels	0	0	0	0	0
Railways	Segments	101	0	0	0	0
	Bridges	57	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	5	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	5	0	0	0	0
Bus	Facilities	2	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	0	0
	Runways	2	0	0	0	0

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	0	0	0	0
Waste Water	70	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	2	0	0	0	0
Communication	11	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	5,627	0	0
Waste Water	3,376	0	0
Natural Gas	13	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water						
Electric Power						

Induced Earthquake Damage

Fire Following Earthquake

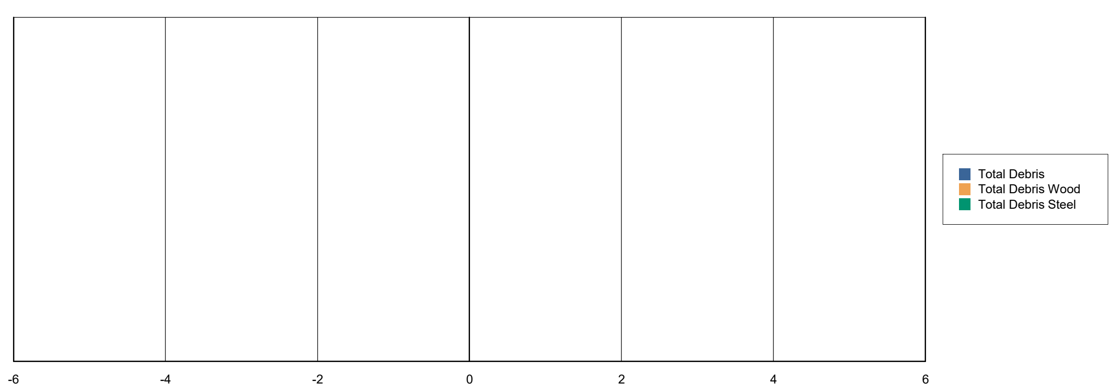
Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about sq. mi % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of tons of debris will be generated. Of the total amount, Brick/Wood comprises % of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require   truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)



Brick/ Wood **Reinforced Concrete/Steel** **Total Debris** **Truck Load**

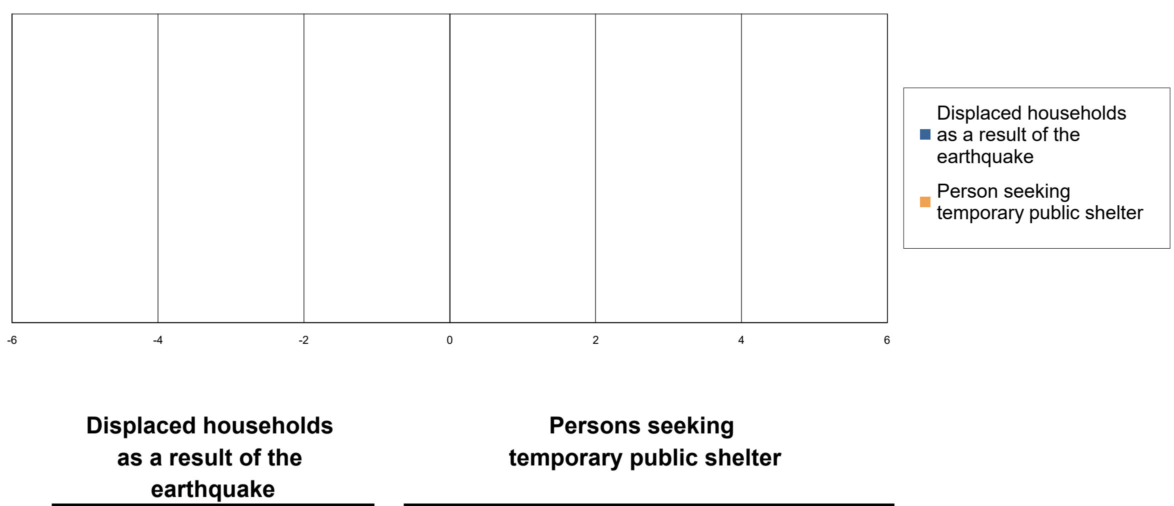
(@25 tons/truck)

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates households to be displaced due to the earthquake. Of these, people (out of a total population of 233,385) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter



Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.00	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.00	0.00	0.00	0.00
	Other-Residential	0.00	0.00	0.00	0.00
	Single Family	0.04	0.00	0.00	0.00
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0.03	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.01	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.00	0.00	0.00	0.00
	Other-Residential	0.00	0.00	0.00	0.00
	Single Family	0.01	0.00	0.00	0.00
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0.02	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.00	0.00	0.00	0.00
	Other-Residential	0.00	0.00	0.00	0.00
	Single Family	0.01	0.00	0.00	0.00
	Total	**0**	**0**	**0**	**0**

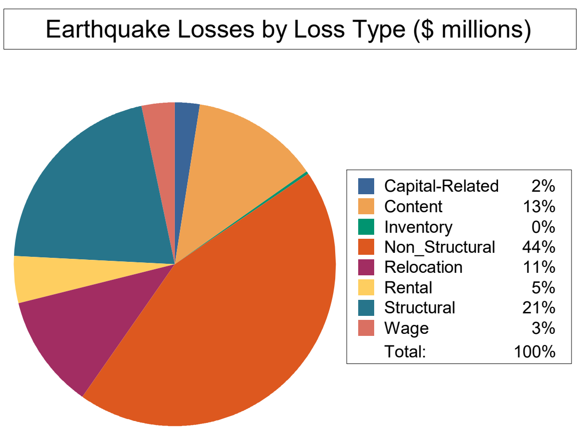
Economic Loss

The total economic loss estimated for the earthquake is 0.19 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 0.19 (millions of dollars); 22 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 70 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.



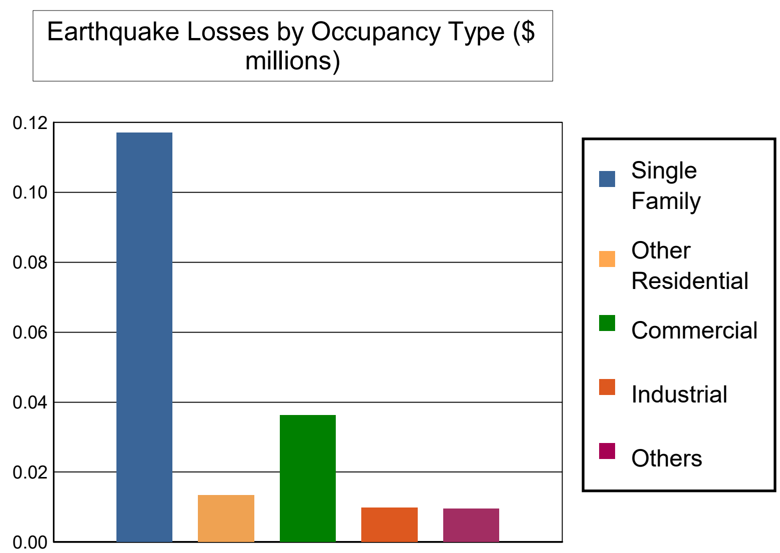


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	0.0004	0.0049	0.0001	0.0007	0.0061
	Capital-Related	0.0000	0.0002	0.0041	0.0001	0.0001	0.0045
	Rental	0.0041	0.0013	0.0029	0.0000	0.0002	0.0085
	Relocation	0.0144	0.0008	0.0040	0.0005	0.0016	0.0213
	Subtotal	**0.0185**	**0.0027**	**0.0159**	**0.0007**	**0.0026**	**0.0404**
Capital Stock Losses							
	Structural	0.0285	0.0022	0.0050	0.0016	0.0017	0.0390
	Non_Structural	0.0568	0.0071	0.0104	0.0043	0.0035	0.0821
	Content	0.0133	0.0015	0.0049	0.0028	0.0017	0.0242
	Inventory	0.0000	0.0000	0.0001	0.0004	0.0000	0.0005
	Subtotal	**0.0986**	**0.0108**	**0.0204**	**0.0091**	**0.0069**	**0.1458**
	Total	**0.12**	**0.01**	**0.04**	**0.01**	**0.01**	**0.19**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	2070.0370	0.0000	0.00
	Bridges	953.2185	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**3023.2555**	**0.0000**	
Railways	Segments	209.9936	0.0000	0.00
	Bridges	260.0625	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**470.0561**	**0.0000**	
Light Rail	Segments	61.6474	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	14.6000	0.0000	0.00
	Subtotal	**76.2474**	**0.0000**	
Bus	Facilities	2.9200	0.0000	0.00
	Subtotal	**2.9200**	**0.0000**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Airport	Facilities	27.5575	0.0000	0.00
	Runways	68.6473	0.0000	0.00
	Subtotal	**96.2048**	**0.0000**	
	Total	**3,668.68**	**0.00**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	65.9340	0.0000	0.00
	Distribution Lines	181.1197	0.0000	0.00
	Subtotal	**247.0537**	**0.0000**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	9134.1250	0.0000	0.00
	Distribution Lines	108.6718	0.0000	0.00
	Subtotal	**9242.7968**	**0.0000**	
Natural Gas	Pipelines	12.9284	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	72.4479	0.0000	0.00
	Subtotal	**85.3763**	**0.0000**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	317.5500	0.0000	0.00
	Subtotal	**317.5500**	**0.0000**	
Communication	Facilities	1.0890	0.0000	0.00
	Subtotal	**1.0890**	**0.0000**	
	Total	**9,893.87**	**0.00**	

Appendix A: County Listing for the Region

Frederick,MD

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Maryland					
	Frederick	233,385	28,211	6,020	34,232
Total Region		**233,385**	**28,211**	**6,020**	**34,232**

Flood

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_1

Flood Scenario: Mulit

Print Date: Monday, August 2, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 154 square miles and contains 1,492 census blocks. The region contains over 13 thousand households and has a total population of 34,951 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 13,924 buildings in the region with a total building replacement value (excluding contents) of 4,884 million dollars. Approximately 92.06% of the buildings (and 89.46% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 13,924 buildings in the region which have an aggregate total replacement value of 4,884 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,369,448	89.5%
Commercial	298,832	6.1%
Industrial	83,521	1.7%
Agricultural	23,904	0.5%
Religion	65,399	1.3%
Government	17,551	0.4%
Education	25,330	0.5%
Total	**4,883,985**	**100%**

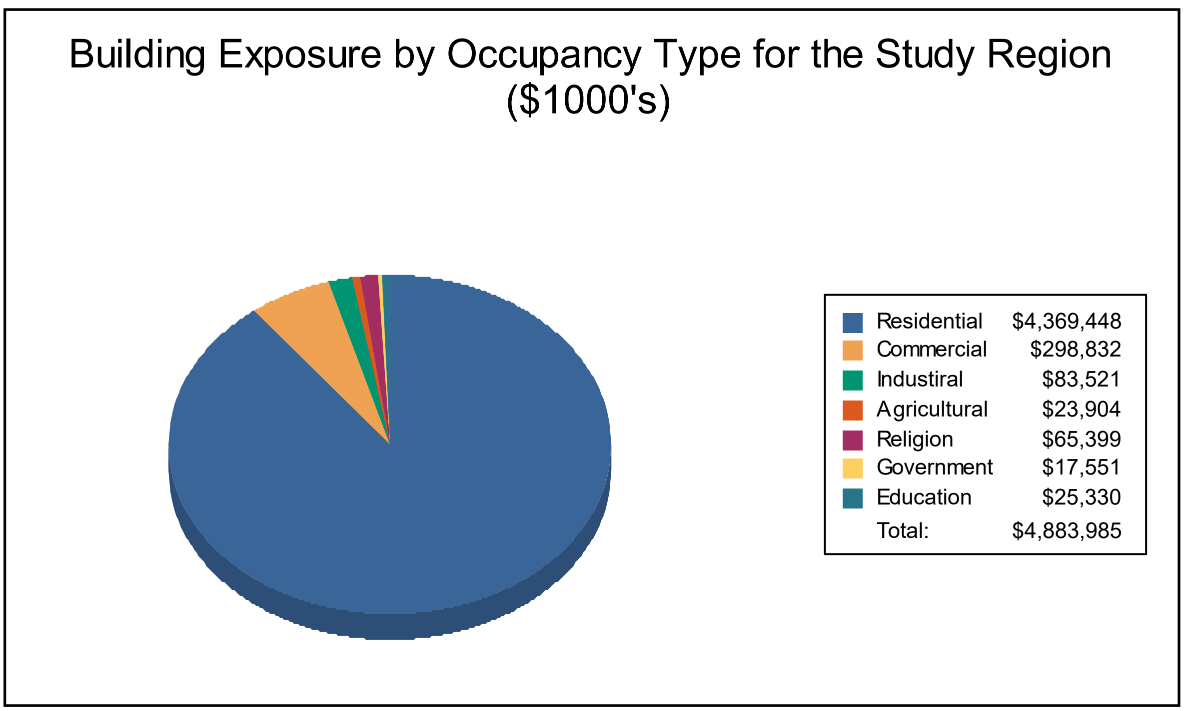
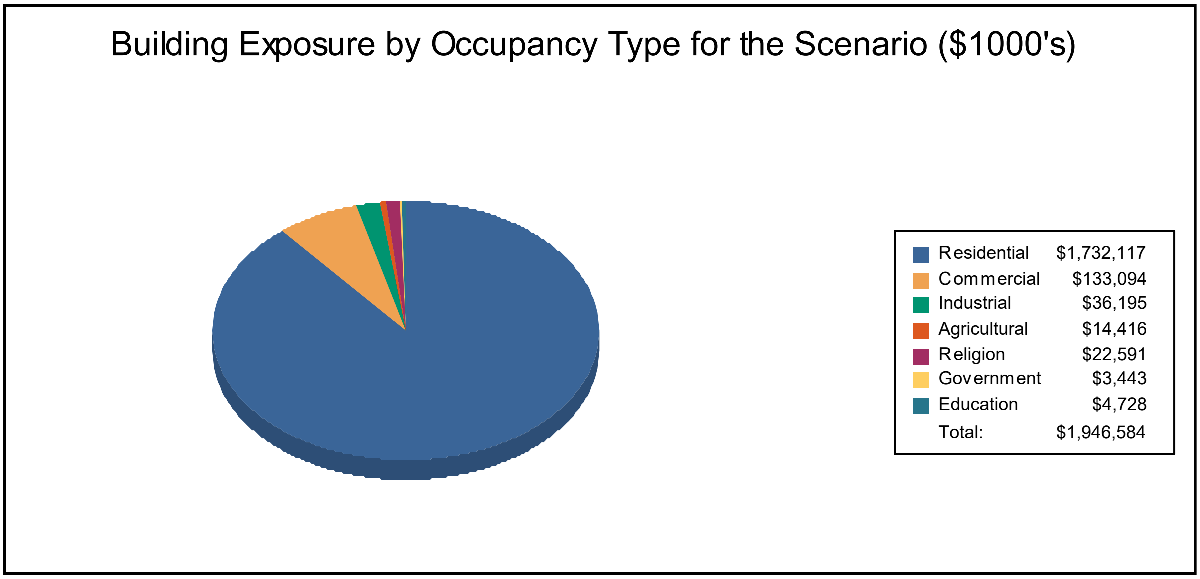


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,732,117	89.0%
Commercial	133,094	6.8%
Industrial	36,195	1.9%
Agricultural	14,416	0.7%
Religion	22,591	1.2%
Government	3,443	0.2%
Education	4,728	0.2%
Total	**1,946,584**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 14 schools, 6 fire stations, 2 police stations and no emergency operation centers.

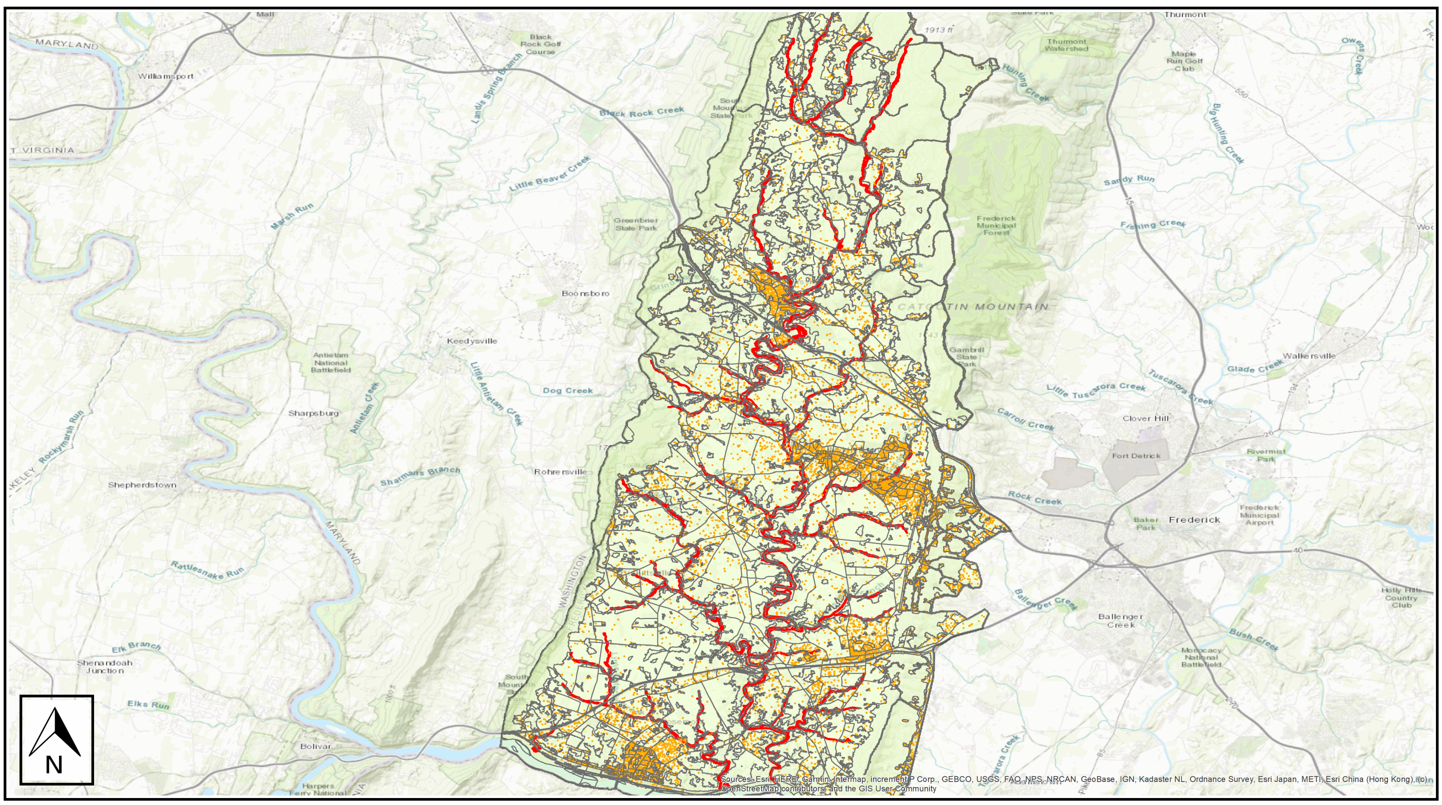
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_1
Scenario Name:	Mulit
Return Period Analyzed:	10
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



![HAZUS: Earthquake • Wind • Flood • Tsunami]

Building Damage

General Building Stock Damage

Hazus estimates that about 2 buildings will be at least moderately damaged. This is over 60% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

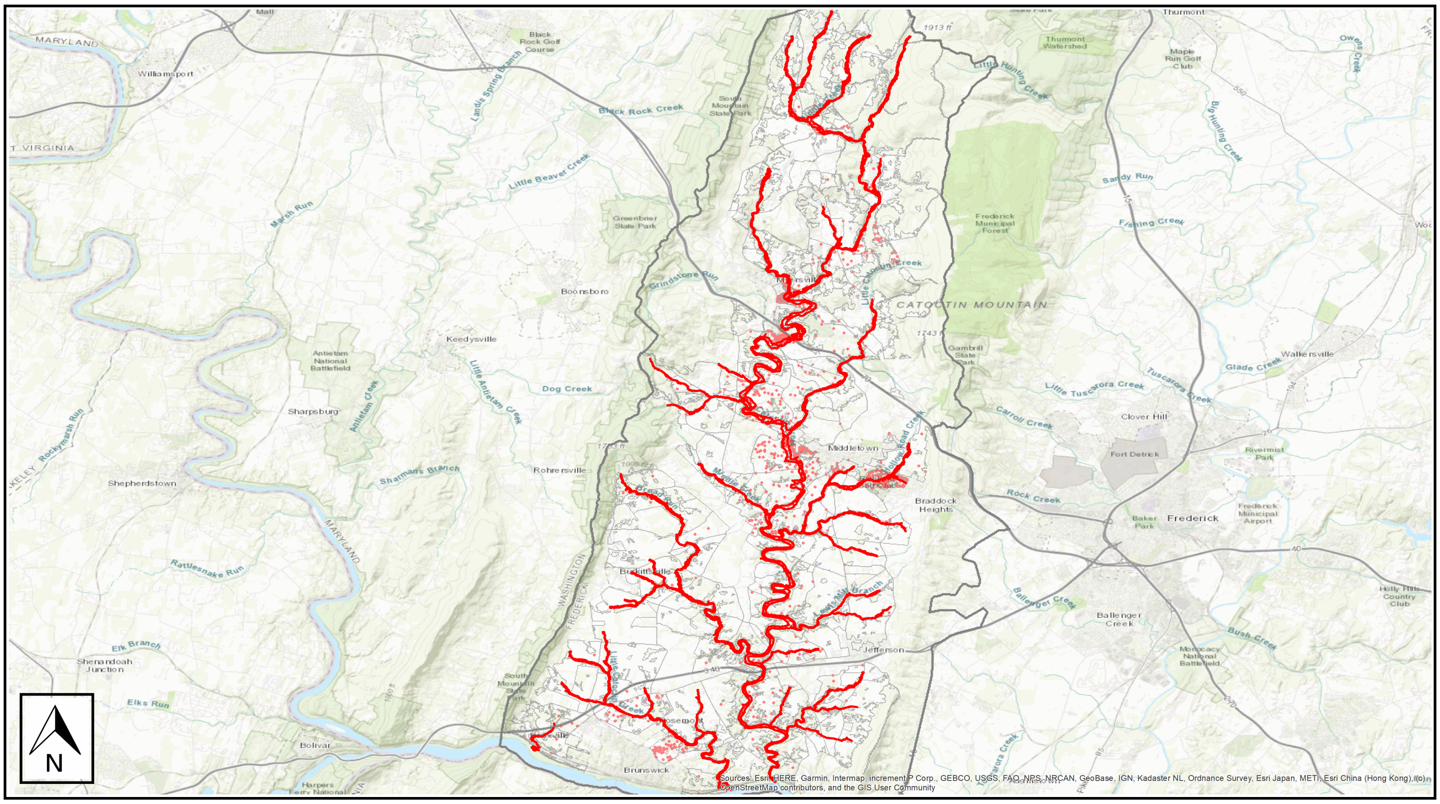


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	1	33	2	67	0	0	0	0	0	0	0	0
Total	**1**		**2**		**0**		**0**		**0**		**0**	

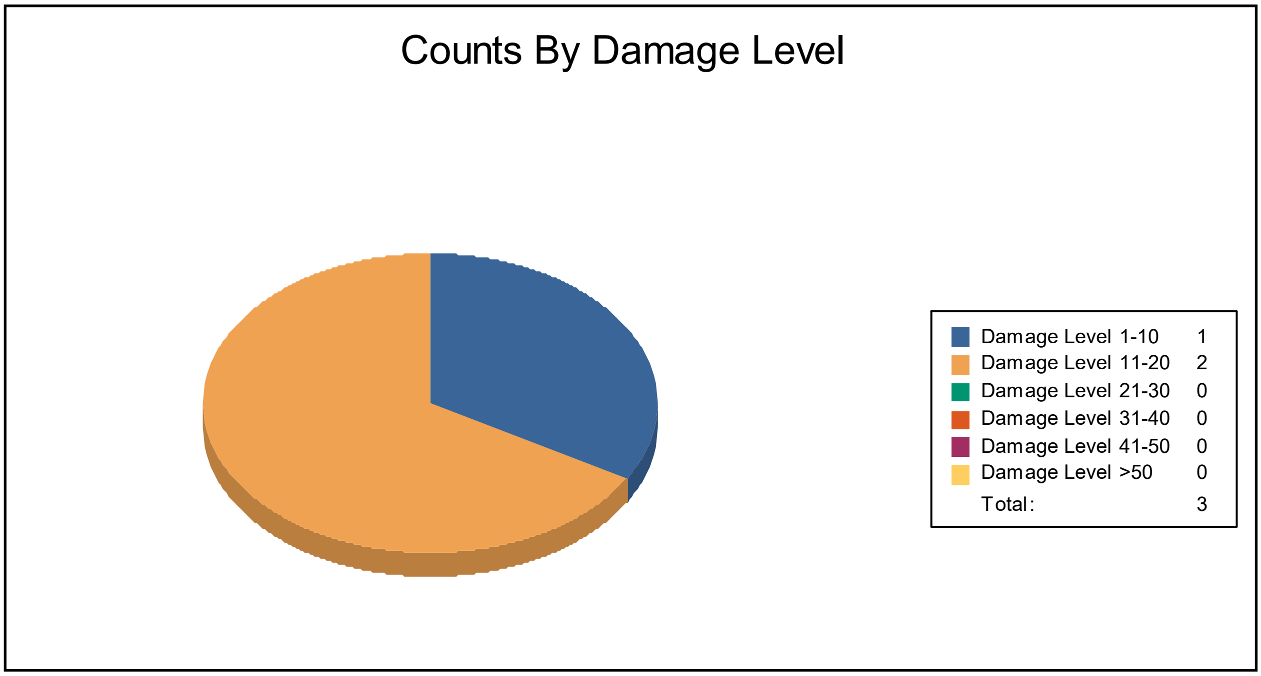


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	1	33	2	67	0	0	0	0	0	0	0	0

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	6	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	14	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

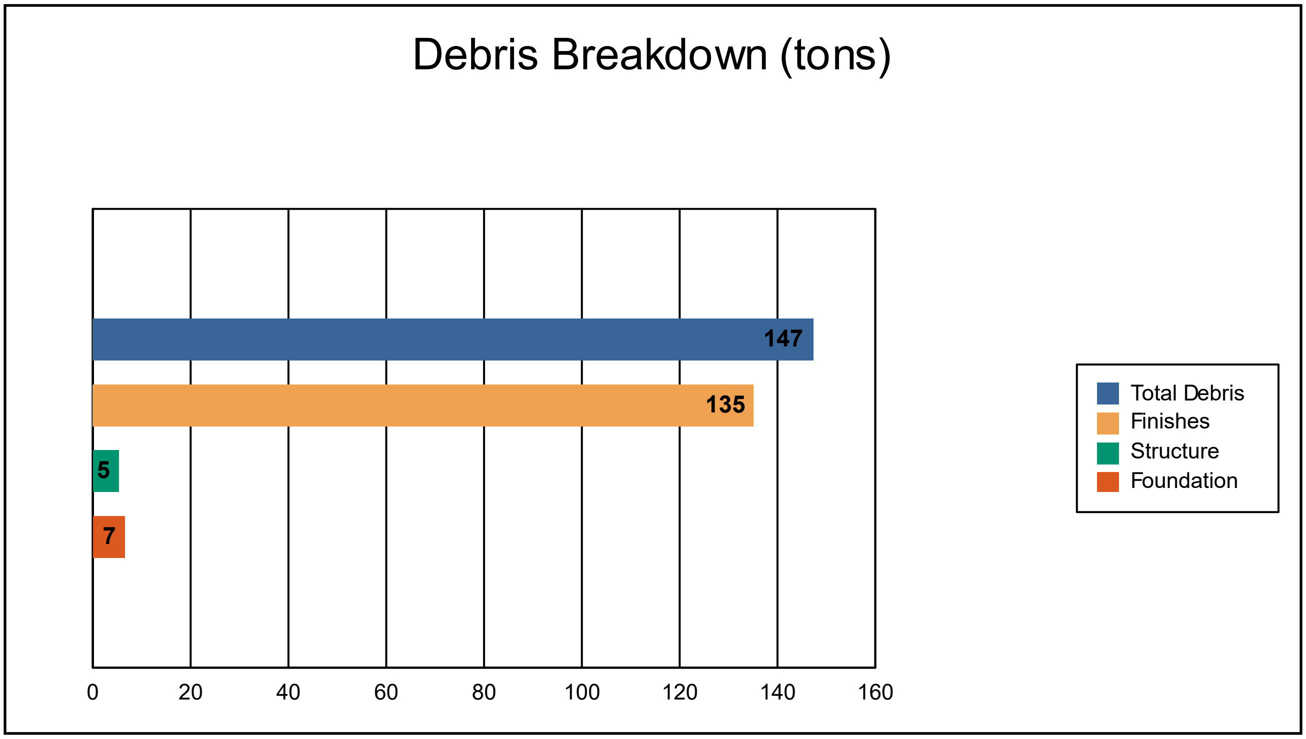
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.



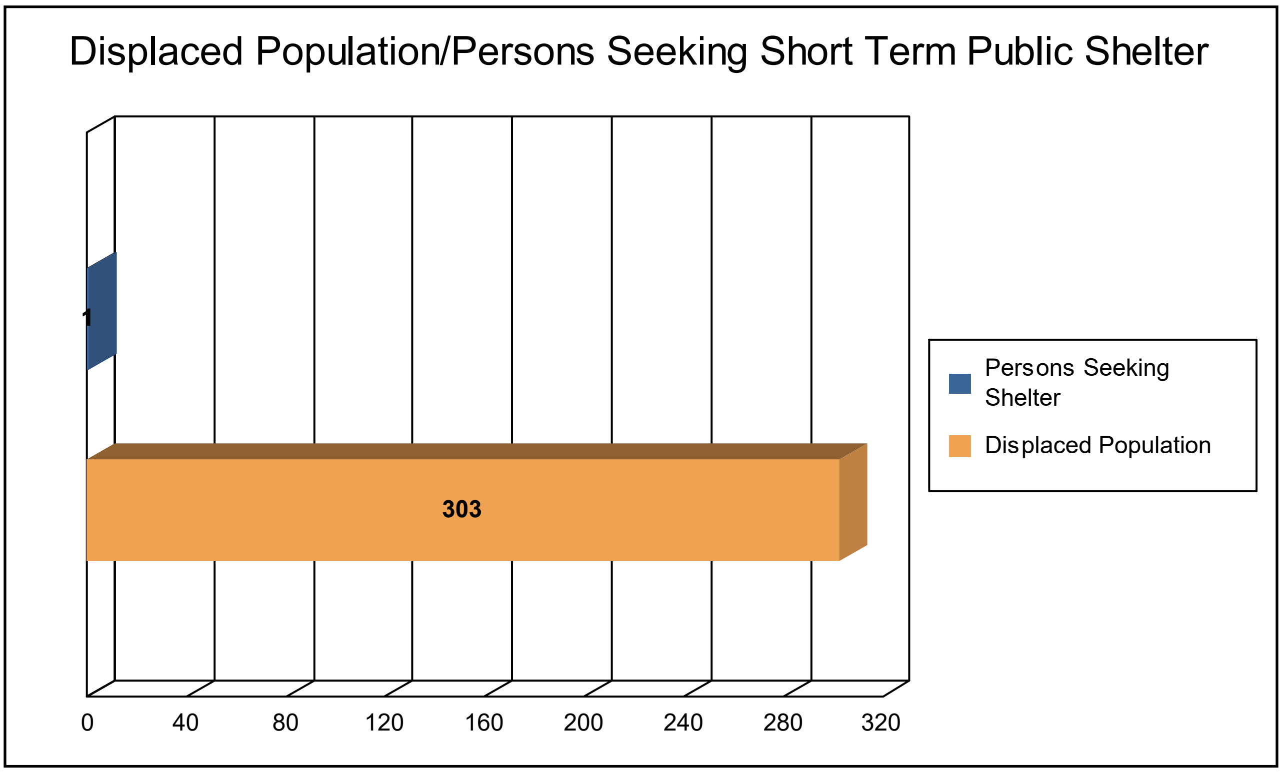
The model estimates that a total of 147 tons of debris will be generated. Of the total amount, Finishes comprises 92% of the total, Structure comprises 4% of the total, and Foundation comprises 5%. If the debris tonnage is converted into an estimated number of truckloads, it will require 6 truckloads (@25 tons/truck) to remove the debris generated by the flood.

HAZUS
EARTHQUAKE • WIND • FLOOD • TSUNAMI

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 101 households (or 303 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1 people (out of a total population of 34,951) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 19.89 million dollars, which represents 1.02 % of the total replacement value of the scenario buildings.

Building-Related Losses

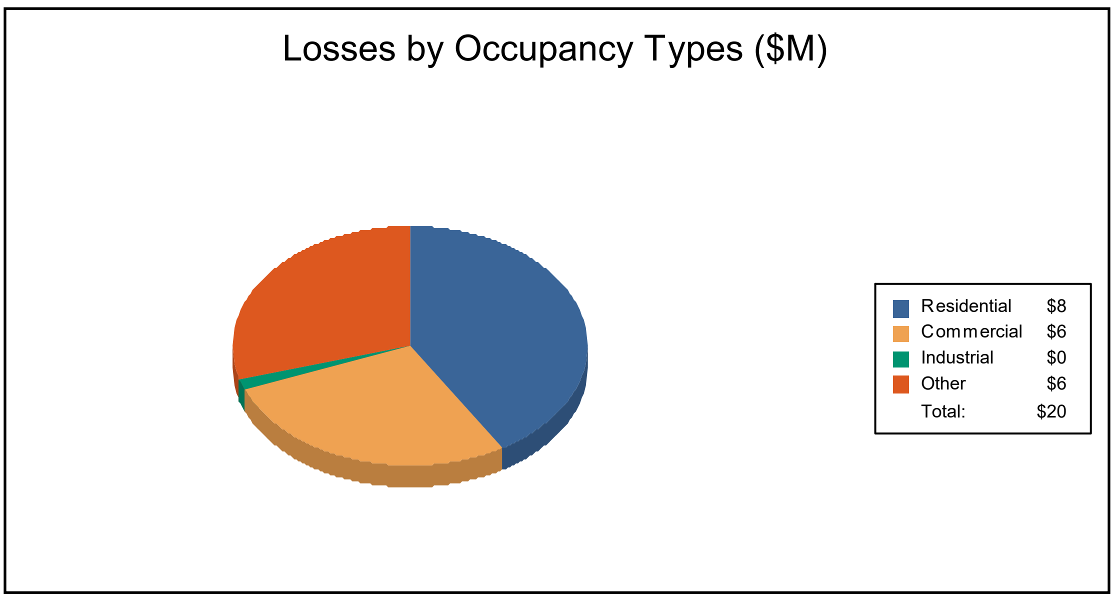
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 8.36 million dollars. 58% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 41.52% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	4.33	0.24	0.09	0.06	4.72
	Content	2.21	0.88	0.15	0.38	3.62
	Inventory	0.00	0.00	0.02	0.00	0.02
	Subtotal	**6.54**	**1.12**	**0.26**	**0.44**	**8.36**
Business Interruption						
	Income	0.03	1.99	0.00	0.22	2.24
	Relocation	1.27	0.27	0.00	0.10	1.64
	Rental Income	0.35	0.12	0.00	0.01	0.48
	Wage	0.07	2.03	0.01	5.07	7.18
	Subtotal	**1.72**	**4.40**	**0.02**	**5.40**	**11.53**
ALL	**Total**	**8.26**	**5.52**	**0.27**	**5.84**	**19.89**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Maryland				
Frederick	34,951	4,369,448	514,537	4,883,985
Total	**34,951**	**4,369,448**	**514,537**	**4,883,985**
Total Study Region	**34,951**	**4,369,448**	**514,537**	**4,883,985**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_2

Flood Scenario: Multi

Print Date: Tuesday, August 3, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

HAZUS
EARTHQUAKE • WIND • FLOOD • TSUNAMI

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FEMA

RiskMAP
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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 128 square miles and contains 1,470 census blocks. The region contains over 13 thousand households and has a total population of 39,698 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 14,322 buildings in the region with a total building replacement value (excluding contents) of 6,331 million dollars. Approximately 92.32% of the buildings (and 82.33% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 14,322 buildings in the region which have an aggregate total replacement value of 6,331 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	5,212,418	82.3%
Commercial	386,876	6.1%
Industrial	595,666	9.4%
Agricultural	33,020	0.5%
Religion	58,625	0.9%
Government	25,544	0.4%
Education	18,866	0.3%
Total	**6,331,015**	**100%**

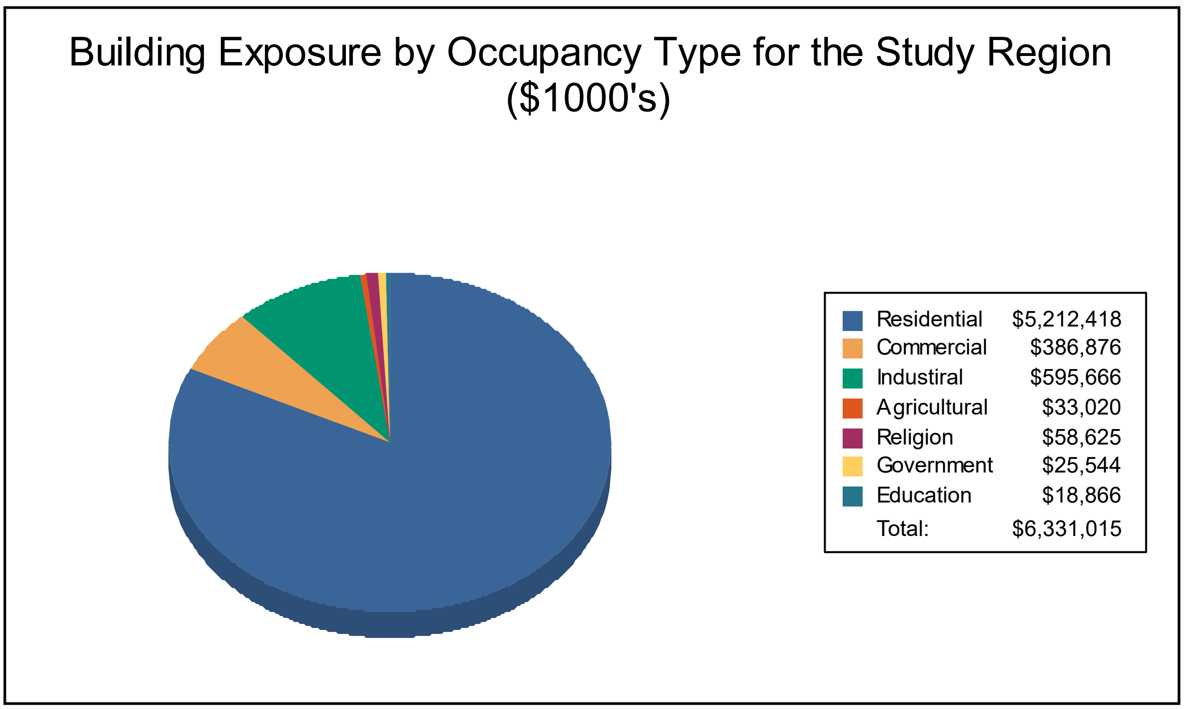
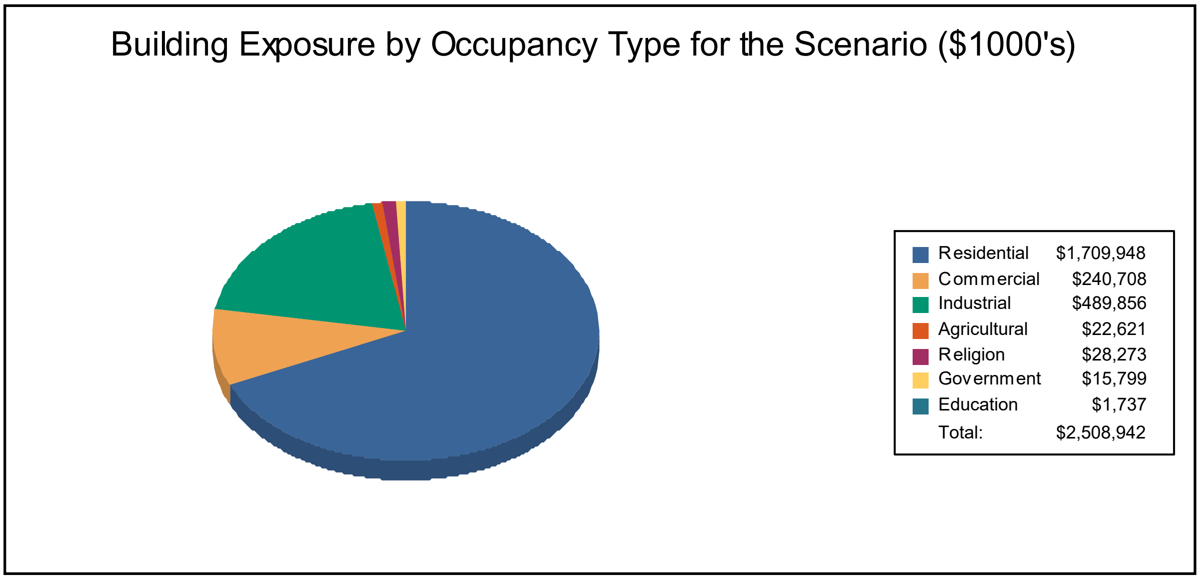


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,709,948	68.2%
Commercial	240,708	9.6%
Industrial	489,856	19.5%
Agricultural	22,621	0.9%
Religion	28,273	1.1%
Government	15,799	0.6%
Education	1,737	0.1%
Total	**2,508,942**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

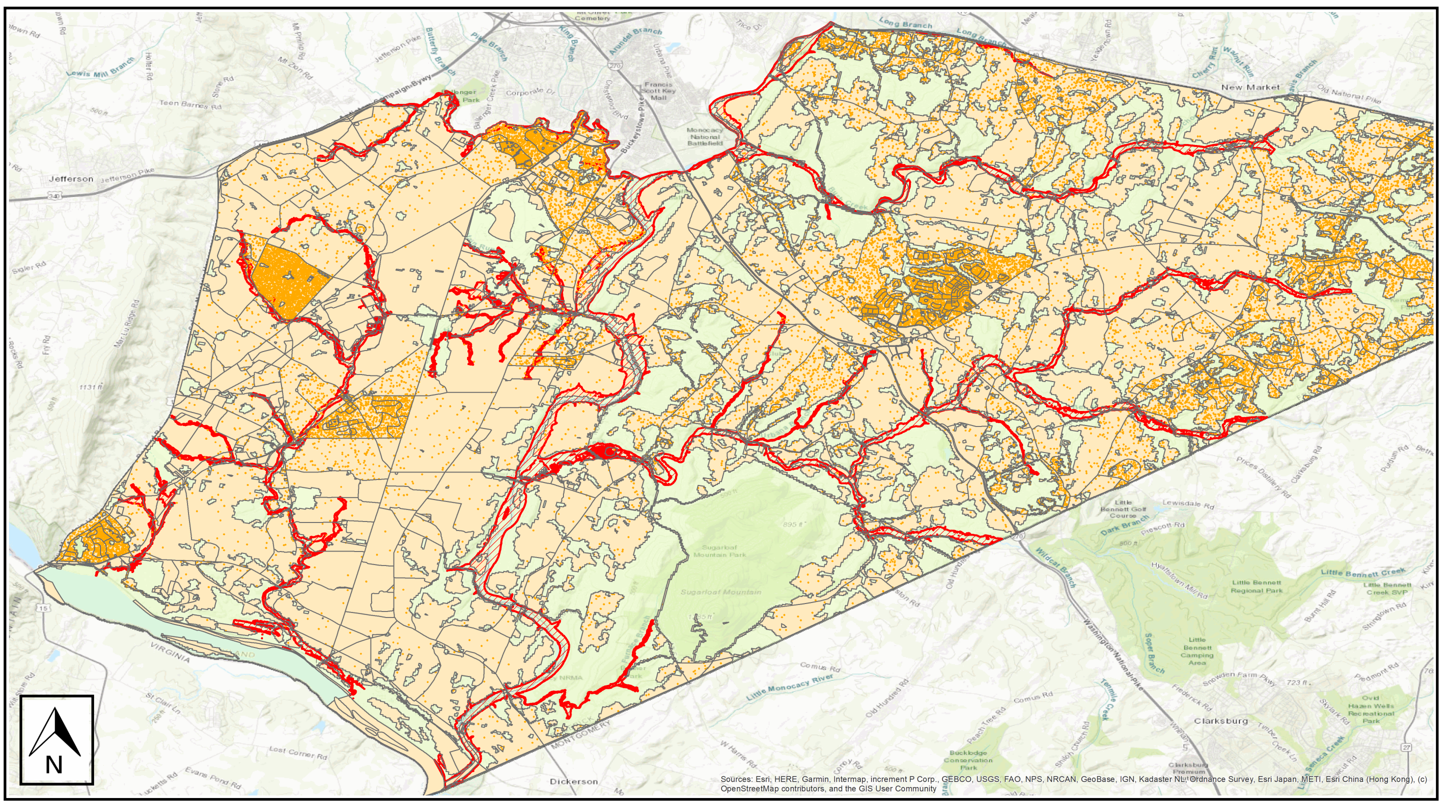
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_2
Scenario Name:	Multi
Return Period Analyzed:	10
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 65 buildings will be at least moderately damaged. This is over 56% of the total number of buildings in the scenario. There are an estimated 5 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

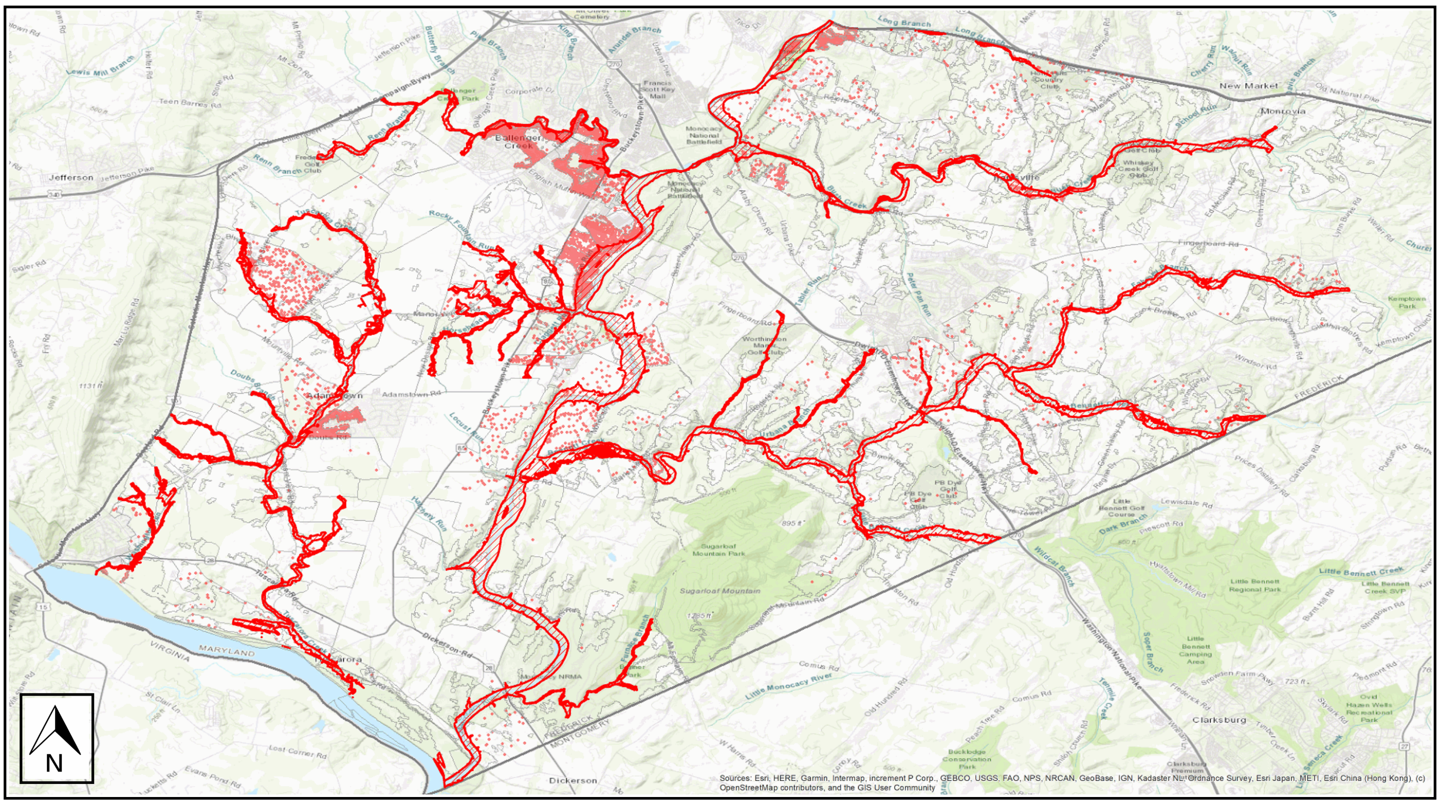


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	12	16	25	32	15	19	12	16	8	10	5	6
Total	**12**		**25**		**15**		**12**		**8**		**5**	

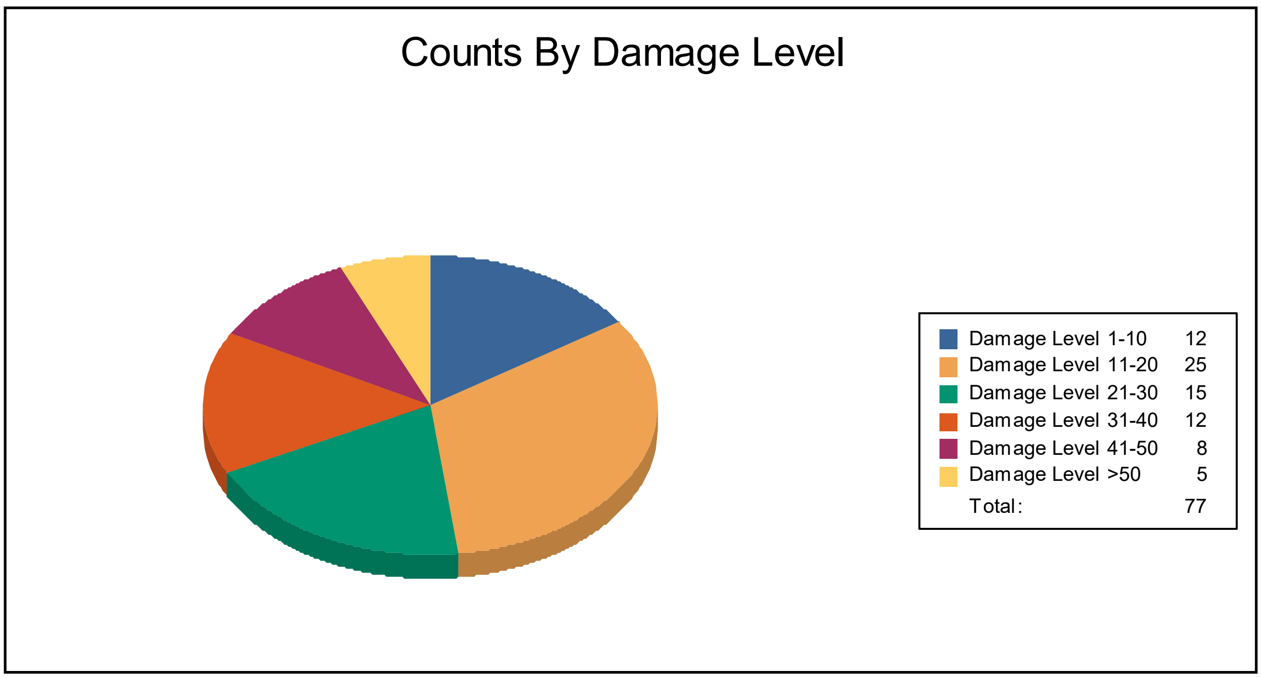


Table 4: Expected Building Damage by Building Type

Building Type	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	>50 Count	>50 (%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	3	14	6	29	5	24	4	19	3	14	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	9	16	19	34	10	18	8	14	5	9	5	9

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

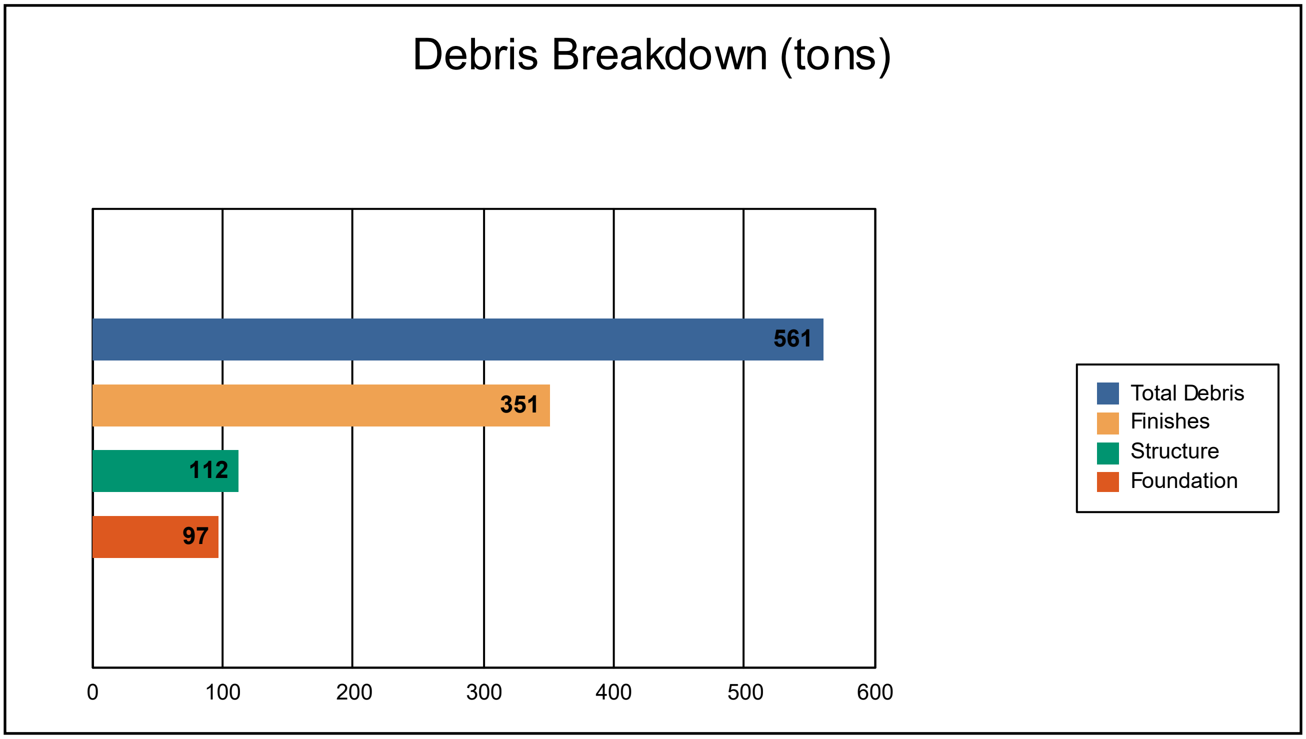
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

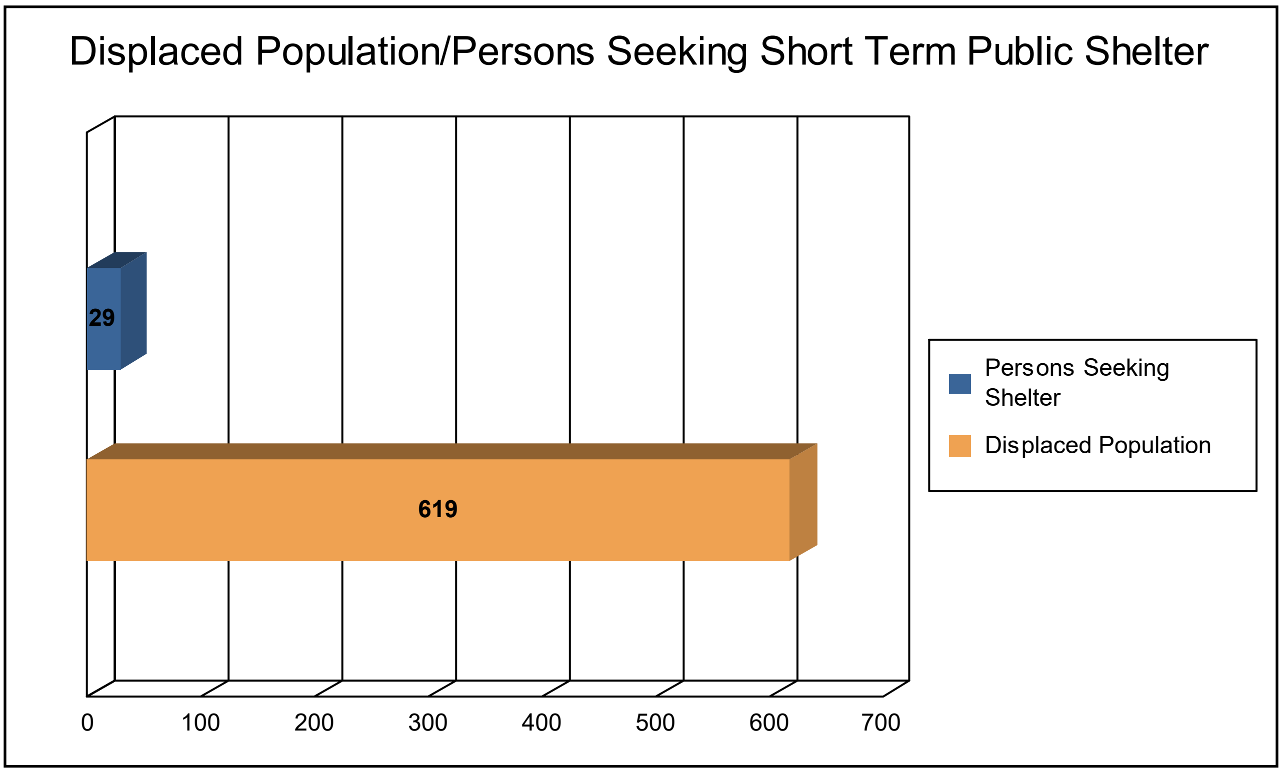


The model estimates that a total of 561 tons of debris will be generated. Of the total amount, Finishes comprises 63% of the total, Structure comprises 20% of the total, and Foundation comprises 17%. If the debris tonnage is converted into an estimated number of truckloads, it will require 23 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 206 households (or 619 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 29 people (out of a total population of 39,698) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 58.29 million dollars, which represents 2.32 % of the total replacement value of the scenario buildings.

Building-Related Losses

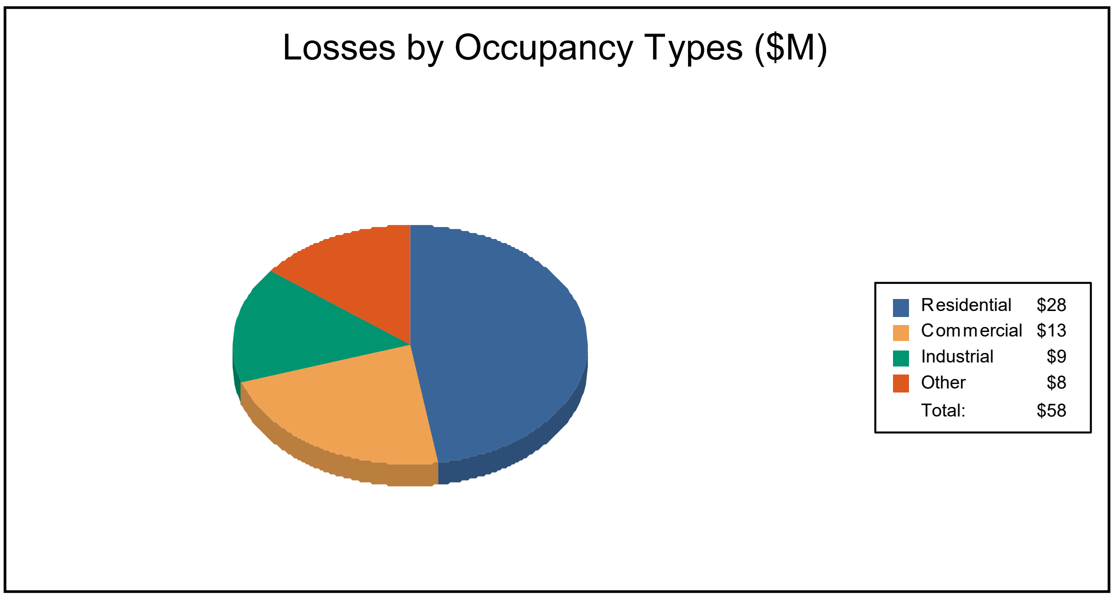
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 38.97 million dollars. 33% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 47.54% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	14.84	1.48	1.95	0.43	18.69
	Content	7.89	4.08	5.34	1.93	19.23
	Inventory	0.00	0.10	0.83	0.12	1.05
	Subtotal	**22.72**	**5.65**	**8.11**	**2.48**	**38.97**
Business Interruption						
	Income	0.19	3.38	0.32	0.53	4.41
	Relocation	3.17	0.55	0.20	0.12	4.03
	Rental Income	1.19	0.41	0.04	0.00	1.64
	Wage	0.45	3.16	0.33	5.30	9.24
	Subtotal	**4.99**	**7.50**	**0.88**	**5.95**	**19.32**
ALL	**Total**	**27.71**	**13.15**	**9.00**	**8.43**	**58.29**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Maryland				
Frederick	39,698	5,212,418	1,118,597	6,331,015
Total	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**
Total Study Region	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_3

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 73 square miles and contains 2,890 census blocks. The region contains over 41 thousand households and has a total population of 106,724 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 36,786 buildings in the region with a total building replacement value (excluding contents) of 15,635 million dollars. Approximately 90.42% of the buildings (and 78.16% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 36,786 buildings in the region which have an aggregate total replacement value of 15,635 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	12,220,022	78.2%
Commercial	2,296,995	14.7%
Industrial	454,425	2.9%
Agricultural	26,557	0.2%
Religion	222,953	1.4%
Government	170,628	1.1%
Education	243,455	1.6%
Total	**15,635,035**	**100%**

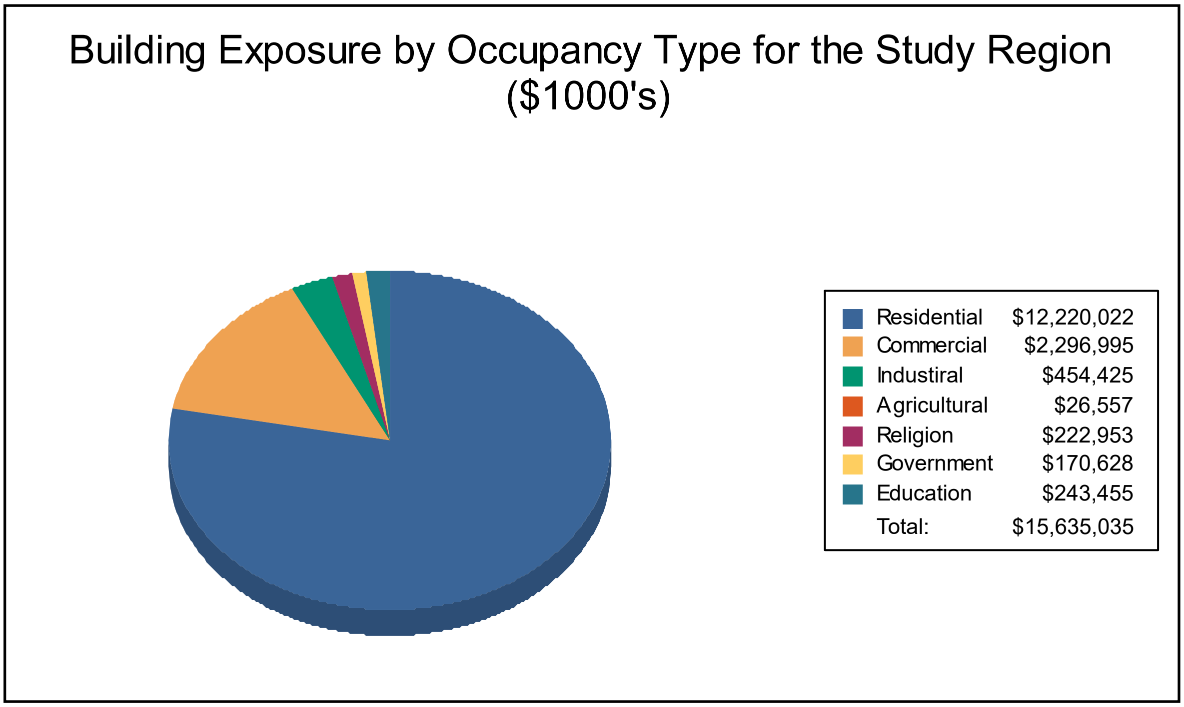
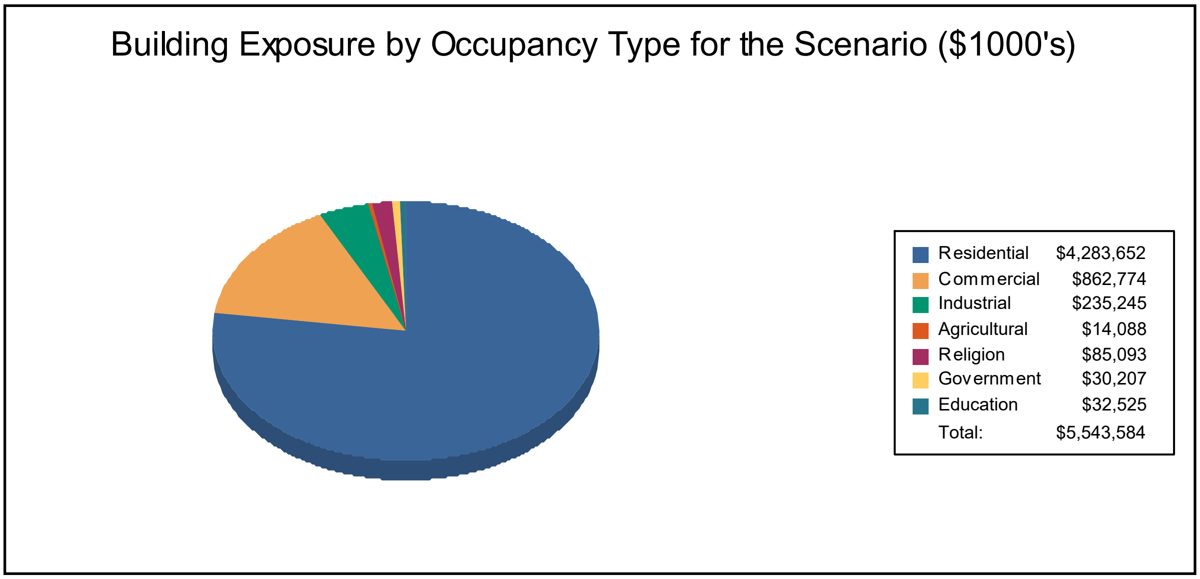


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,283,652	77.3%
Commercial	862,774	15.6%
Industrial	235,245	4.2%
Agricultural	14,088	0.3%
Religion	85,093	1.5%
Government	30,207	0.5%
Education	32,525	0.6%
Total	**5,543,584**	**100%**



Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 48 schools, 10 fire stations, 7 police stations and 2 emergency operation centers.

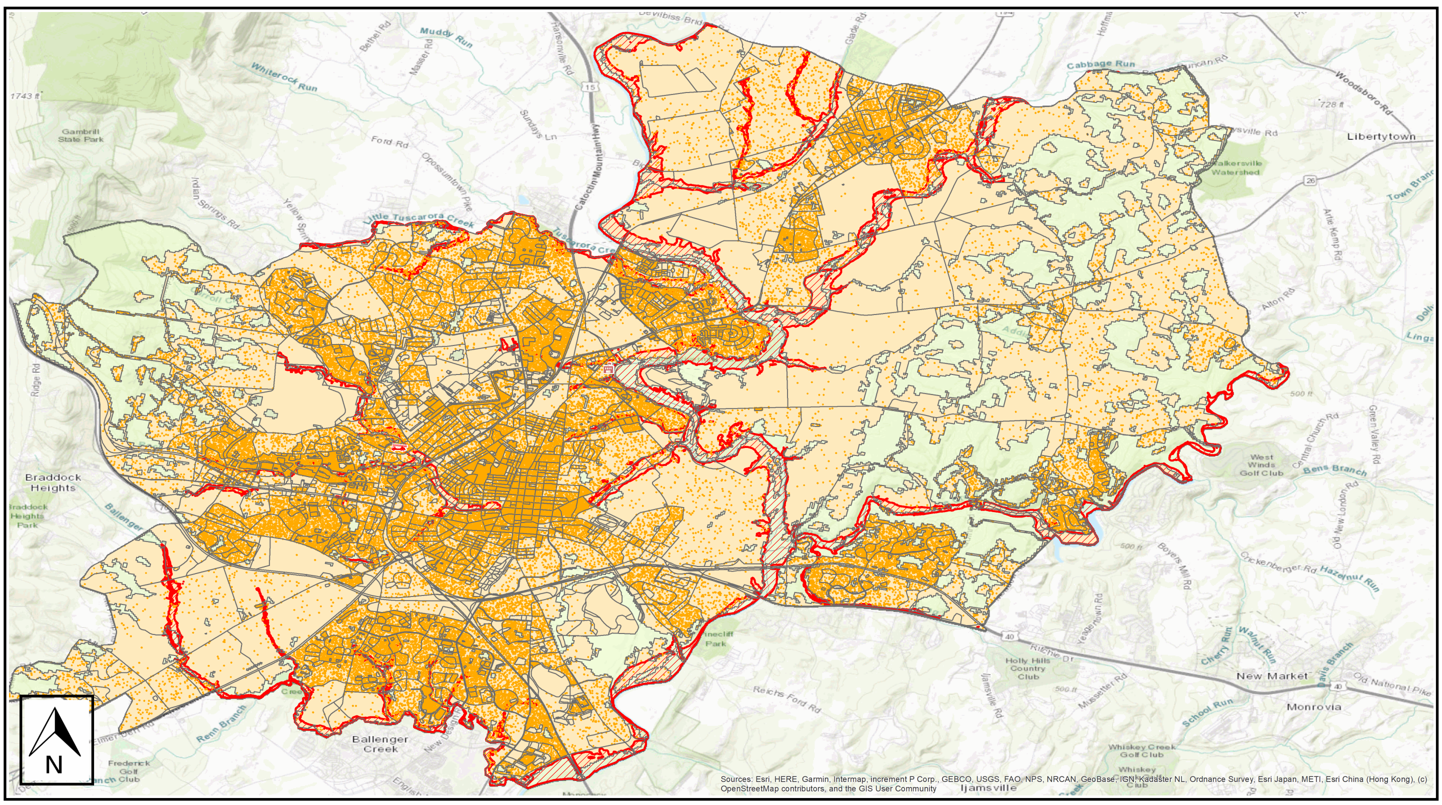
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_3
Scenario Name:	Multi
Return Period Analyzed:	10
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 218 buildings will be at least moderately damaged. This is over 55% of the total number of buildings in the scenario. There are an estimated 35 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

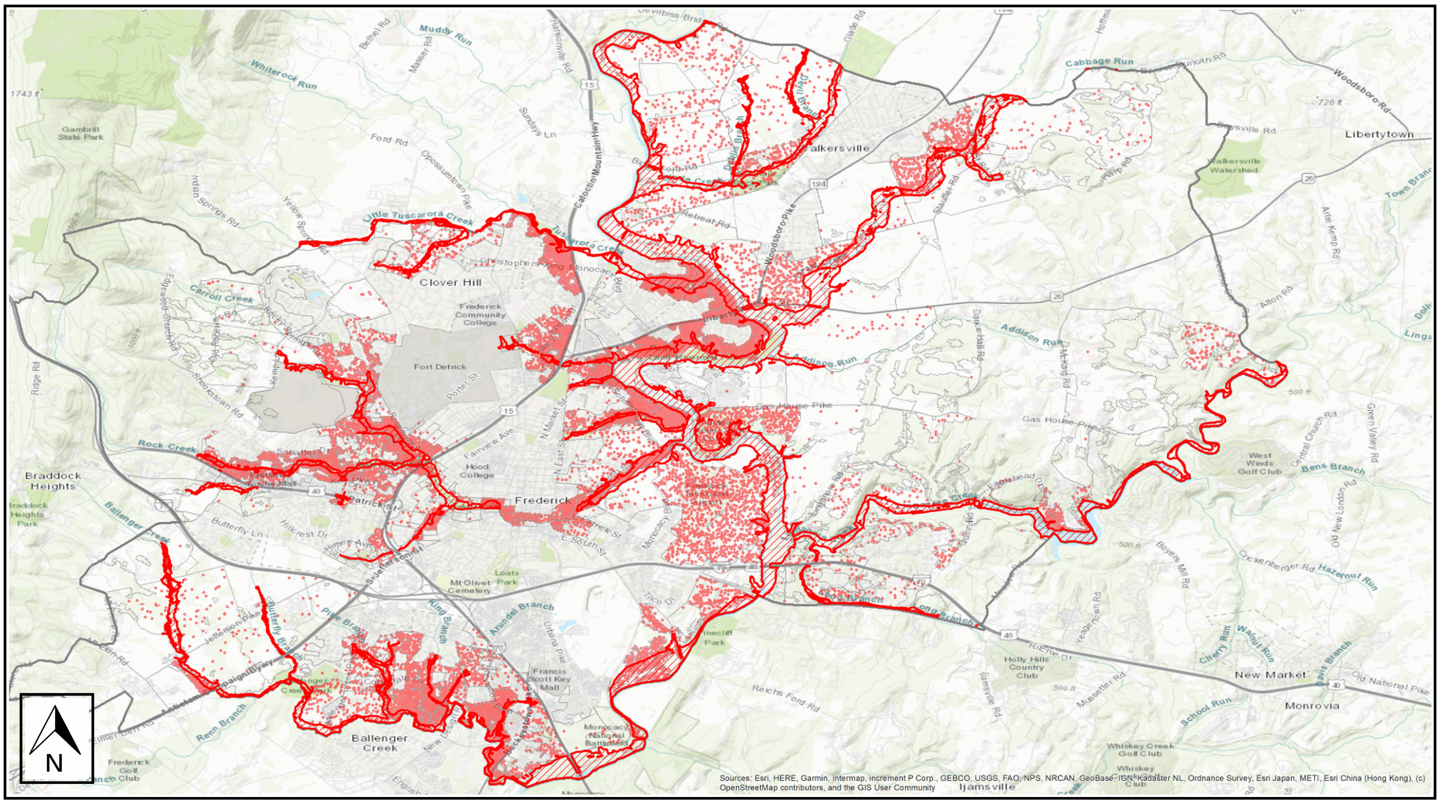


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	2	100	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	82	28	105	35	40	13	23	8	13	4	35	12
Total	**82**		**107**		**40**		**23**		**13**		**35**	

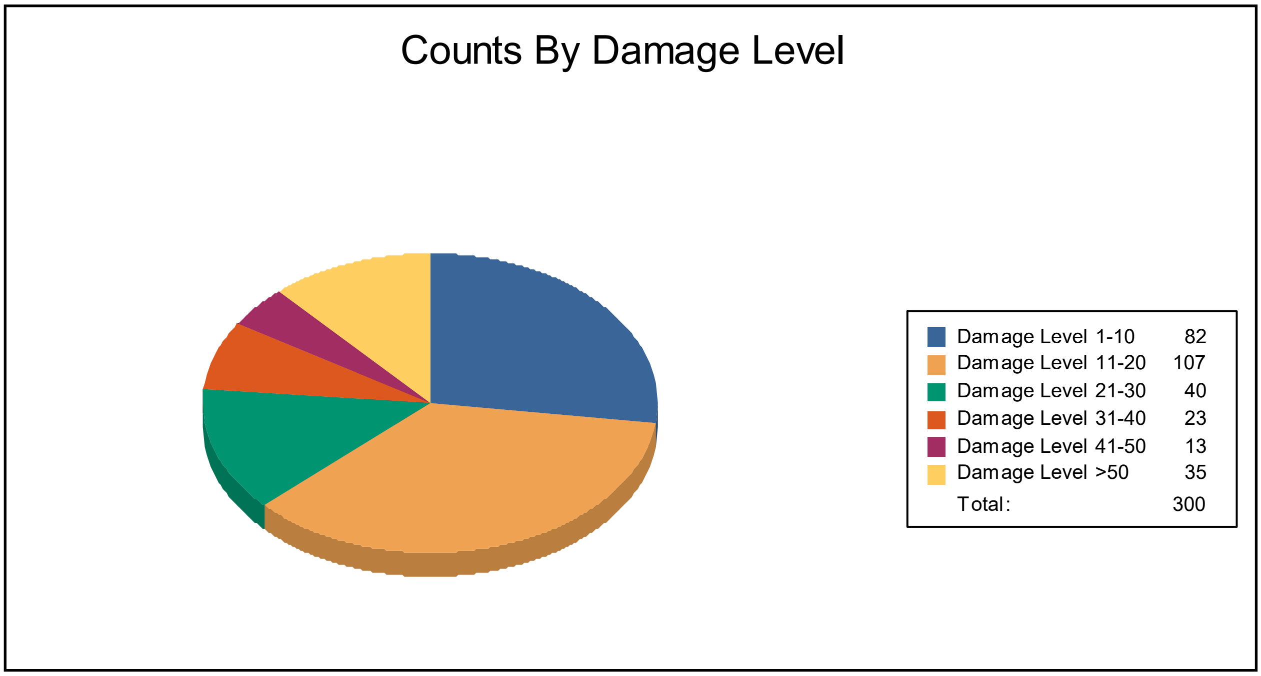


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	21	27	26	33	12	15	5	6	4	5	11	14
Steel	0	0	1	100	0	0	0	0	0	0	0	0
Wood	61	28	79	36	28	13	18	8	9	4	24	11

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 308 hospital beds available for use. On the day of the scenario flood event, the model estimates that 308 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	2	0	0	0
Fire Stations	10	0	0	0
Hospitals	1	0	0	0
Police Stations	7	0	0	0
Schools	48	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

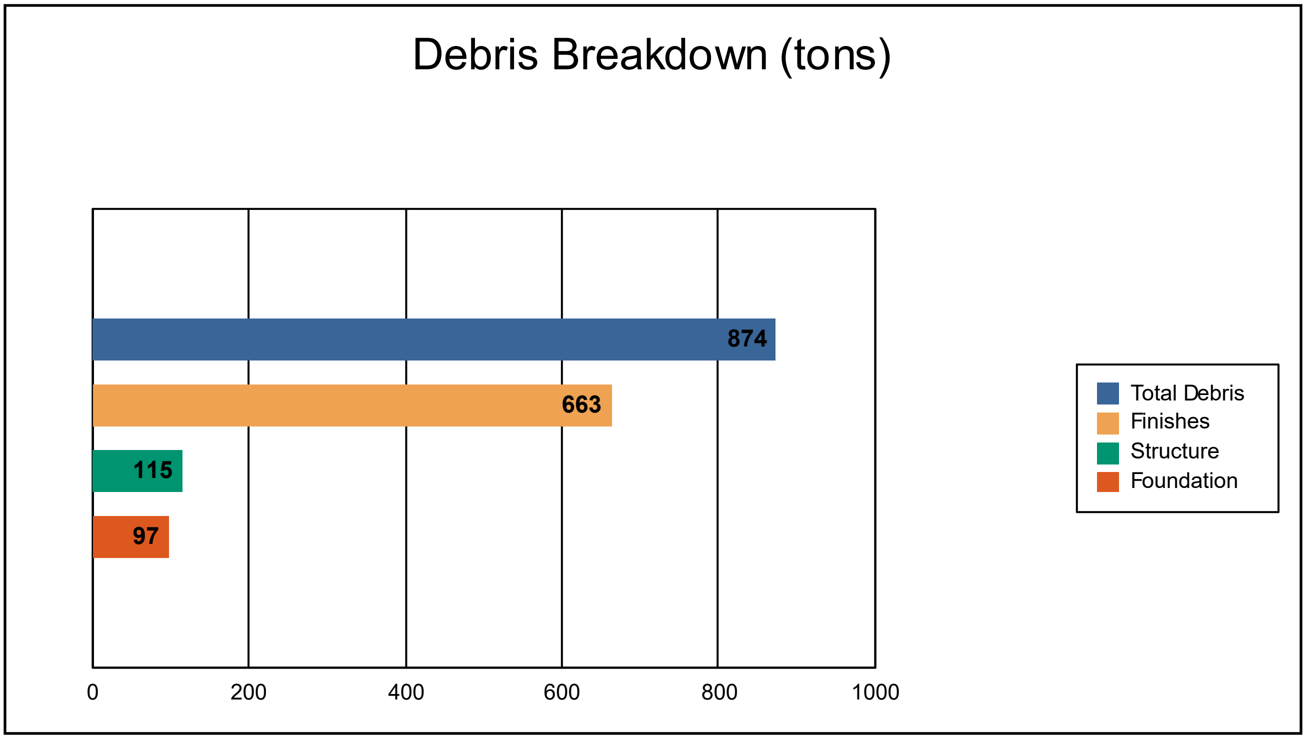
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

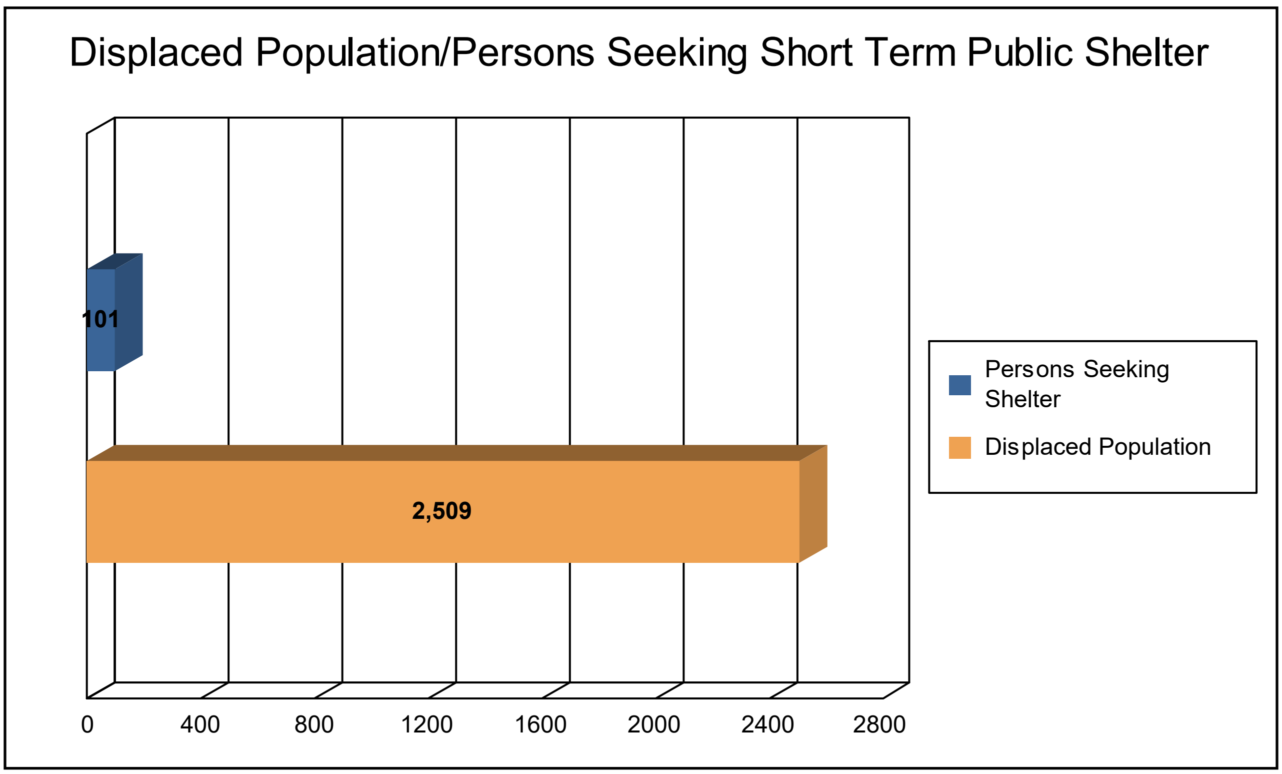


The model estimates that a total of 874 tons of debris will be generated. Of the total amount, Finishes comprises 76% of the total, Structure comprises 13% of the total, and Foundation comprises 11%. If the debris tonnage is converted into an estimated number of truckloads, it will require 35 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 836 households (or 2,509 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 101 people (out of a total population of 106,724) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 244.49 million dollars, which represents 4.41 % of the total replacement value of the scenario buildings.

Building-Related Losses

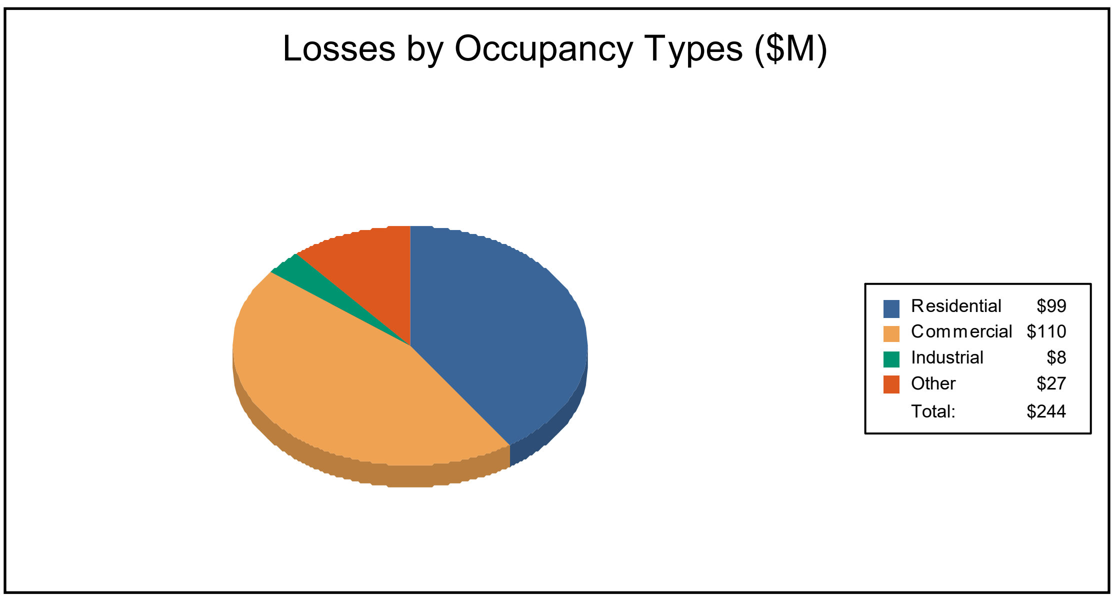
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 134.75 million dollars. 45% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 40.58% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	49.23	12.24	2.28	0.91	64.66
	Content	26.93	32.35	4.44	5.26	68.98
	Inventory	0.00	0.38	0.69	0.05	1.12
	Subtotal	**76.17**	**44.97**	**7.41**	**6.21**	**134.75**
Business Interruption						
	Income	0.89	27.47	0.15	2.10	30.61
	Relocation	14.23	6.52	0.15	0.92	21.81
	Rental Income	5.81	4.52	0.03	0.15	10.51
	Wage	2.11	26.54	0.29	17.87	46.80
	Subtotal	**23.04**	**65.04**	**0.61**	**21.05**	**109.74**
ALL	**Total**	**99.20**	**110.01**	**8.02**	**27.25**	**244.49**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Frederick	106,724	12,220,022	3,415,013	15,635,035
Total	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**
Total Study Region	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_4

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 138 square miles and contains 1,074 census blocks. The region contains over 9 thousand households and has a total population of 27,180 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 10,335 buildings in the region with a total building replacement value (excluding contents) of 3,945 million dollars. Approximately 91.67% of the buildings (and 88.71% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 10,335 buildings in the region which have an aggregate total replacement value of 3,945 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	3,499,625	88.7%
Commercial	238,367	6.0%
Industrial	89,655	2.3%
Agricultural	29,561	0.7%
Religion	45,679	1.2%
Government	5,013	0.1%
Education	37,265	0.9%
Total	**3,945,165**	**100%**

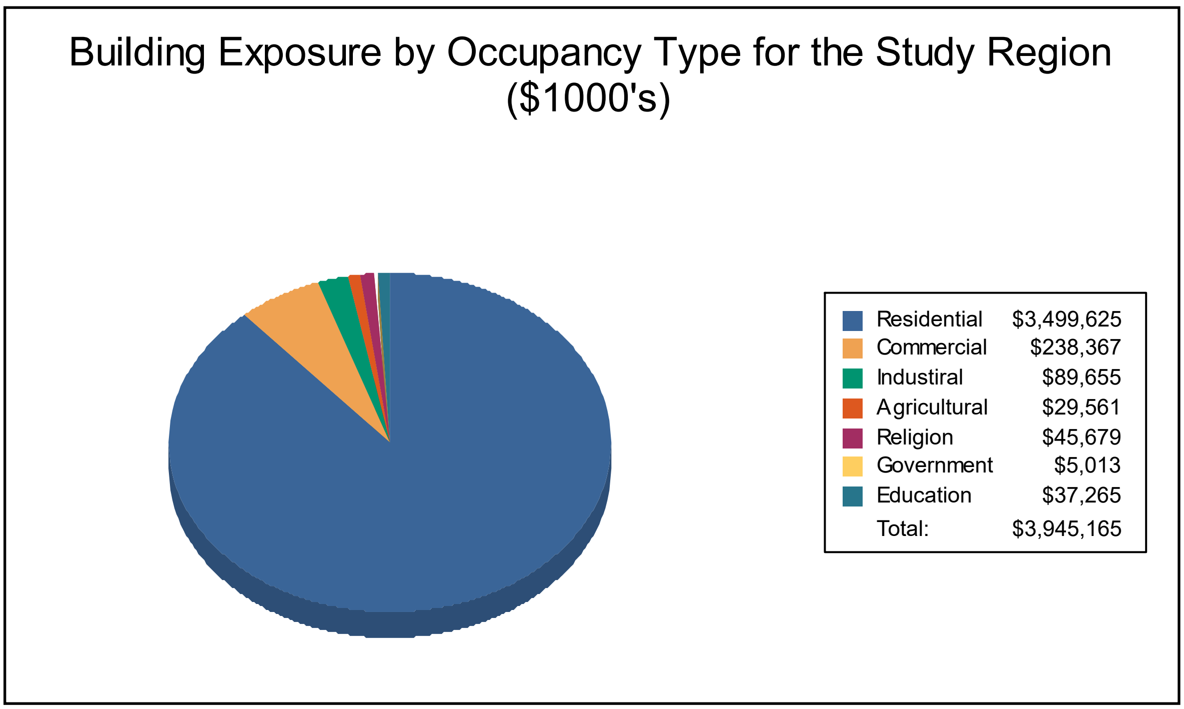
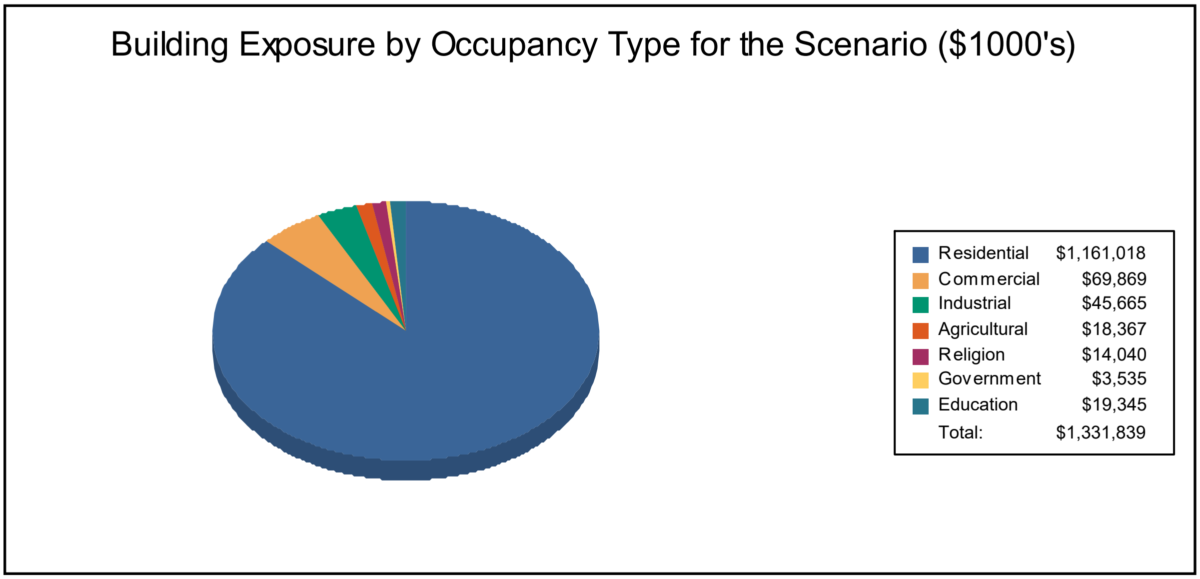


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,161,018	87.2%
Commercial	69,869	5.2%
Industrial	45,665	3.4%
Agricultural	18,367	1.4%
Religion	14,040	1.1%
Government	3,535	0.3%
Education	19,345	1.5%
Total	**1,331,839**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

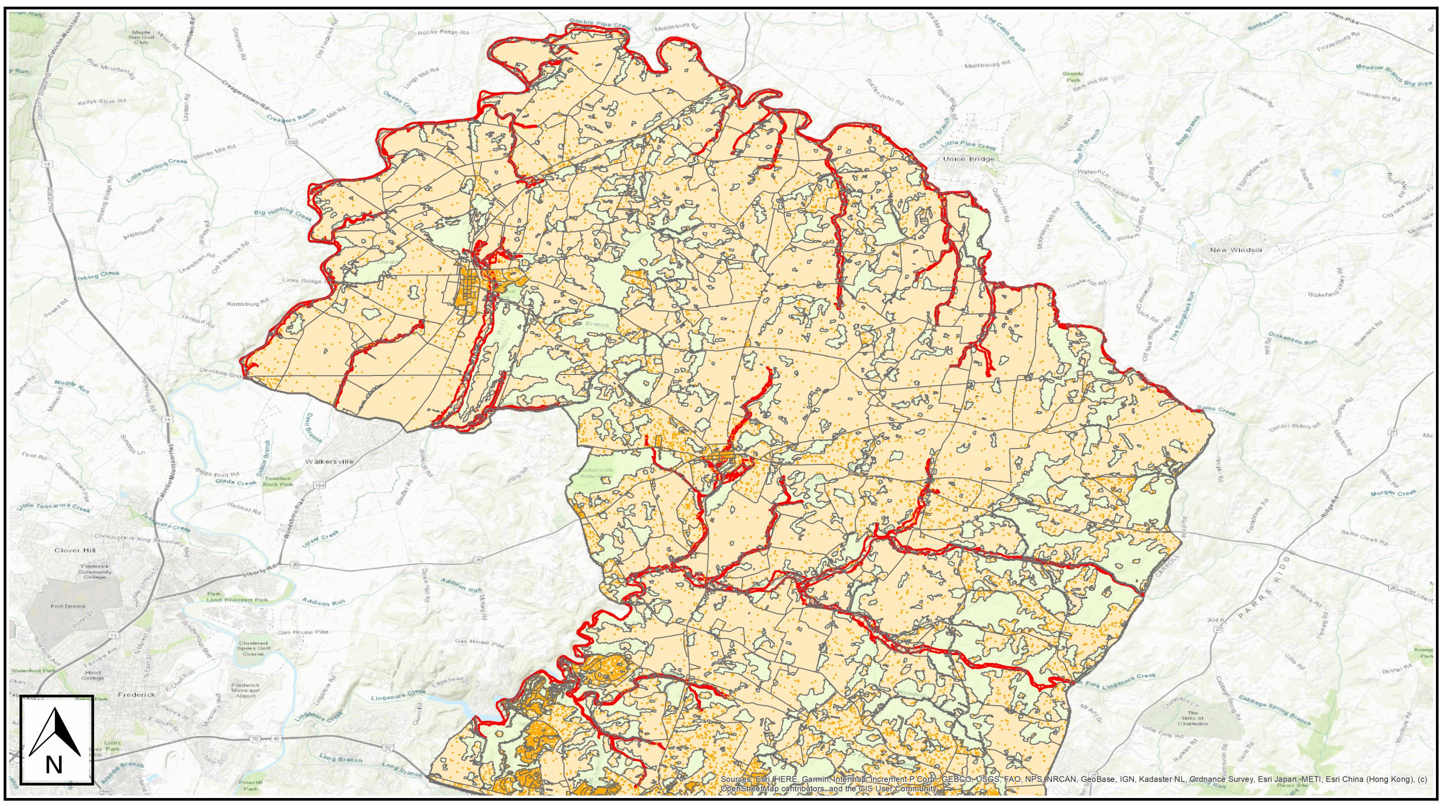
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_4
Scenario Name:	Multi
Return Period Analyzed:	10
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 10 buildings will be at least moderately damaged. This is over 54% of the total number of buildings in the scenario. There are an estimated 1 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

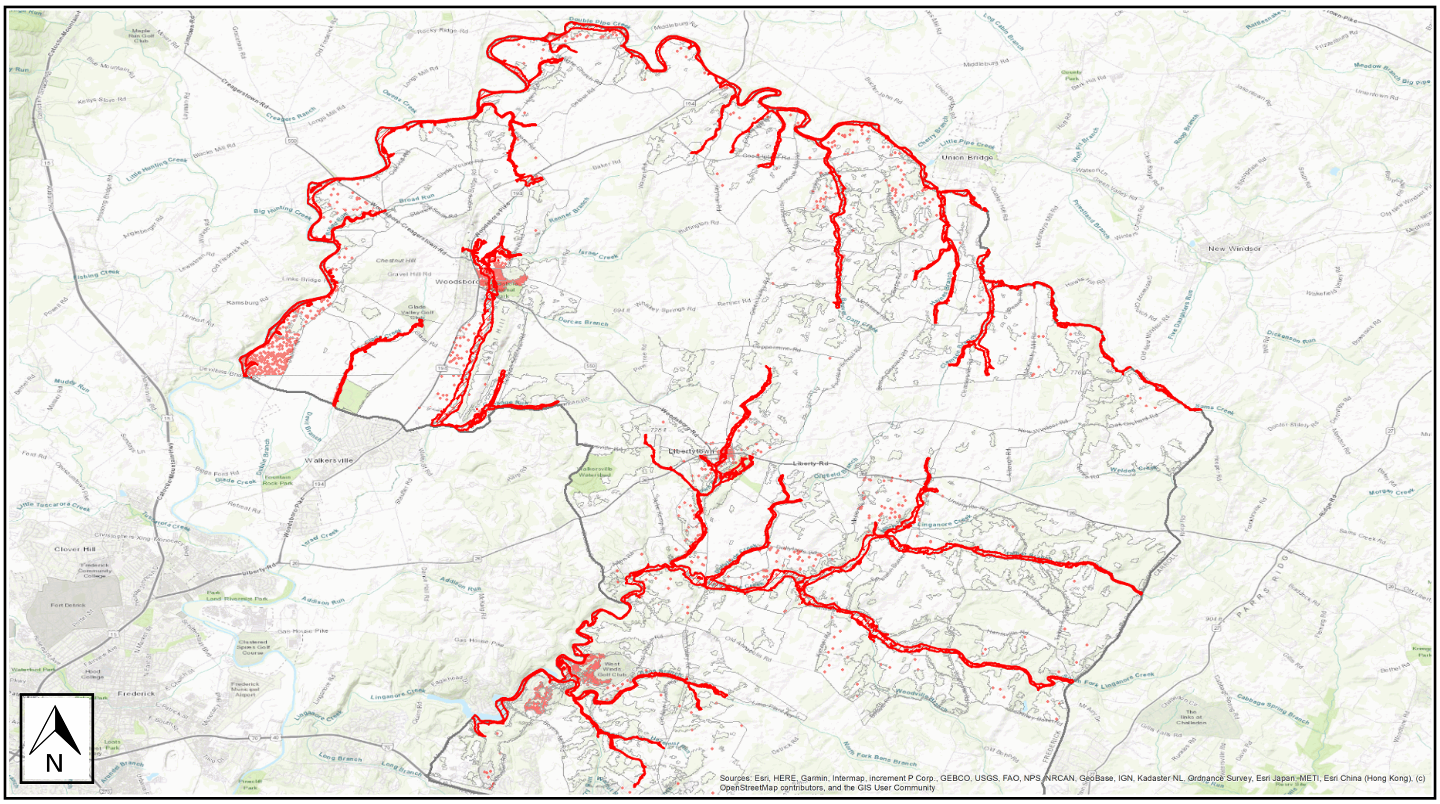


Table 3: Expected Building Damage by Occupancy

Occupancy	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	>50 Count	>50 (%)
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	1	9	4	36	2	18	2	18	1	9	1	9
Total	**1**		**4**		**2**		**2**		**1**		**1**	

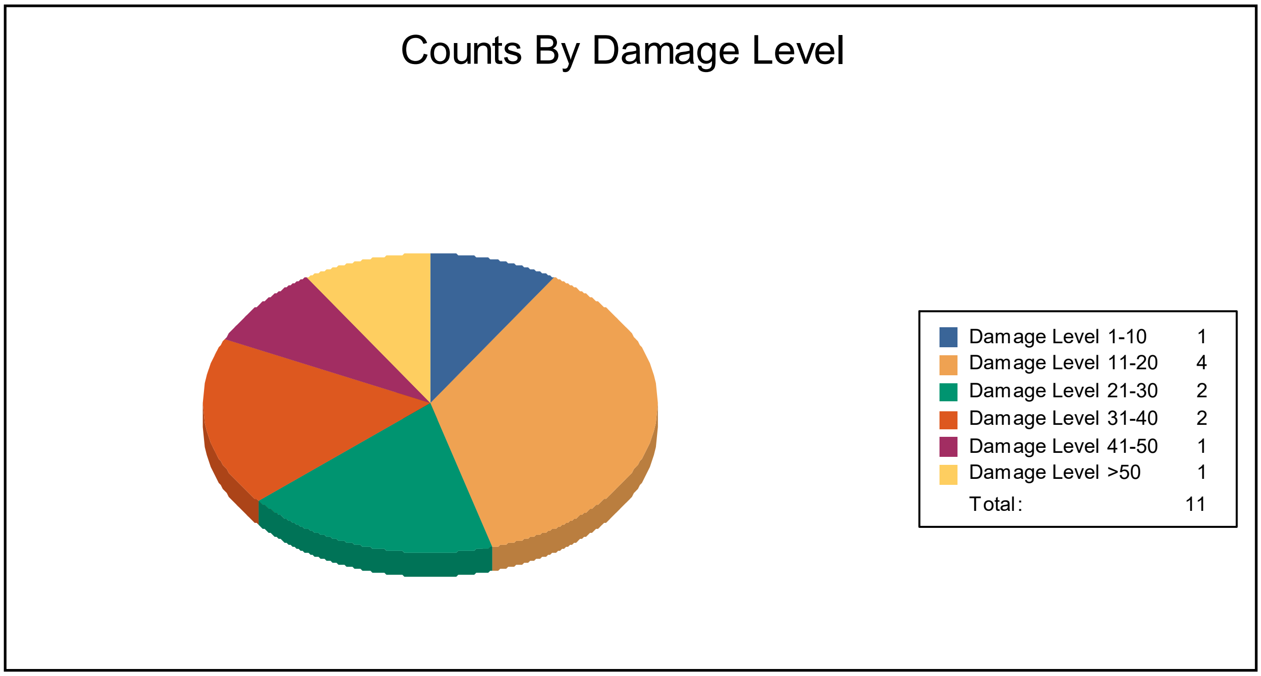


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	1	100	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	1	10	3	30	2	20	2	20	1	10	1	10

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

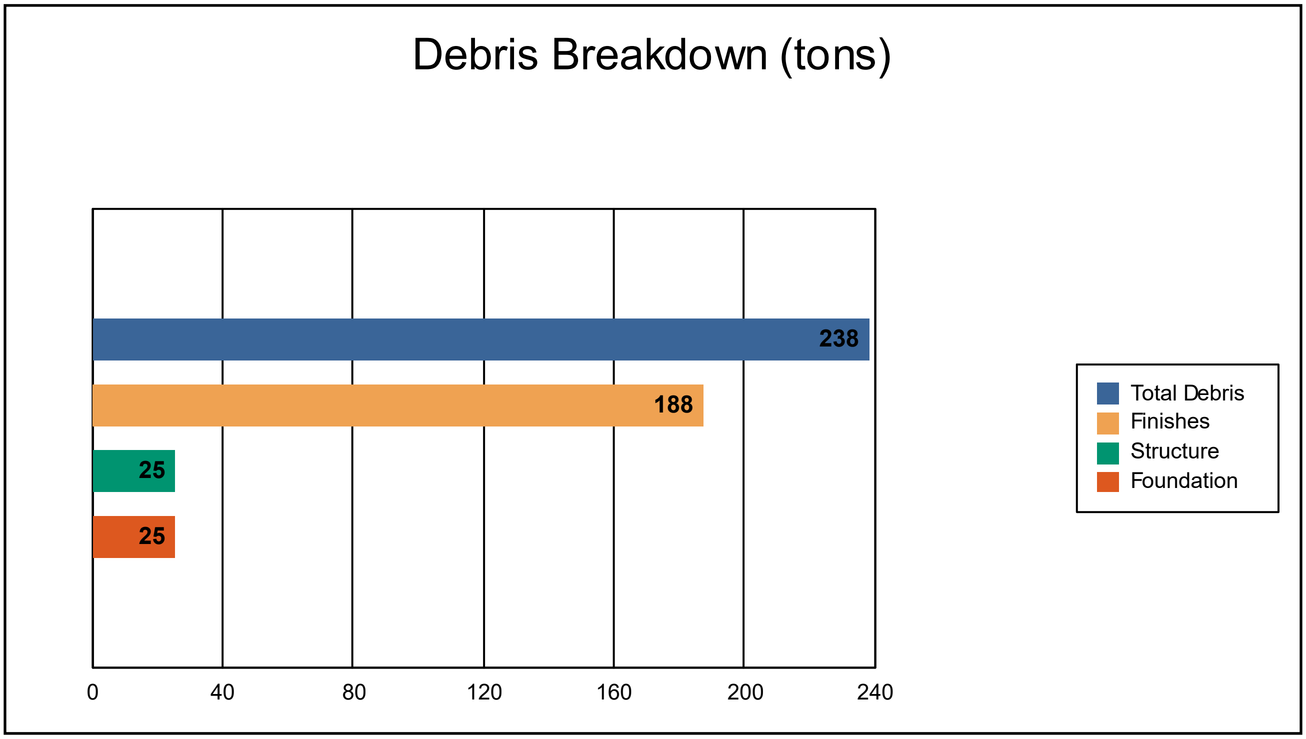
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

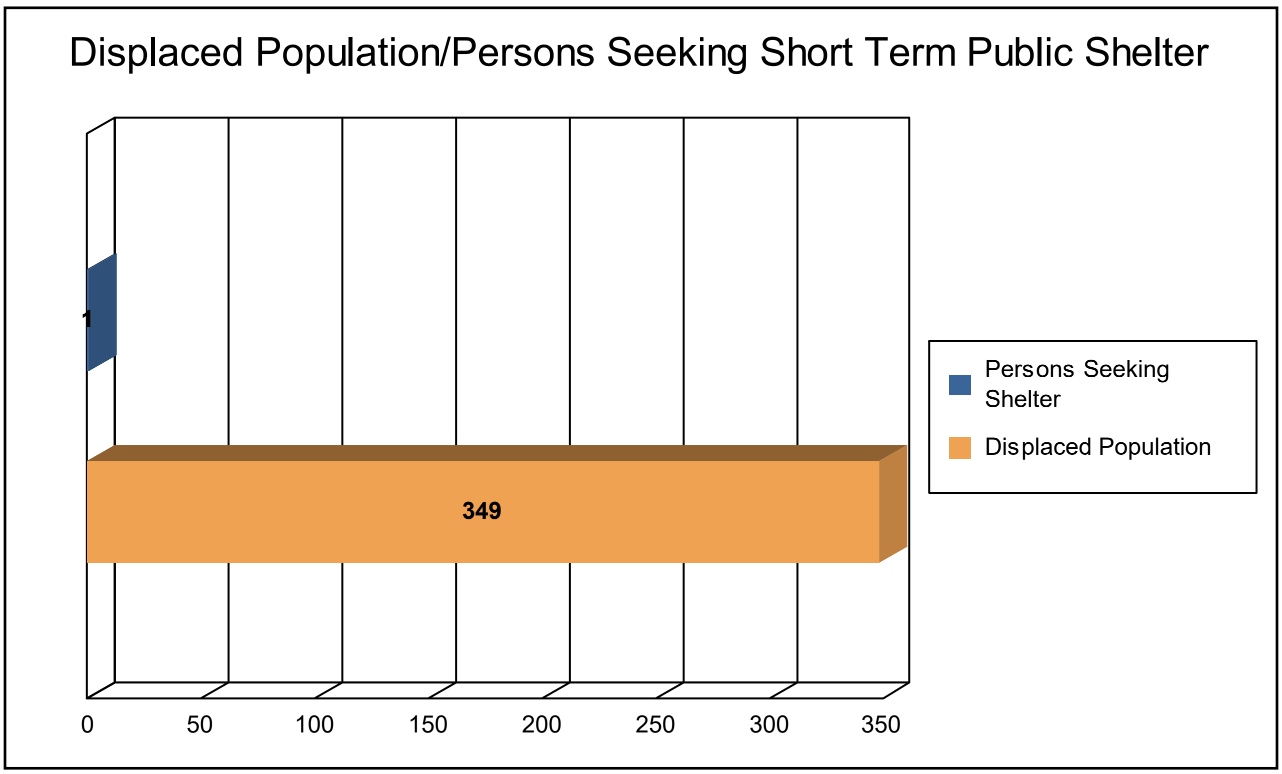


The model estimates that a total of 238 tons of debris will be generated. Of the total amount, Finishes comprises 79% of the total, Structure comprises 11% of the total, and Foundation comprises 11%. If the debris tonnage is converted into an estimated number of truckloads, it will require 10 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 116 households (or 349 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1 people (out of a total population of 27,180) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 23.20 million dollars, which represents 1.74 % of the total replacement value of the scenario buildings.

Building-Related Losses

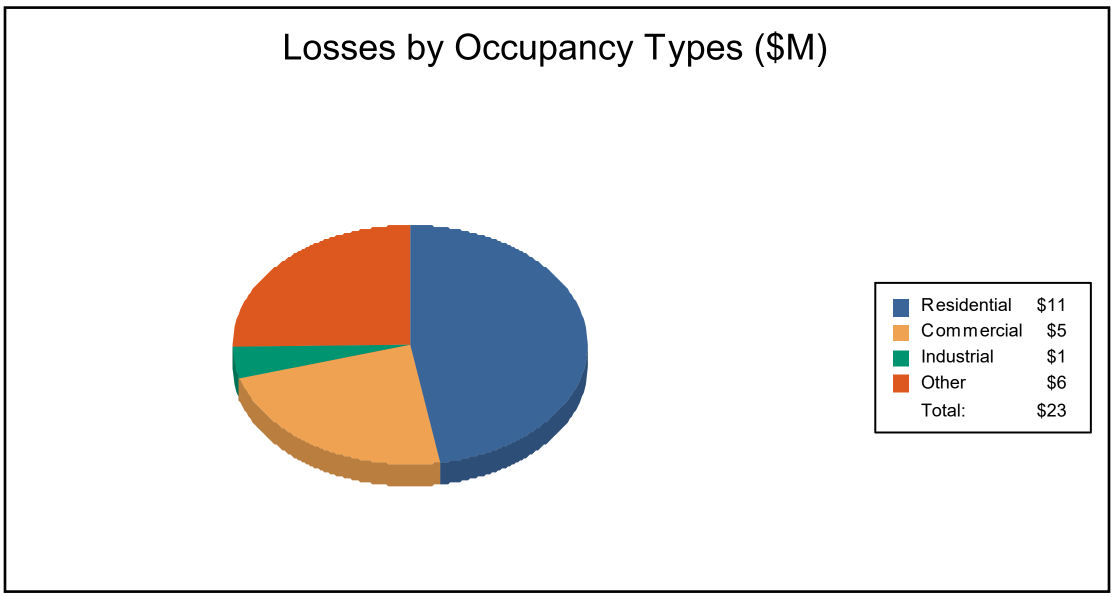
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 12.48 million dollars. 46% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 47.11% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	5.86	0.30	0.27	0.17	6.61
	Content	3.01	1.11	0.55	1.10	5.76
	Inventory	0.00	0.01	0.10	0.00	0.11
	Subtotal	**8.87**	**1.42**	**0.92**	**1.28**	**12.48**
Business Interruption						
	Income	0.00	1.87	0.03	0.62	2.51
	Relocation	1.62	0.21	0.02	0.24	2.10
	Rental Income	0.44	0.15	0.00	0.02	0.61
	Wage	0.00	1.78	0.04	3.69	5.51
	Subtotal	**2.06**	**4.01**	**0.09**	**4.56**	**10.72**
ALL	**Total**	**10.93**	**5.43**	**1.01**	**5.83**	**23.20**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	27,180	3,499,625	445,540	3,945,165
Total	**27,180**	**3,499,625**	**445,540**	**3,945,165**
Total Study Region	**27,180**	**3,499,625**	**445,540**	**3,945,165**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_5

Flood Scenario: Multi

Print Date: Thursday, August 5, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 173 square miles and contains 1,430 census blocks. The region contains over 9 thousand households and has a total population of 24,832 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 9,774 buildings in the region with a total building replacement value (excluding contents) of 3,437 million dollars. Approximately 90.65% of the buildings (and 84.66% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 9,774 buildings in the region which have an aggregate total replacement value of 3,437 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,909,982	84.7%
Commercial	227,400	6.6%
Industrial	98,717	2.9%
Agricultural	22,332	0.6%
Religion	118,912	3.5%
Government	39,615	1.2%
Education	20,149	0.6%
Total	**3,437,107**	**100%**

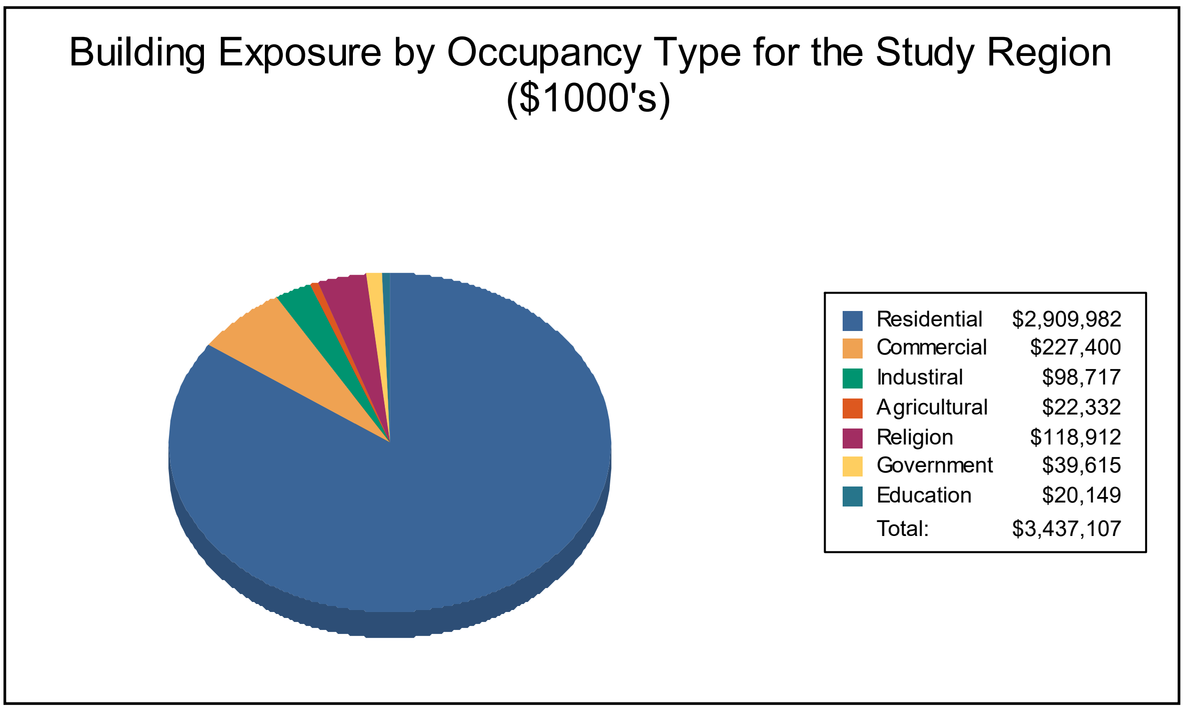
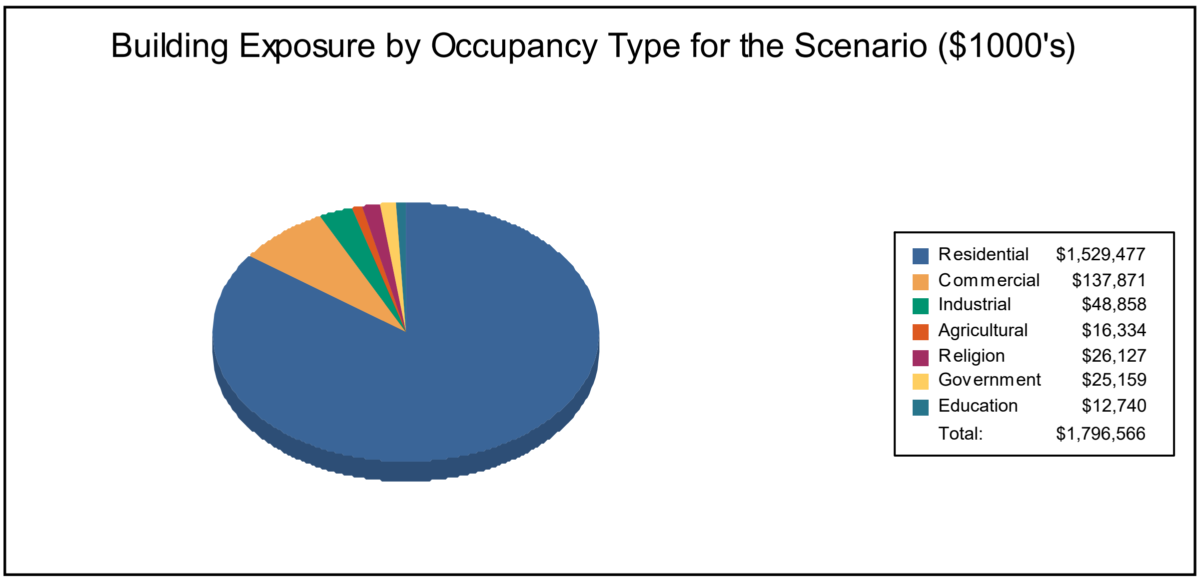


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,529,477	85.1%
Commercial	137,871	7.7%
Industrial	48,858	2.7%
Agricultural	16,334	0.9%
Religion	26,127	1.5%
Government	25,159	1.4%
Education	12,740	0.7%
Total	**1,796,566**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 11 schools, 7 fire stations, 2 police stations and no emergency operation centers.

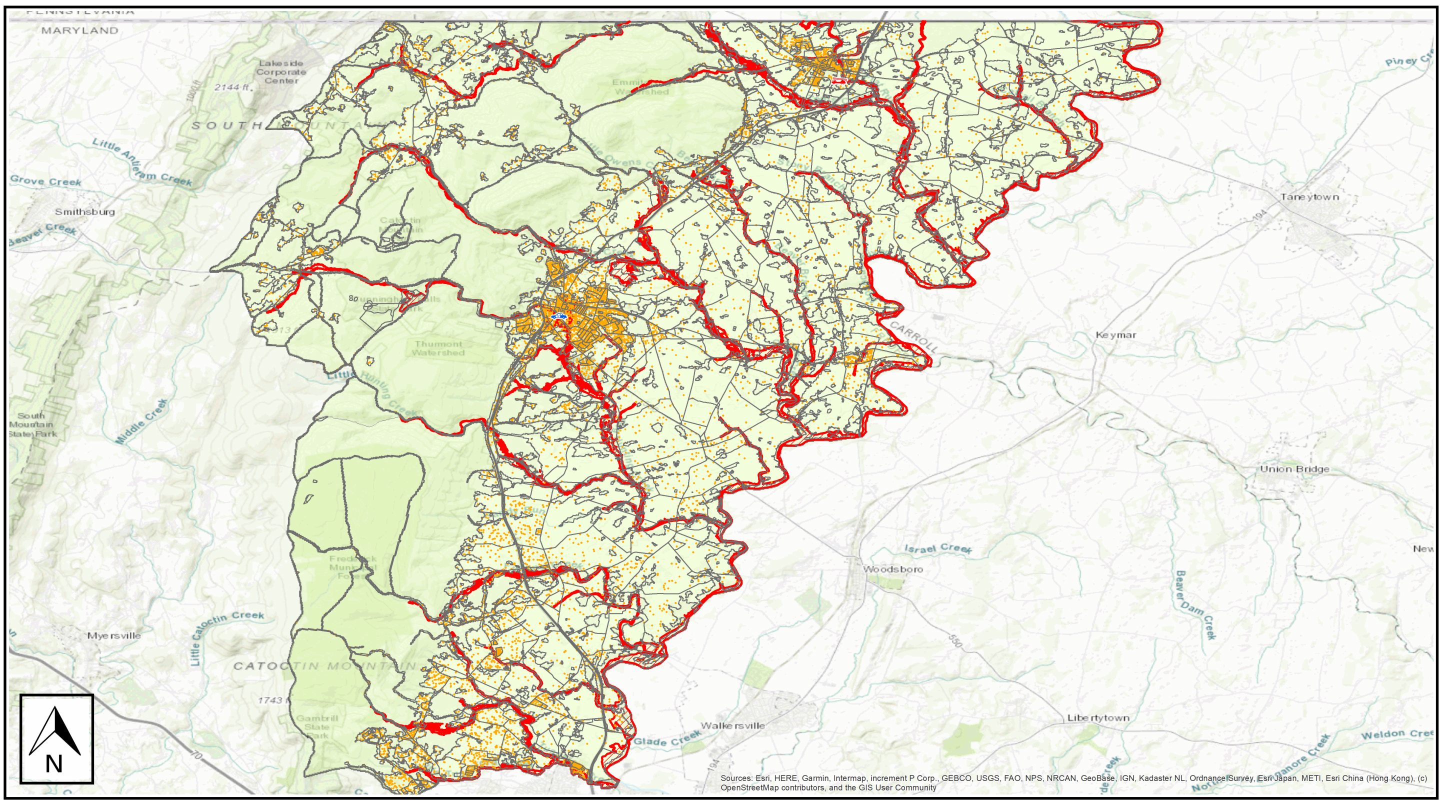
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_5
Scenario Name:	Multi
Return Period Analyzed:	10
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 5 buildings will be at least moderately damaged. This is over 43% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

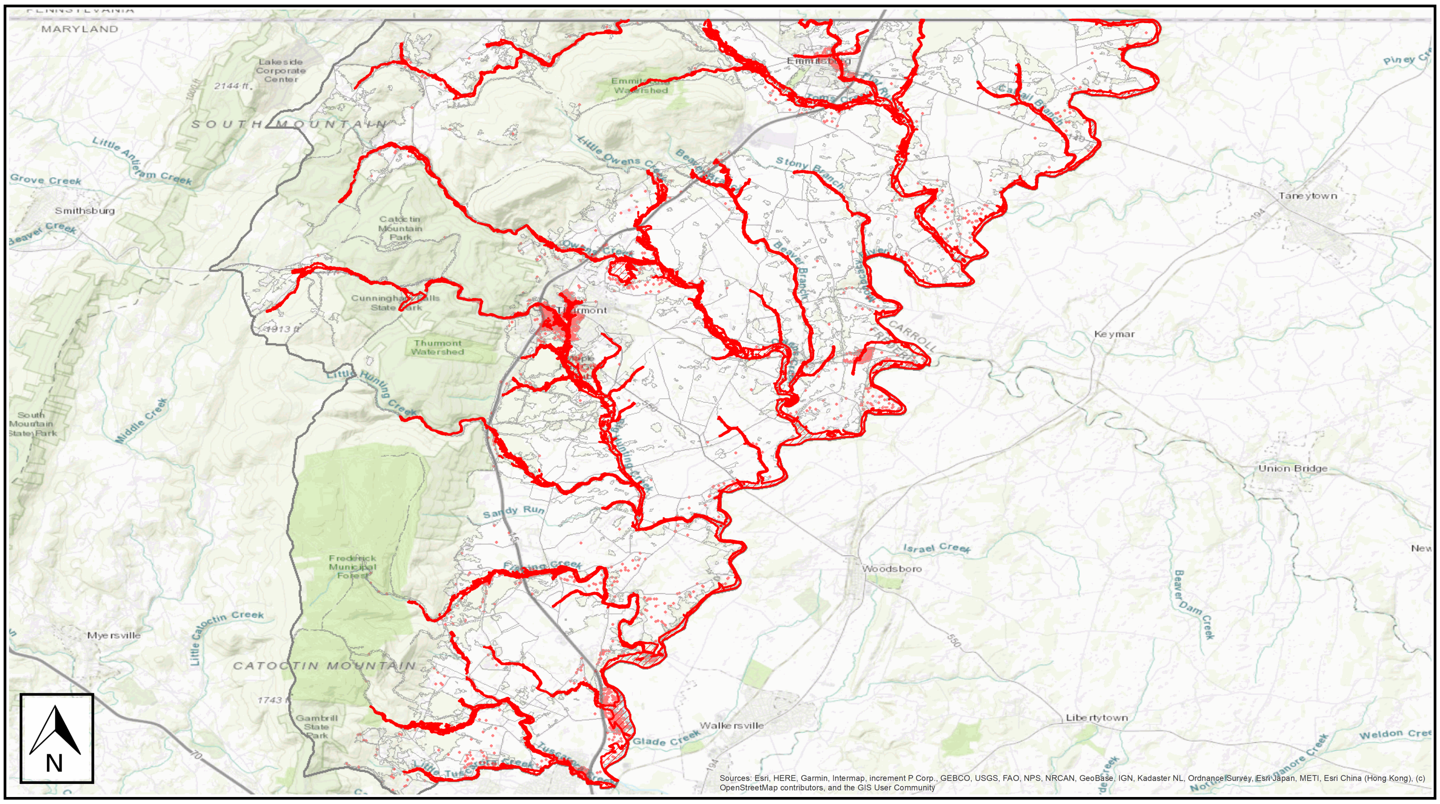


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	7	58	5	42	0	0	0	0	0	0	0	0
Total	**7**		**5**		**0**		**0**		**0**		**0**	

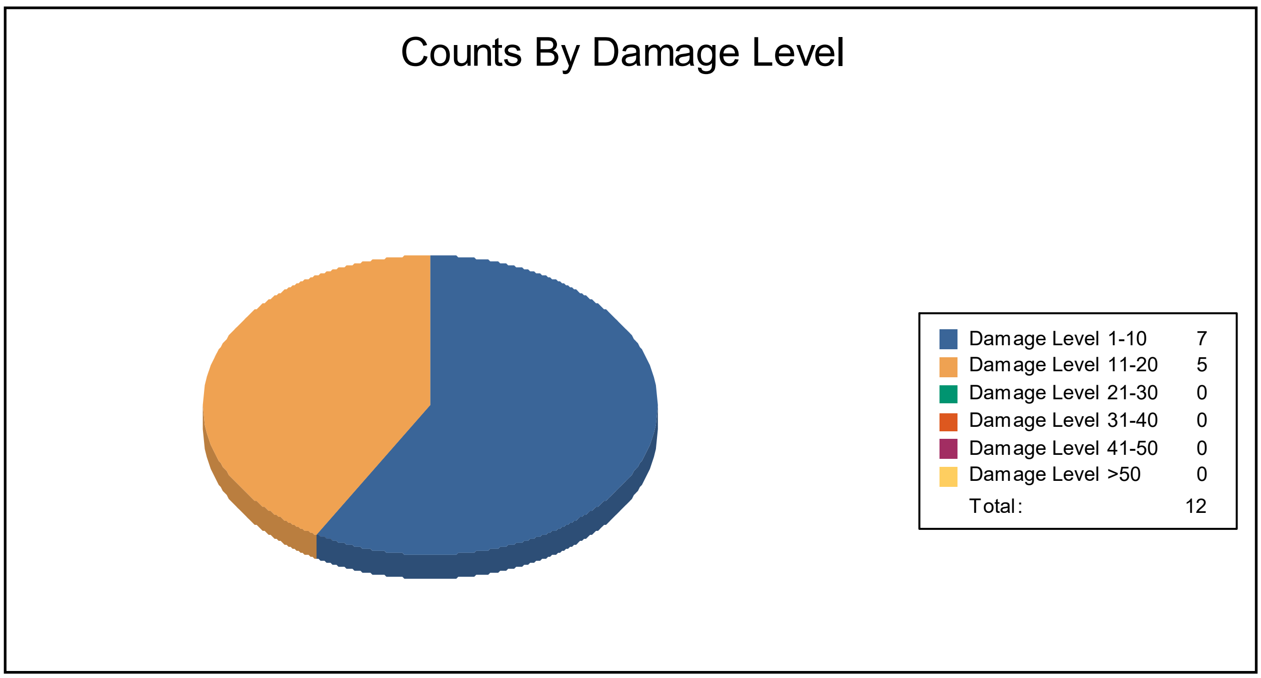


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	2	67	1	33	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	5	56	4	44	0	0	0	0	0	0	0	0

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	7	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	11	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

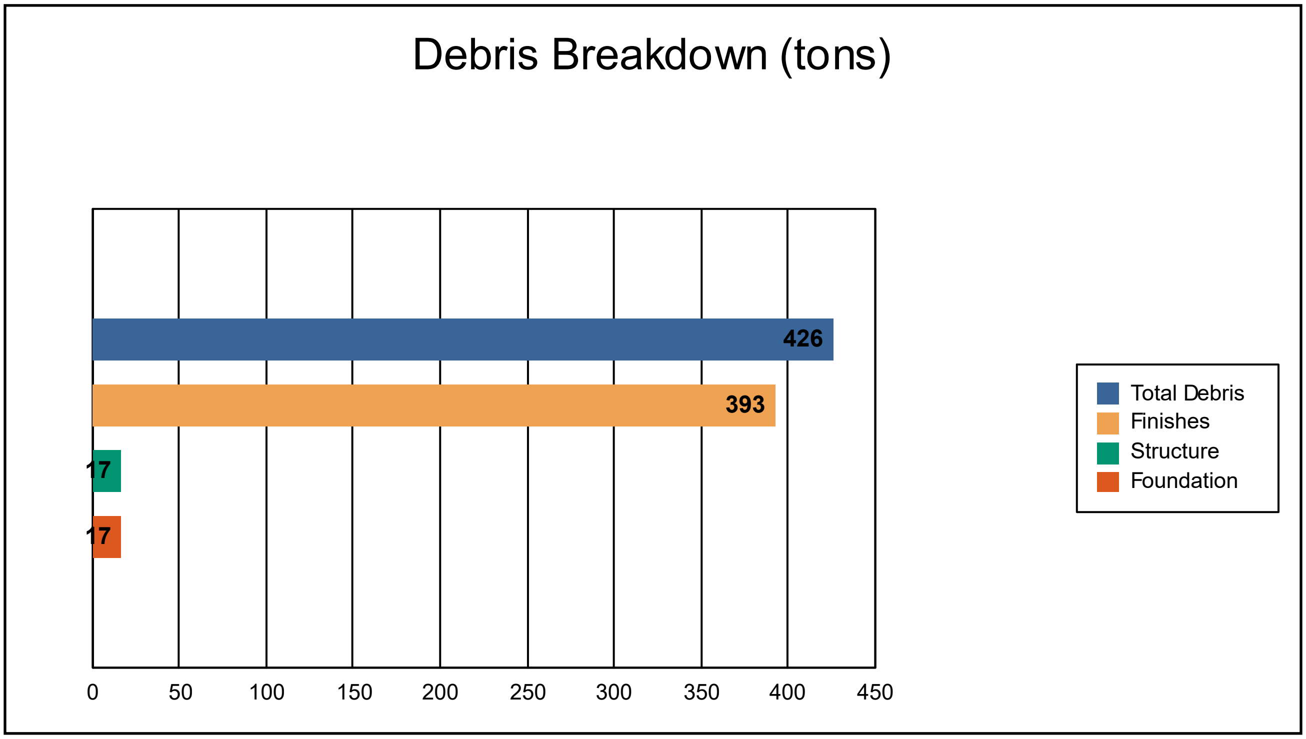
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

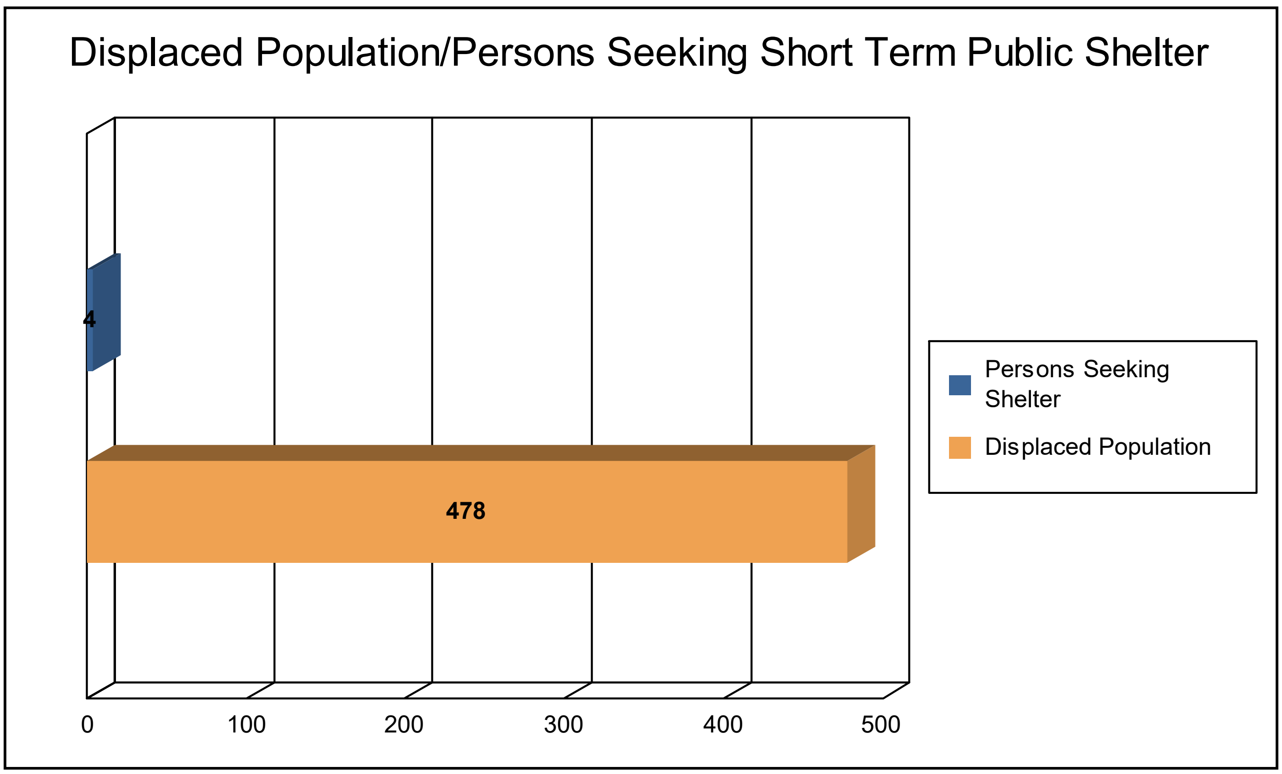


The model estimates that a total of 426 tons of debris will be generated. Of the total amount, Finishes comprises 92% of the total, Structure comprises 4% of the total, and Foundation comprises 4%. If the debris tonnage is converted into an estimated number of truckloads, it will require 18 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 159 households (or 478 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 4 people (out of a total population of 24,832) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 36.87 million dollars, which represents 2.05 % of the total replacement value of the scenario buildings.

Building-Related Losses

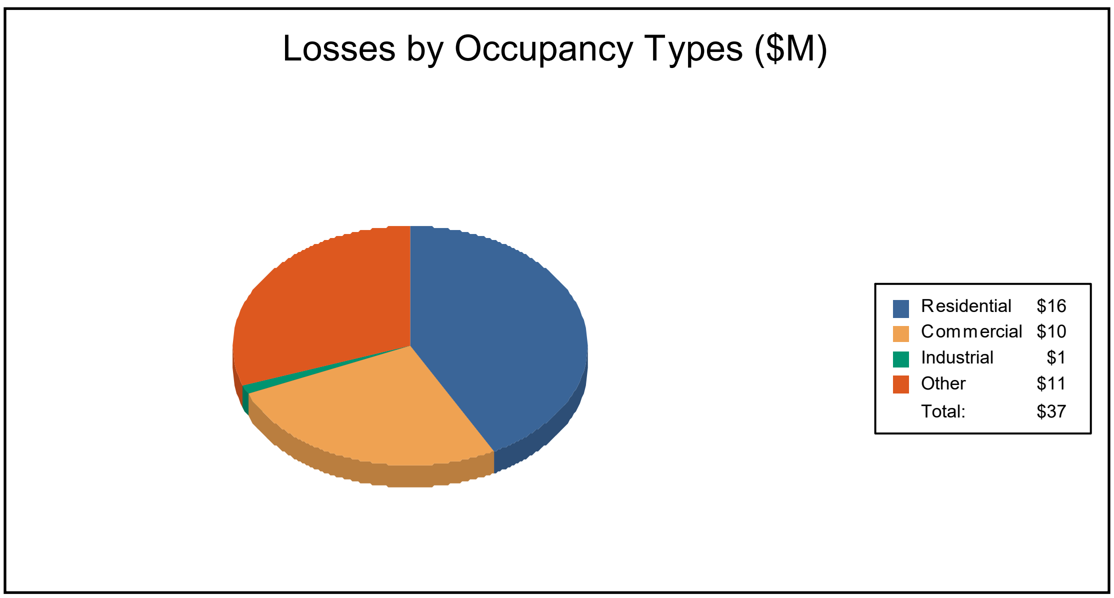
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 14.68 million dollars. 60% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 42.29% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	6.59	0.59	0.17	0.20	7.55
	Content	3.57	2.18	0.28	1.00	7.03
	Inventory	0.00	0.03	0.04	0.04	0.10
	Subtotal	**10.16**	**2.80**	**0.48**	**1.24**	**14.68**
Business Interruption						
	Income	0.59	3.08	0.01	0.57	4.24
	Relocation	2.43	0.35	0.00	0.26	3.04
	Rental Income	1.00	0.27	0.00	0.02	1.29
	Wage	1.41	3.11	0.02	9.10	13.63
	Subtotal	**5.43**	**6.79**	**0.02**	**9.95**	**22.20**
ALL	**Total**	**15.59**	**9.60**	**0.50**	**11.18**	**36.87**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Frederick	24,832	2,909,982	527,125	3,437,107
Total	**24,832**	**2,909,982**	**527,125**	**3,437,107**
Total Study Region	**24,832**	**2,909,982**	**527,125**	**3,437,107**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_1

Flood Scenario: Mulit

Print Date: Monday, August 2, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 154 square miles and contains 1,492 census blocks. The region contains over 13 thousand households and has a total population of 34,951 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 13,924 buildings in the region with a total building replacement value (excluding contents) of 4,884 million dollars. Approximately 92.06% of the buildings (and 89.46% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 13,924 buildings in the region which have an aggregate total replacement value of 4,884 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,369,448	89.5%
Commercial	298,832	6.1%
Industrial	83,521	1.7%
Agricultural	23,904	0.5%
Religion	65,399	1.3%
Government	17,551	0.4%
Education	25,330	0.5%
Total	**4,883,985**	**100%**

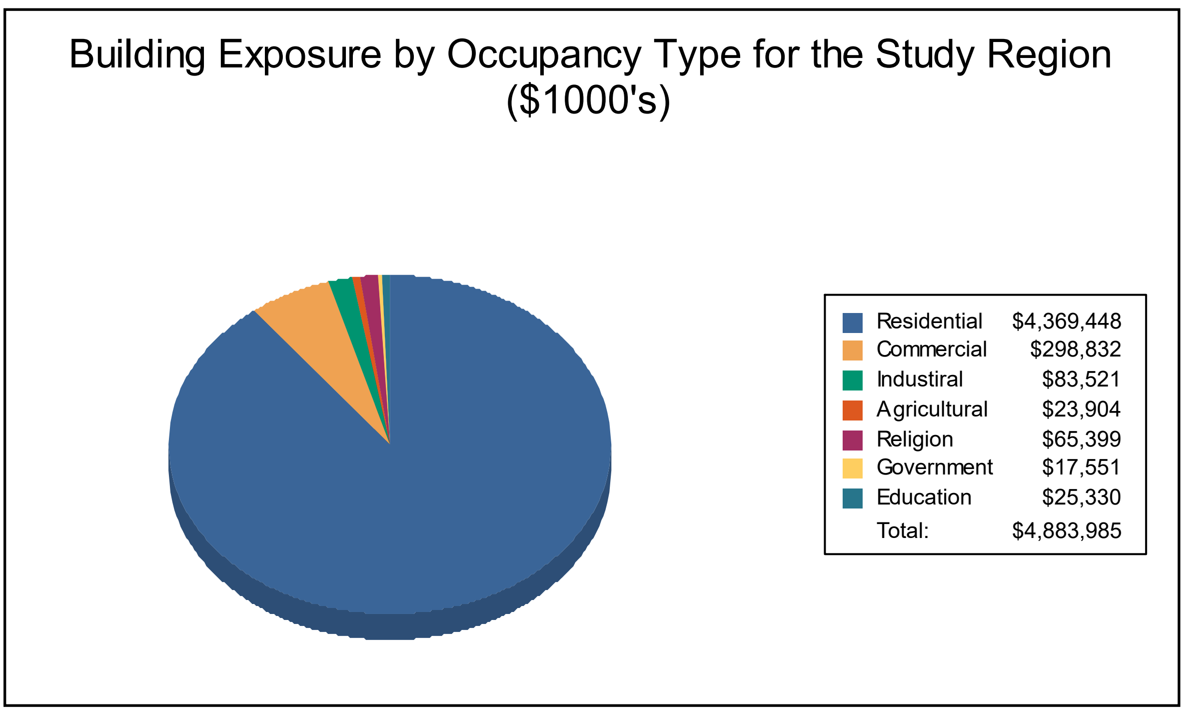


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,732,117	89.0%
Commercial	133,094	6.8%
Industrial	36,195	1.9%
Agricultural	14,416	0.7%
Religion	22,591	1.2%
Government	3,443	0.2%
Education	4,728	0.2%
Total	**1,946,584**	**100%**

Building Exposure by Occupancy Type for the Scenario ($1000's)

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 14 schools, 6 fire stations, 2 police stations and no emergency operation centers.

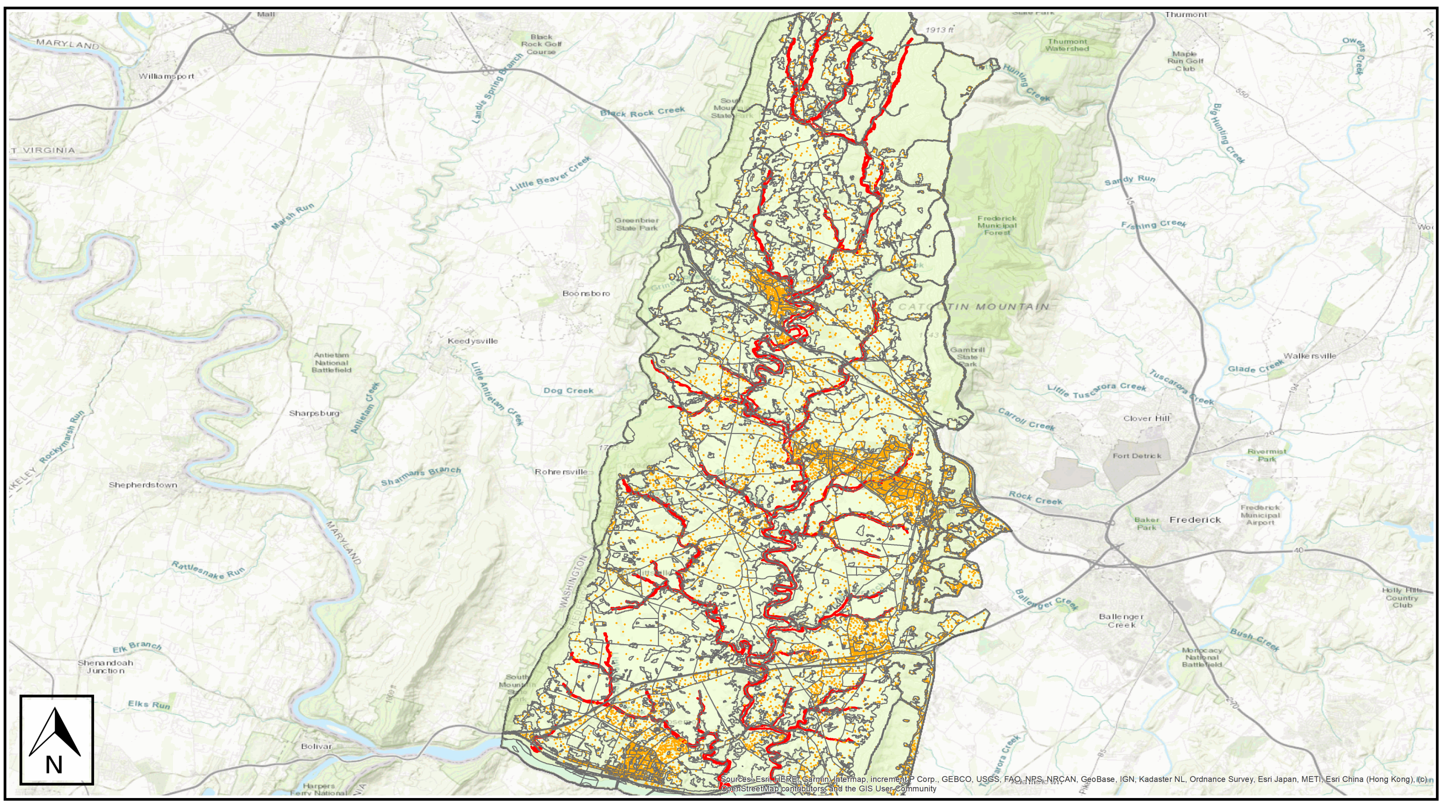
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_1
Scenario Name:	Mulit
Return Period Analyzed:	25
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 5 buildings will be at least moderately damaged. This is over 56% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the ‘damage states’ is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

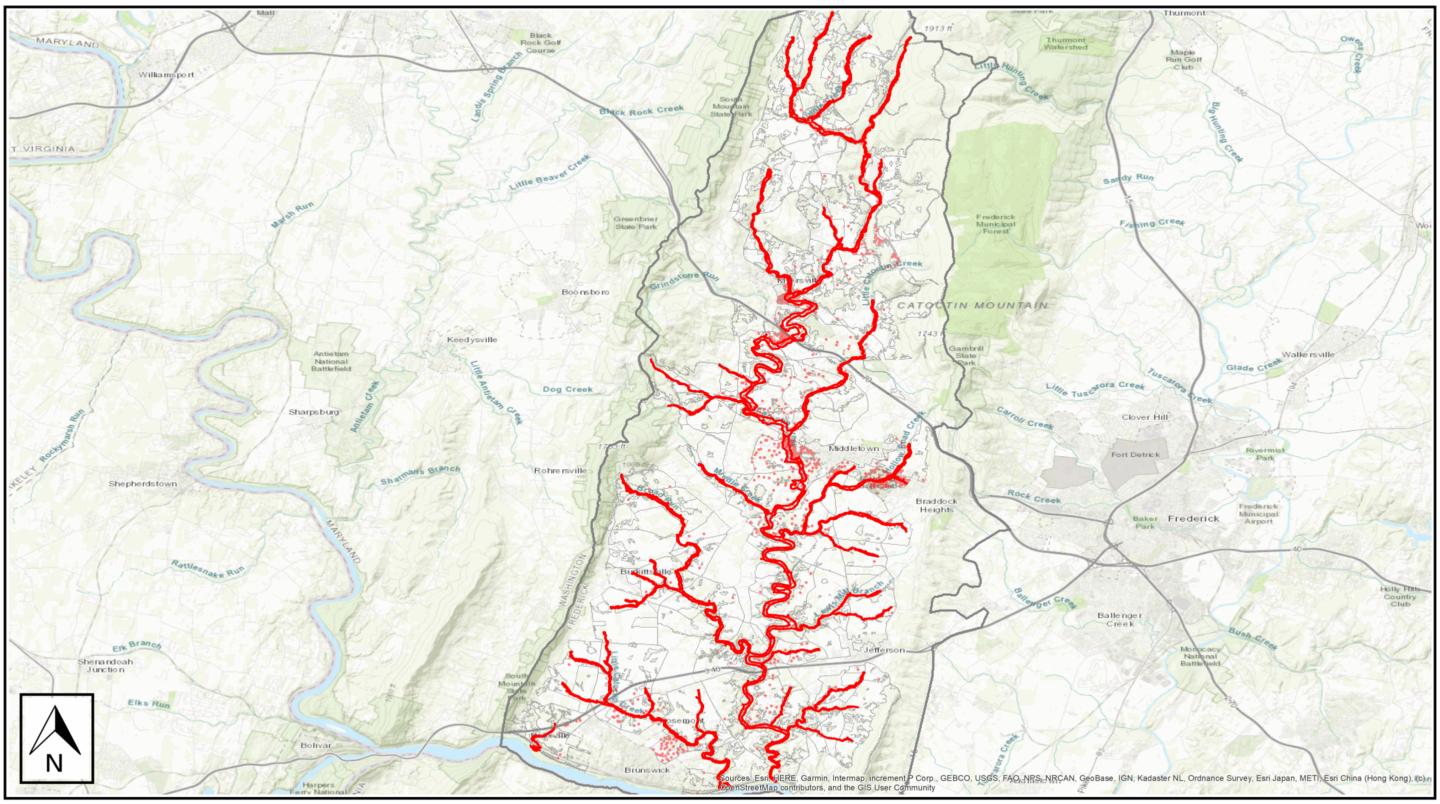


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	5	100	0	0	0	0	0	0	0	0
Total	**0**		**5**		**0**		**0**		**0**		**0**	

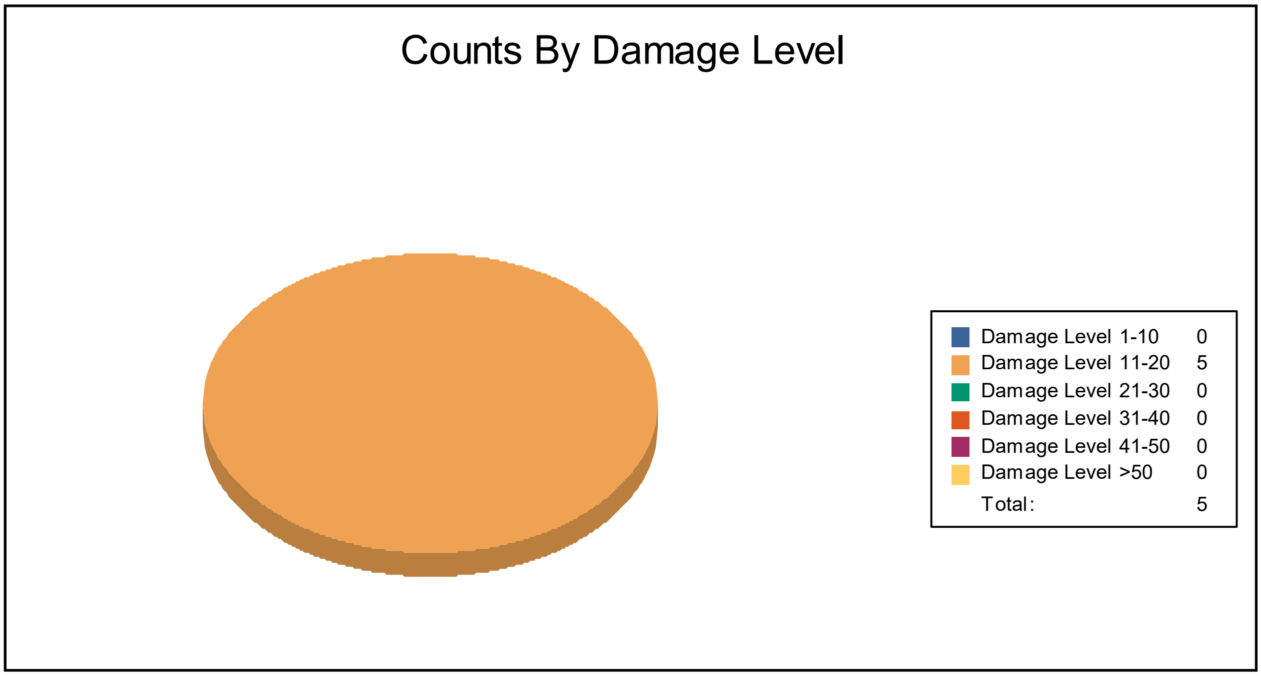


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	0	0	5	100	0	0	0	0	0	0	0	0

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	6	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	14	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

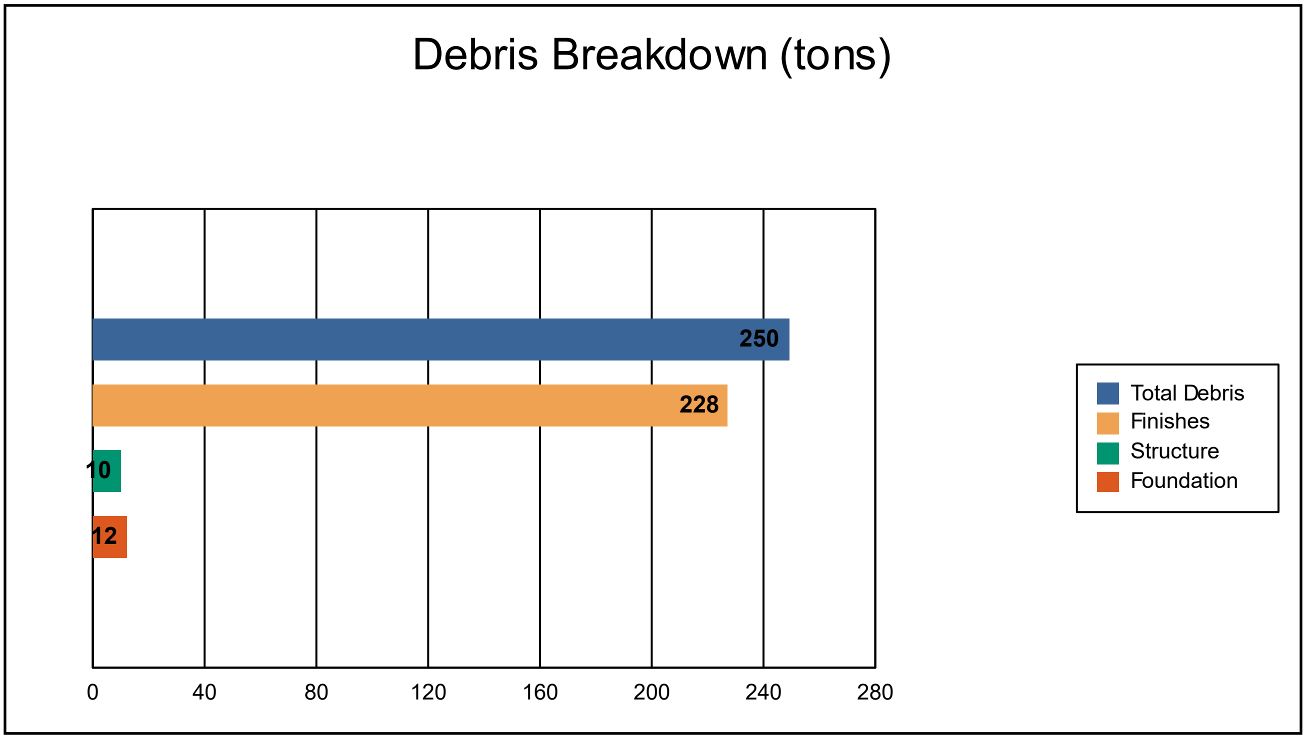
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

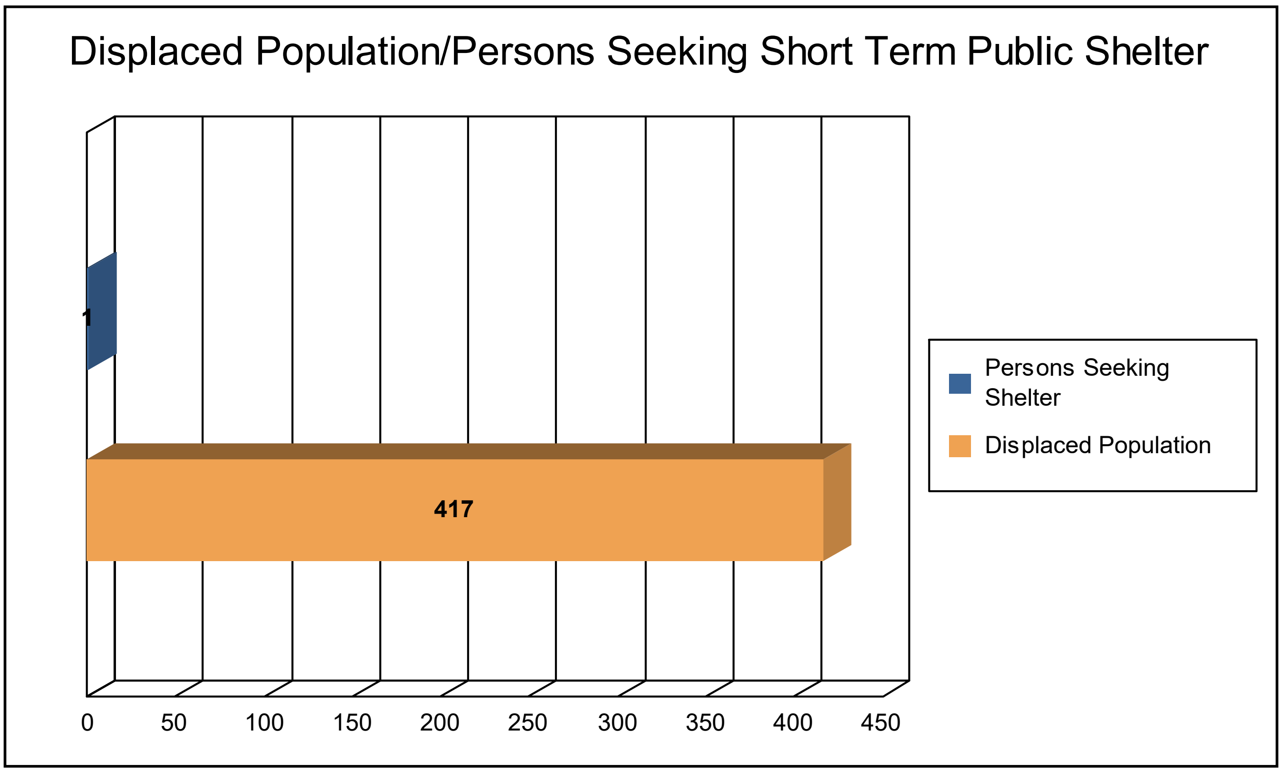


The model estimates that a total of 250 tons of debris will be generated. Of the total amount, Finishes comprises 91% of the total, Structure comprises 4% of the total, and Foundation comprises 5%. If the debris tonnage is converted into an estimated number of truckloads, it will require 10 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 139 households (or 417 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1 people (out of a total population of 34,951) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 28.93 million dollars, which represents 1.49 % of the total replacement value of the scenario buildings.

Building-Related Losses

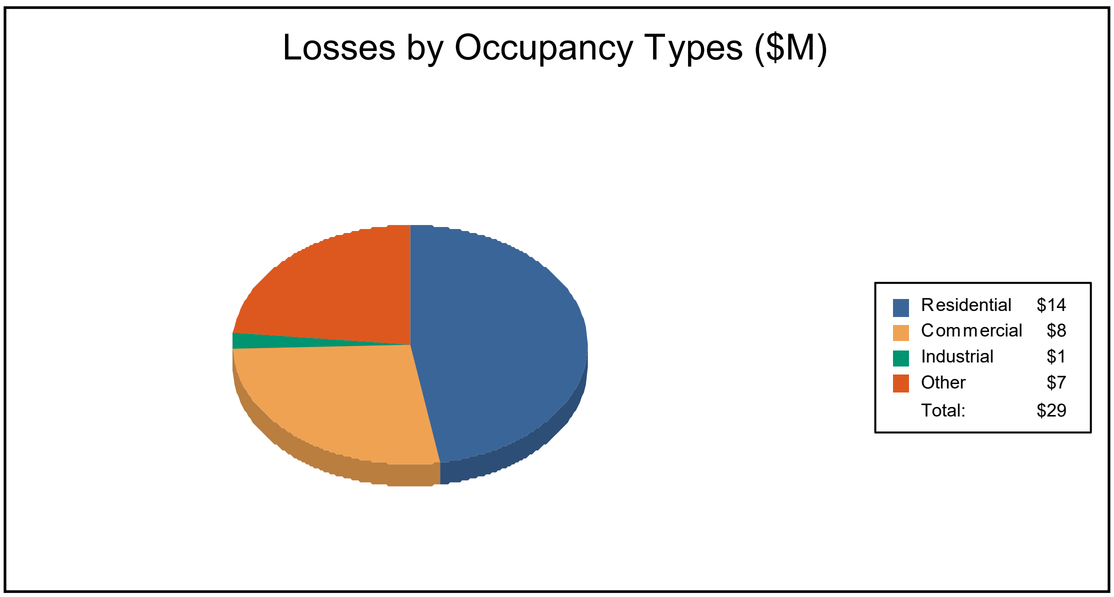
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 14.91 million dollars. 48% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 47.34% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	7.43	0.51	0.19	0.12	8.26
	Content	3.80	1.72	0.33	0.75	6.60
	Inventory	0.00	0.01	0.05	0.01	0.06
	Subtotal	**11.23**	**2.24**	**0.57**	**0.87**	**14.91**
Business Interruption						
	Income	0.04	2.62	0.00	0.28	2.93
	Relocation	1.82	0.31	0.00	0.13	2.26
	Rental Income	0.52	0.15	0.00	0.01	0.67
	Wage	0.09	2.57	0.01	5.49	8.16
	Subtotal	**2.46**	**5.64**	**0.02**	**5.90**	**14.02**
ALL	**Total**	**13.70**	**7.88**	**0.59**	**6.77**	**28.93**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Maryland				
Frederick	34,951	4,369,448	514,537	4,883,985
Total	**34,951**	**4,369,448**	**514,537**	**4,883,985**
Total Study Region	**34,951**	**4,369,448**	**514,537**	**4,883,985**

Hazus: Flood Global Risk Report

Region Name: Frederick_FLD_2

Flood Scenario: Multi

Print Date: Thursday, August 5, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 128 square miles and contains 1,470 census blocks. The region contains over 13 thousand households and has a total population of 39,698 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 14,322 buildings in the region with a total building replacement value (excluding contents) of 6,331 million dollars. Approximately 92.32% of the buildings (and 82.33% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 14,322 buildings in the region which have an aggregate total replacement value of 6,331 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	5,212,418	82.3%
Commercial	386,876	6.1%
Industrial	595,666	9.4%
Agricultural	33,020	0.5%
Religion	58,625	0.9%
Government	25,544	0.4%
Education	18,866	0.3%
Total	**6,331,015**	**100%**

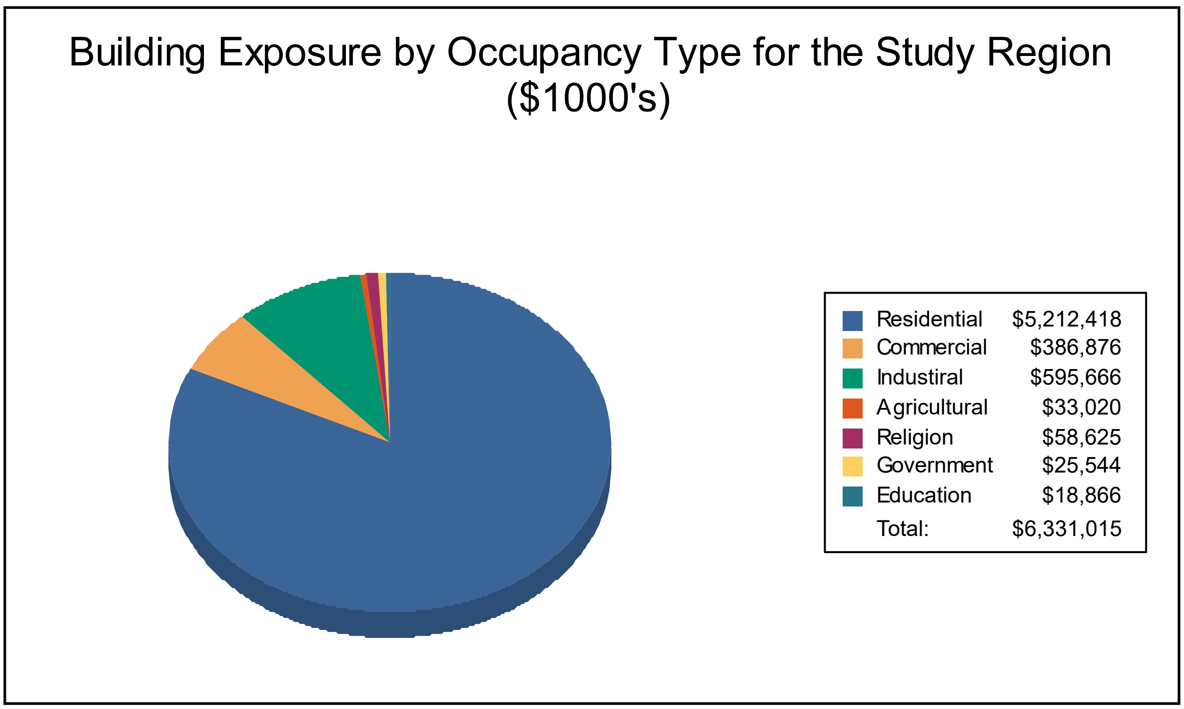
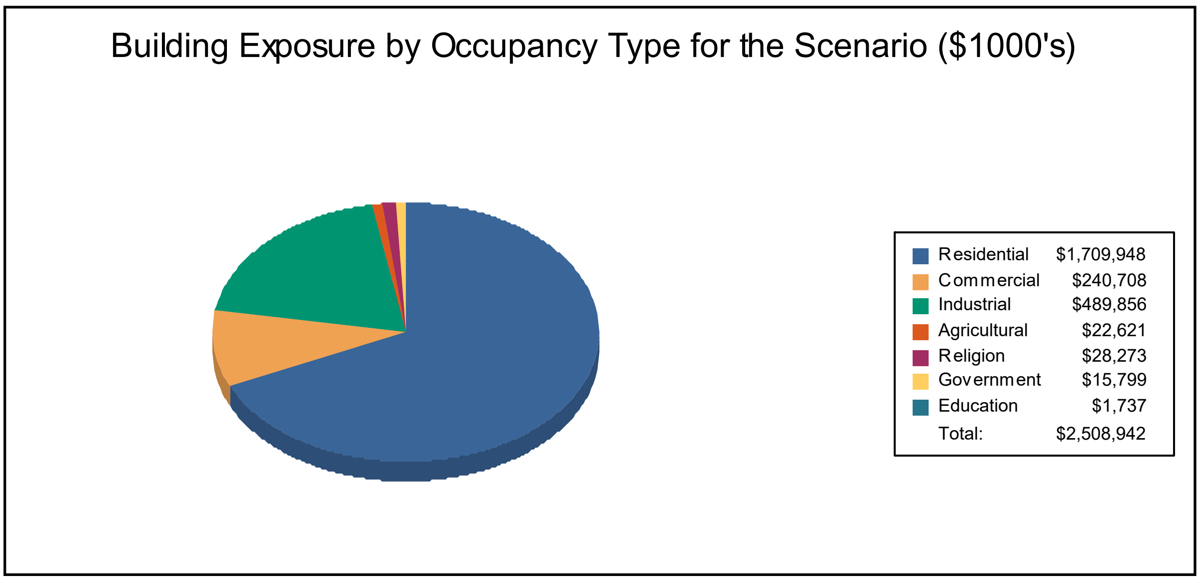


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,709,948	68.2%
Commercial	240,708	9.6%
Industrial	489,856	19.5%
Agricultural	22,621	0.9%
Religion	28,273	1.1%
Government	15,799	0.6%
Education	1,737	0.1%
Total	**2,508,942**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

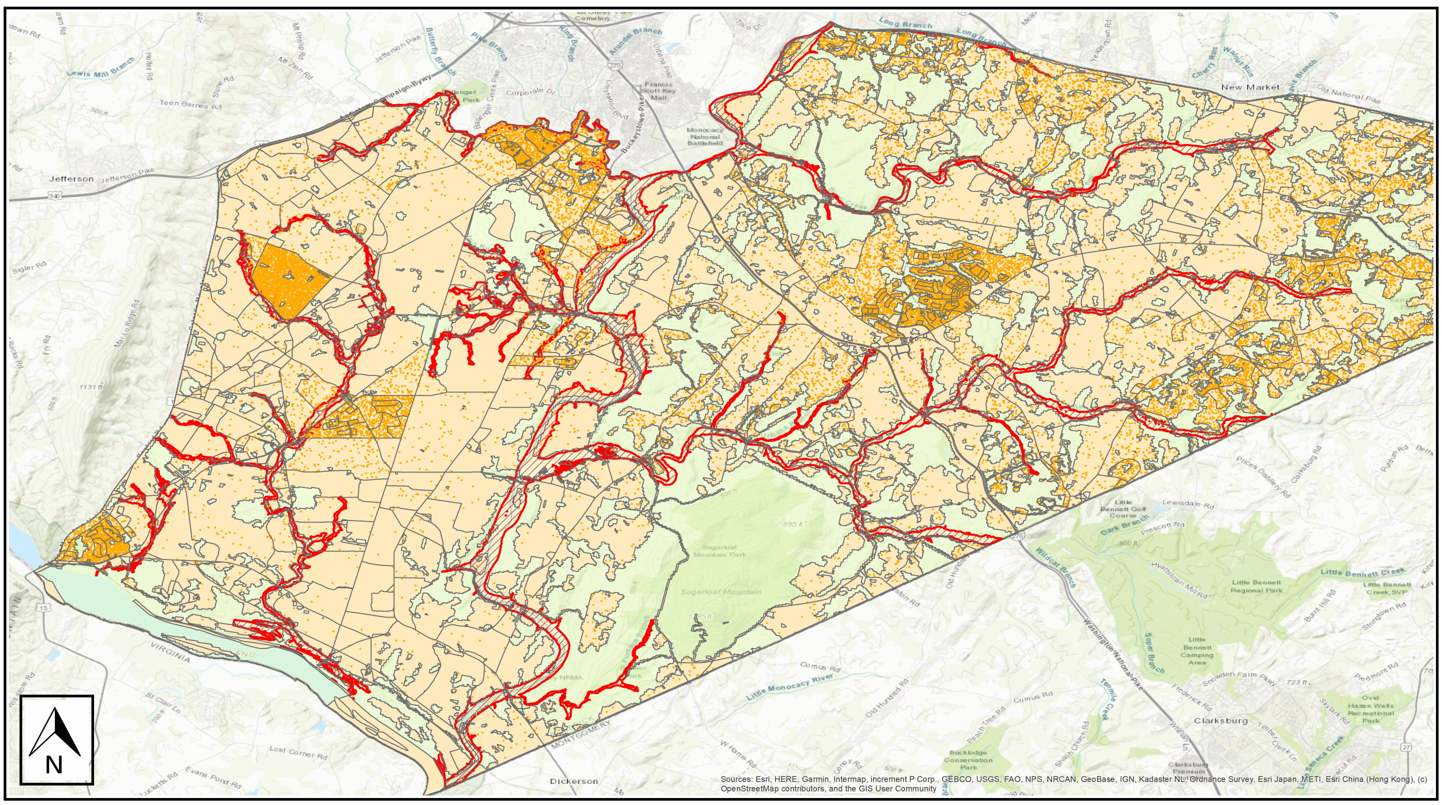
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Frederick_FLD_2
Scenario Name:	Multi
Return Period Analyzed:	25
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 79 buildings will be at least moderately damaged. This is over 49% of the total number of buildings in the scenario. There are an estimated 18 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

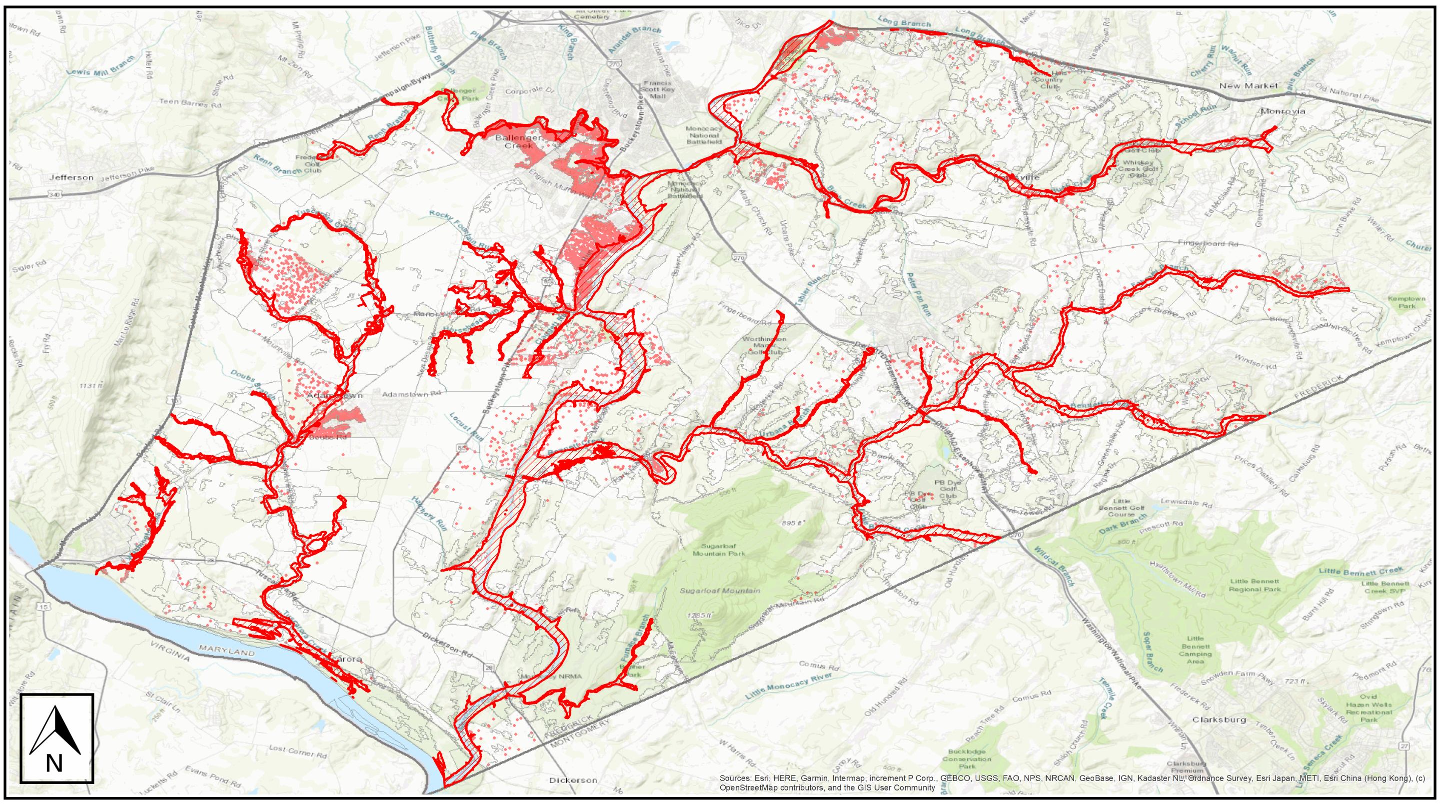


Table 3: Expected Building Damage by Occupancy

Occupancy	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	>50 Count	>50 (%)
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	12	13	22	24	16	18	14	15	9	10	18	20
Total	**12**		**22**		**16**		**14**		**9**		**18**	

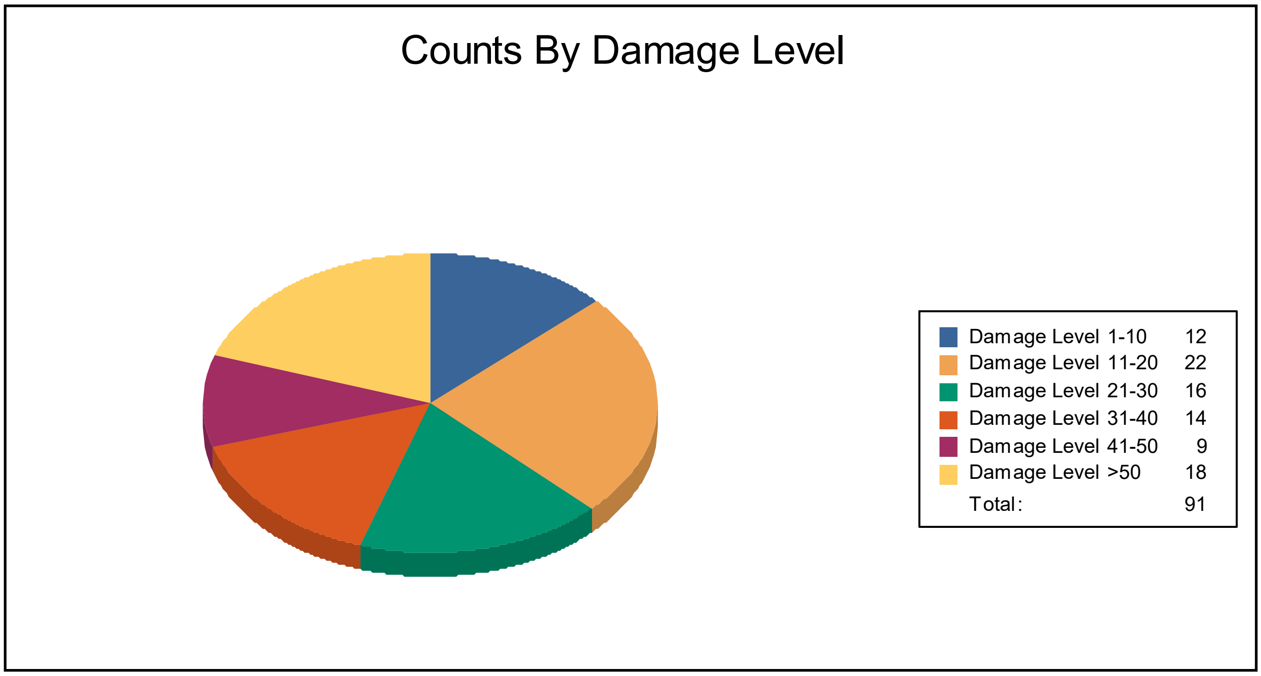


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Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	3	13	6	25	4	17	3	13	3	13	5	21
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	9	13	16	24	12	18	11	16	6	9	13	19

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

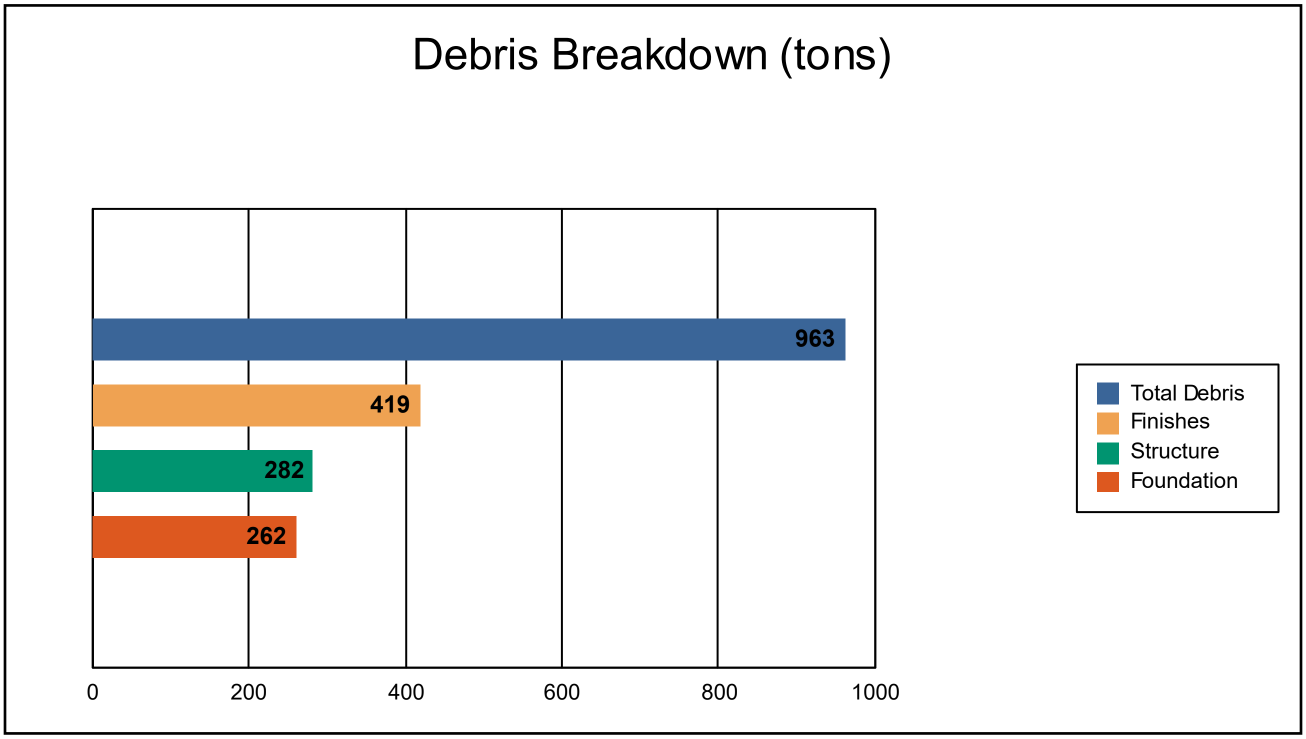
If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

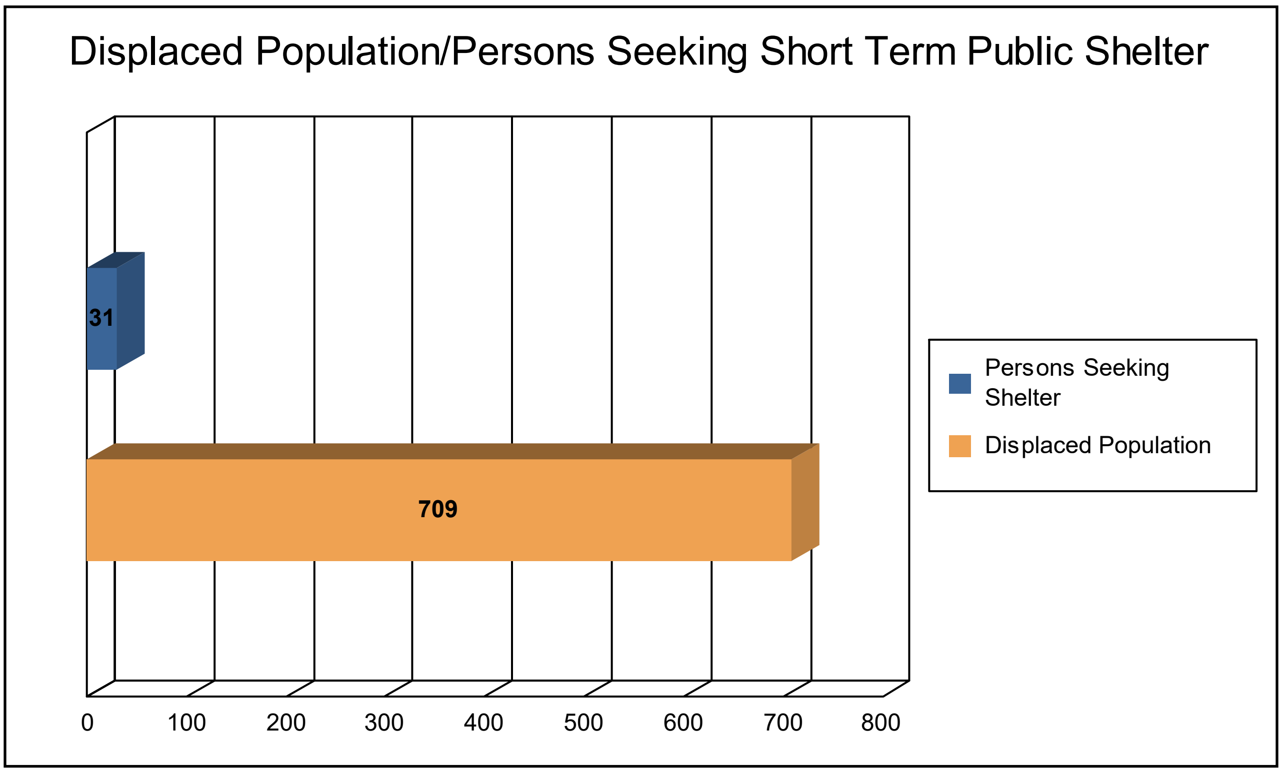


The model estimates that a total of 963 tons of debris will be generated. Of the total amount, Finishes comprises 43% of the total, Structure comprises 29% of the total, and Foundation comprises 27%. If the debris tonnage is converted into an estimated number of truckloads, it will require 39 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 236 households (or 709 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 31 people (out of a total population of 39,698) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 82.36 million dollars, which represents 3.28 % of the total replacement value of the scenario buildings.

Building-Related Losses

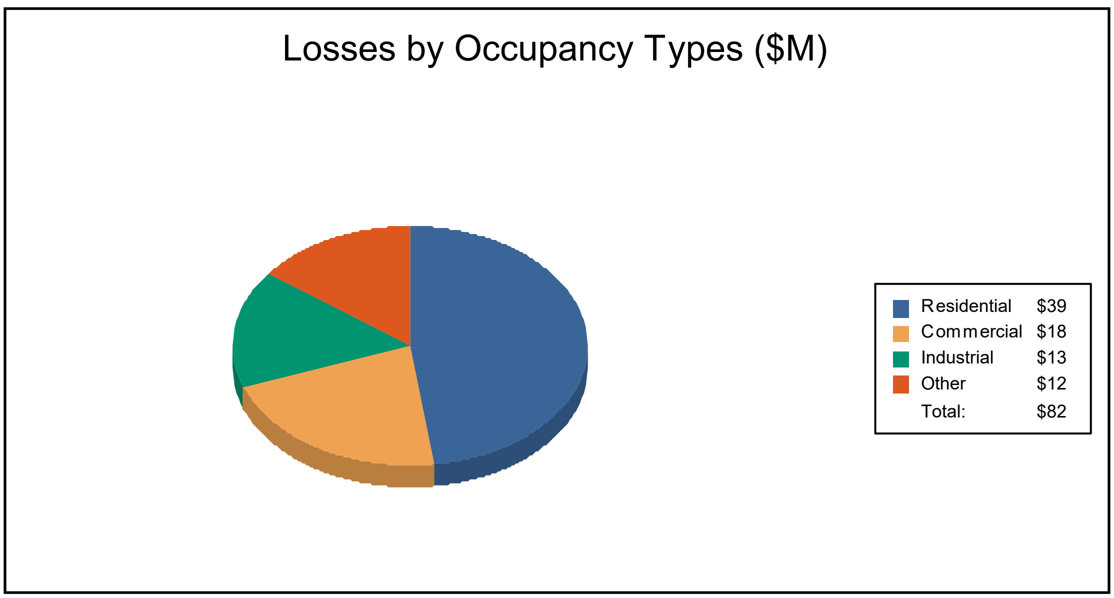
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 57.30 million dollars. 30% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 47.74% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	21.74	2.37	2.92	0.74	27.77
	Content	11.45	6.05	7.78	2.73	28.01
	Inventory	0.00	0.17	1.19	0.17	1.53
	Subtotal	**33.19**	**8.58**	**11.89**	**3.64**	**57.30**
Business Interruption						
	Income	0.22	4.20	0.41	0.64	5.46
	Relocation	3.92	0.65	0.24	0.14	4.95
	Rental Income	1.46	0.49	0.05	0.00	2.01
	Wage	0.53	3.98	0.40	7.73	12.64
	Subtotal	**6.13**	**9.33**	**1.11**	**8.51**	**25.06**
ALL	**Total**	**39.32**	**17.91**	**12.99**	**12.15**	**82.36**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Maryland				
Frederick	39,698	5,212,418	1,118,597	6,331,015
Total	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**
Total Study Region	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_3

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 73 square miles and contains 2,890 census blocks. The region contains over 41 thousand households and has a total population of 106,724 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 36,786 buildings in the region with a total building replacement value (excluding contents) of 15,635 million dollars. Approximately 90.42% of the buildings (and 78.16% of the building value) are associated with residential housing.

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Building Inventory

General Building Stock

Hazus estimates that there are 36,786 buildings in the region which have an aggregate total replacement value of 15,635 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	12,220,022	78.2%
Commercial	2,296,995	14.7%
Industrial	454,425	2.9%
Agricultural	26,557	0.2%
Religion	222,953	1.4%
Government	170,628	1.1%
Education	243,455	1.6%
Total	**15,635,035**	**100%**

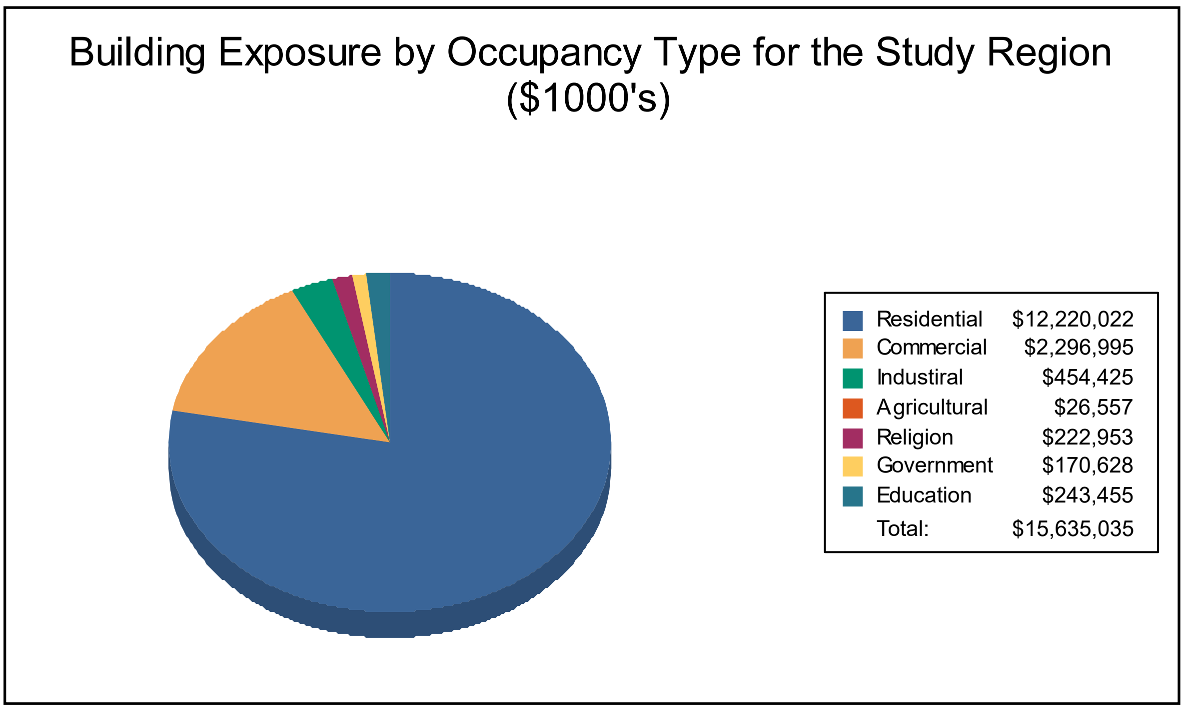

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Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,283,652	77.3%
Commercial	862,774	15.6%
Industrial	235,245	4.2%
Agricultural	14,088	0.3%
Religion	85,093	1.5%
Government	30,207	0.5%
Education	32,525	0.6%
Total	**5,543,584**	**100%**

Building Exposure by Occupancy Type for the Scenario ($1000's)

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 48 schools, 10 fire stations, 7 police stations and 2 emergency operation centers.

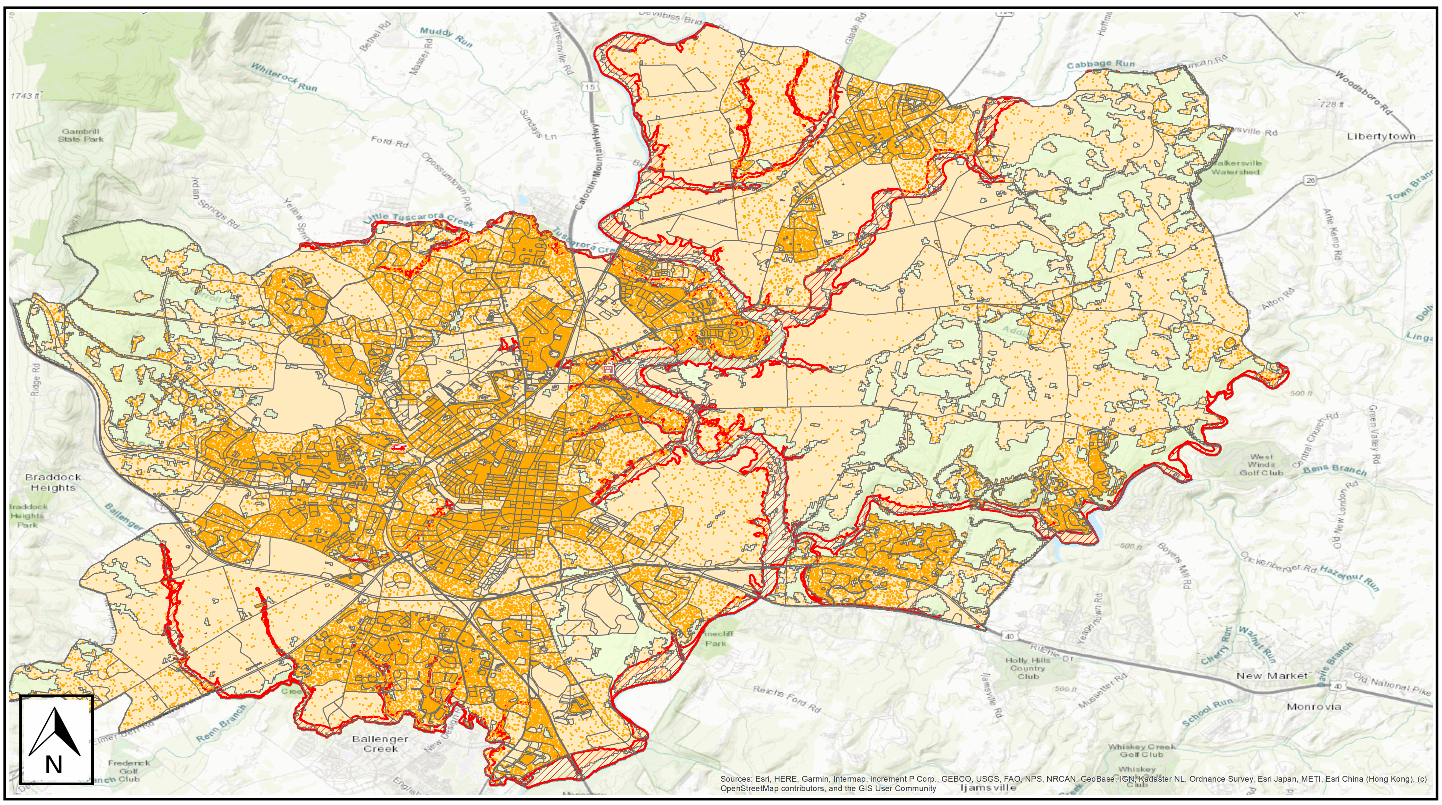
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_3
Scenario Name:	Multi
Return Period Analyzed:	25
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 237 buildings will be at least moderately damaged. This is over 54% of the total number of buildings in the scenario. There are an estimated 47 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

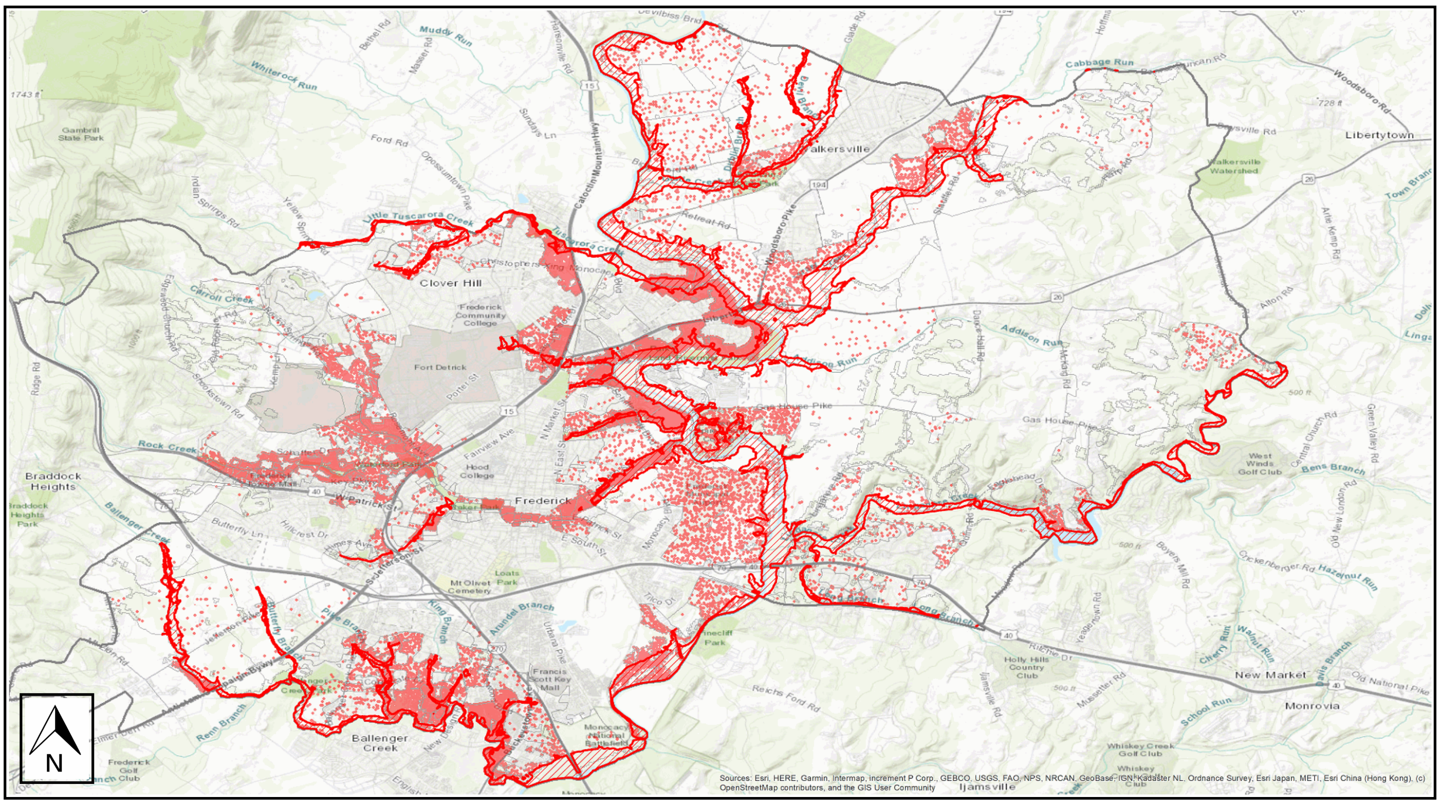


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	1	17	5	83	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	67	22	101	34	42	14	25	8	17	6	47	16
Total	**68**		**106**		**42**		**25**		**17**		**47**	

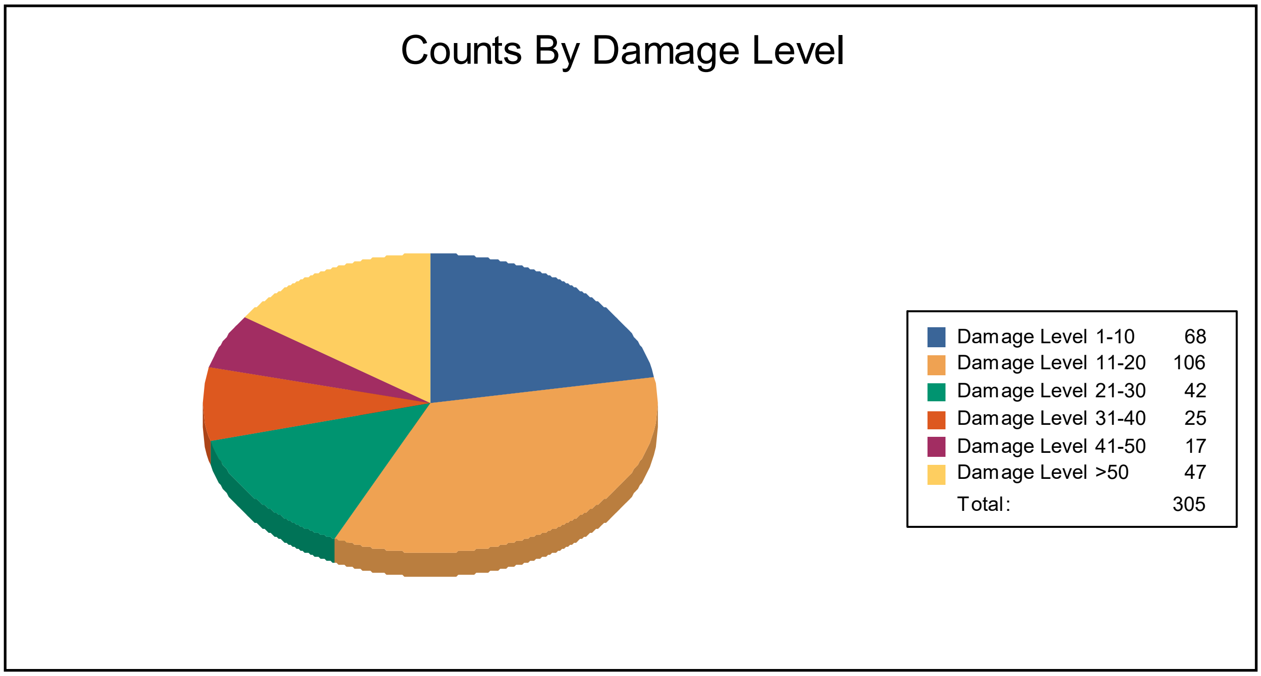


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	17	20	29	34	14	16	7	8	4	5	14	16
Steel	1	33	2	67	0	0	0	0	0	0	0	0
Wood	50	23	74	34	28	13	18	8	13	6	33	15

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 308 hospital beds available for use. On the day of the scenario flood event, the model estimates that 308 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	2	0	0	0
Fire Stations	10	0	0	0
Hospitals	1	0	0	0
Police Stations	7	0	0	0
Schools	48	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

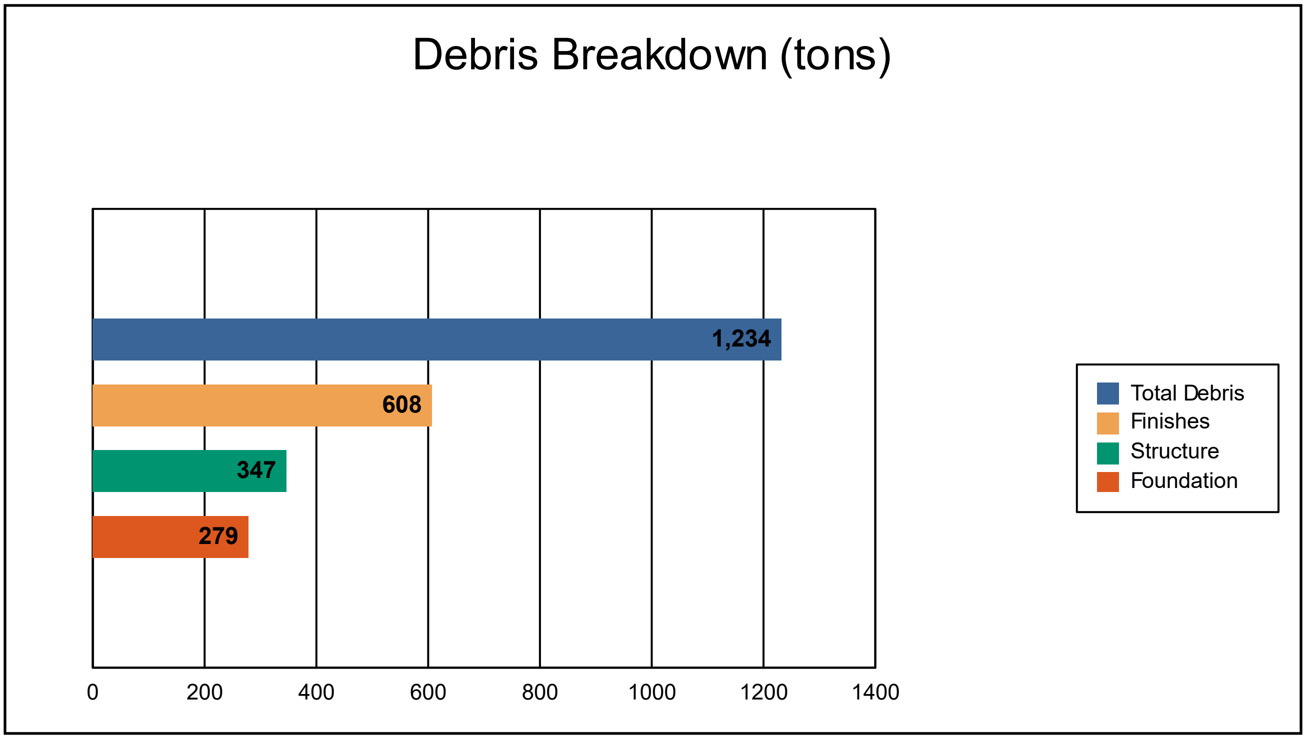
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

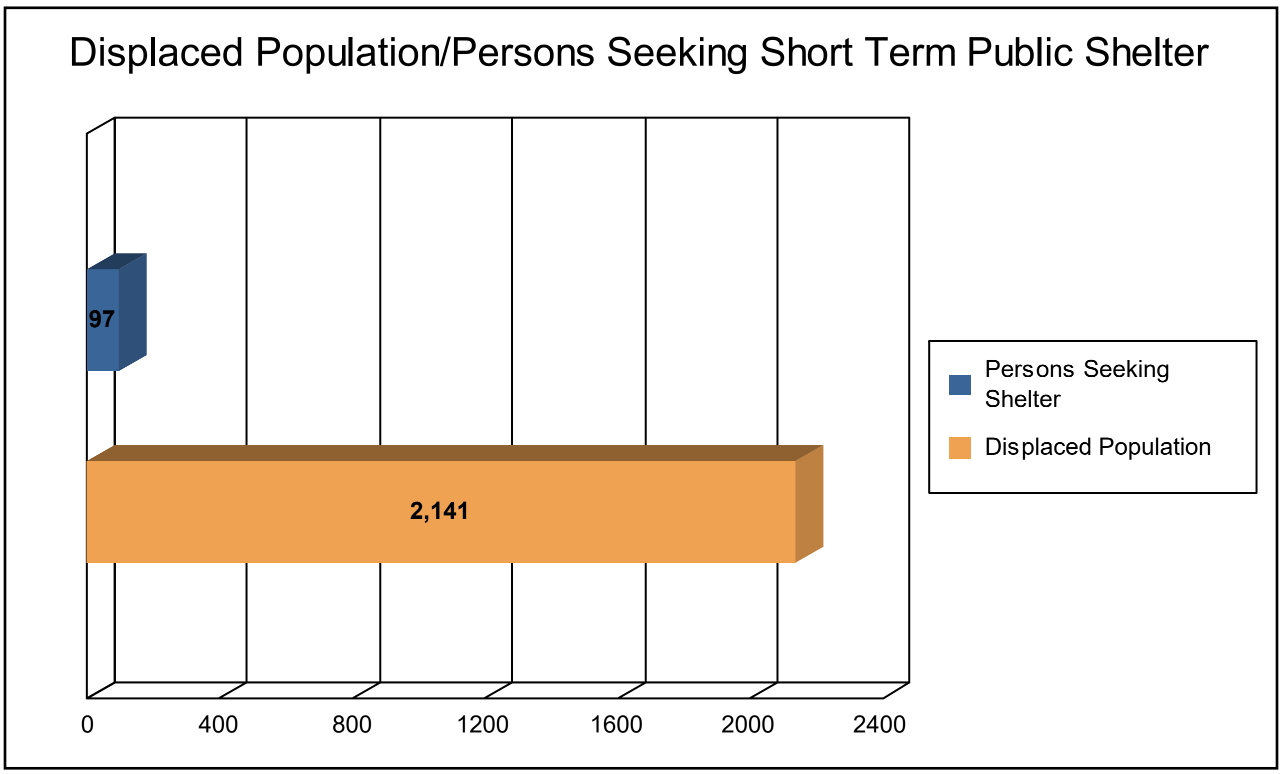


The model estimates that a total of 1,234 tons of debris will be generated. Of the total amount, Finishes comprises 49% of the total, Structure comprises 28% of the total, and Foundation comprises 23%. If the debris tonnage is converted into an estimated number of truckloads, it will require 50 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 714 households (or 2,141 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 97 people (out of a total population of 106,724) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 246.76 million dollars, which represents 4.45 % of the total replacement value of the scenario buildings.

Building-Related Losses

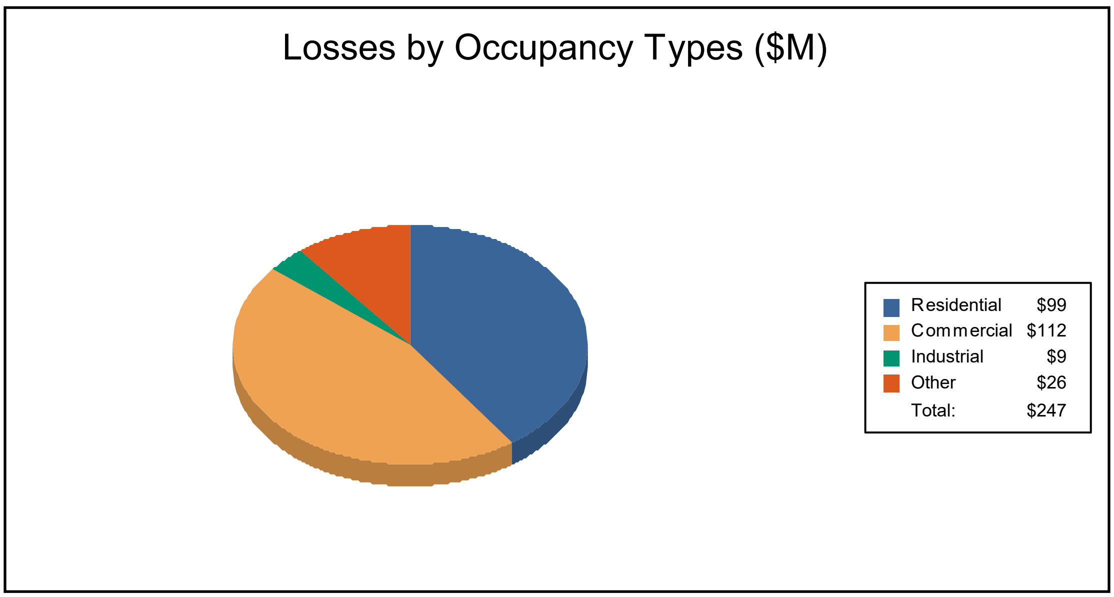
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 141.24 million dollars. 43% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 40.31% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	50.80	14.36	2.67	0.95	68.79
	Content	27.45	33.75	5.20	4.87	71.27
	Inventory	0.00	0.30	0.82	0.05	1.18
	Subtotal	**78.25**	**48.41**	**8.70**	**5.88**	**141.24**
Business Interruption						
	Income	0.86	28.16	0.16	1.77	30.96
	Relocation	13.14	6.62	0.14	0.64	20.55
	Rental Income	5.17	4.65	0.03	0.10	9.95
	Wage	2.04	24.37	0.30	17.36	44.07
	Subtotal	**21.22**	**63.81**	**0.63**	**19.87**	**105.52**
ALL	**Total**	**99.46**	**112.22**	**9.33**	**25.75**	**246.76**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Frederick	106,724	12,220,022	3,415,013	15,635,035
Total	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**
Total Study Region	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_4

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 138 square miles and contains 1,074 census blocks. The region contains over 9 thousand households and has a total population of 27,180 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 10,335 buildings in the region with a total building replacement value (excluding contents) of 3,945 million dollars. Approximately 91.67% of the buildings (and 88.71% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 10,335 buildings in the region which have an aggregate total replacement value of 3,945 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	3,499,625	88.7%
Commercial	238,367	6.0%
Industrial	89,655	2.3%
Agricultural	29,561	0.7%
Religion	45,679	1.2%
Government	5,013	0.1%
Education	37,265	0.9%
Total	**3,945,165**	**100%**

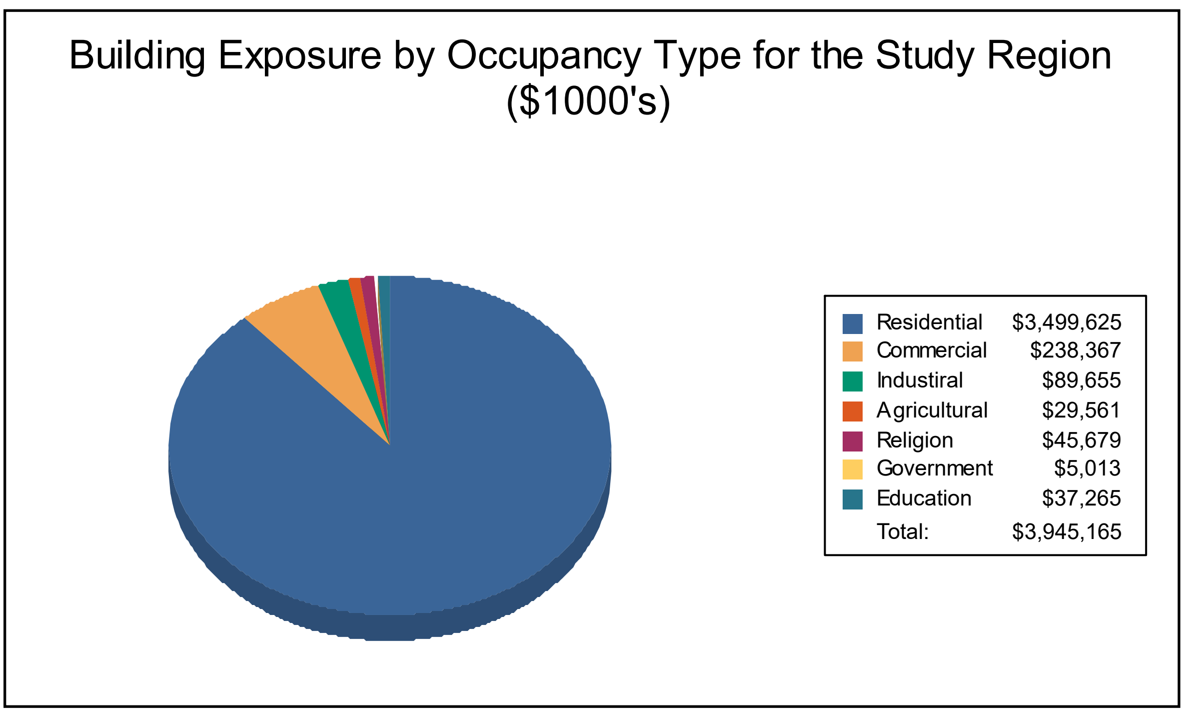
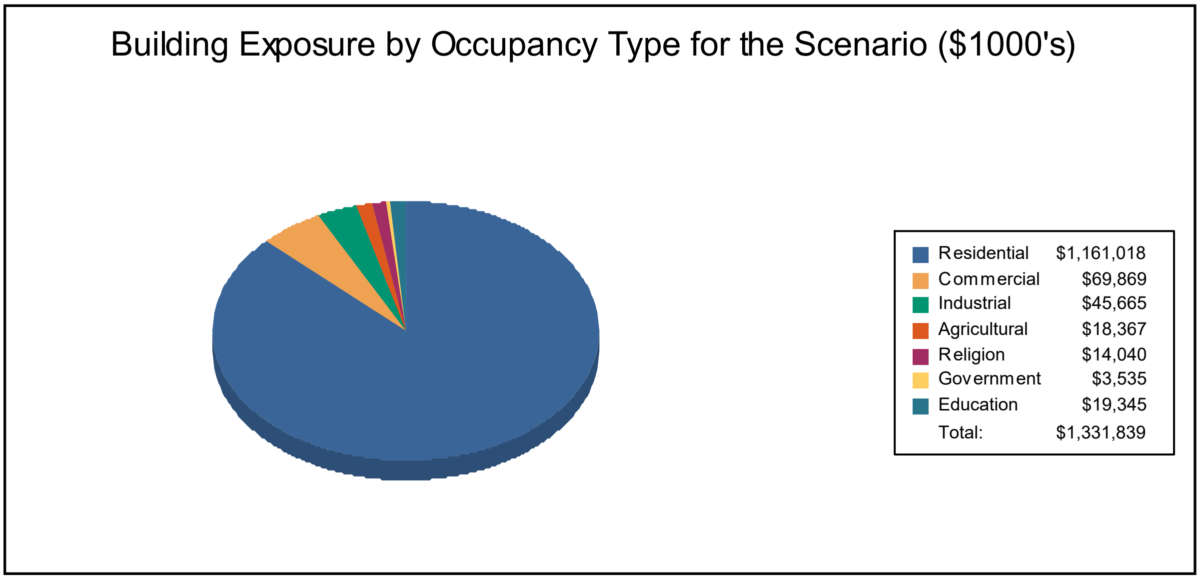


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,161,018	87.2%
Commercial	69,869	5.2%
Industrial	45,665	3.4%
Agricultural	18,367	1.4%
Religion	14,040	1.1%
Government	3,535	0.3%
Education	19,345	1.5%
Total	**1,331,839**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

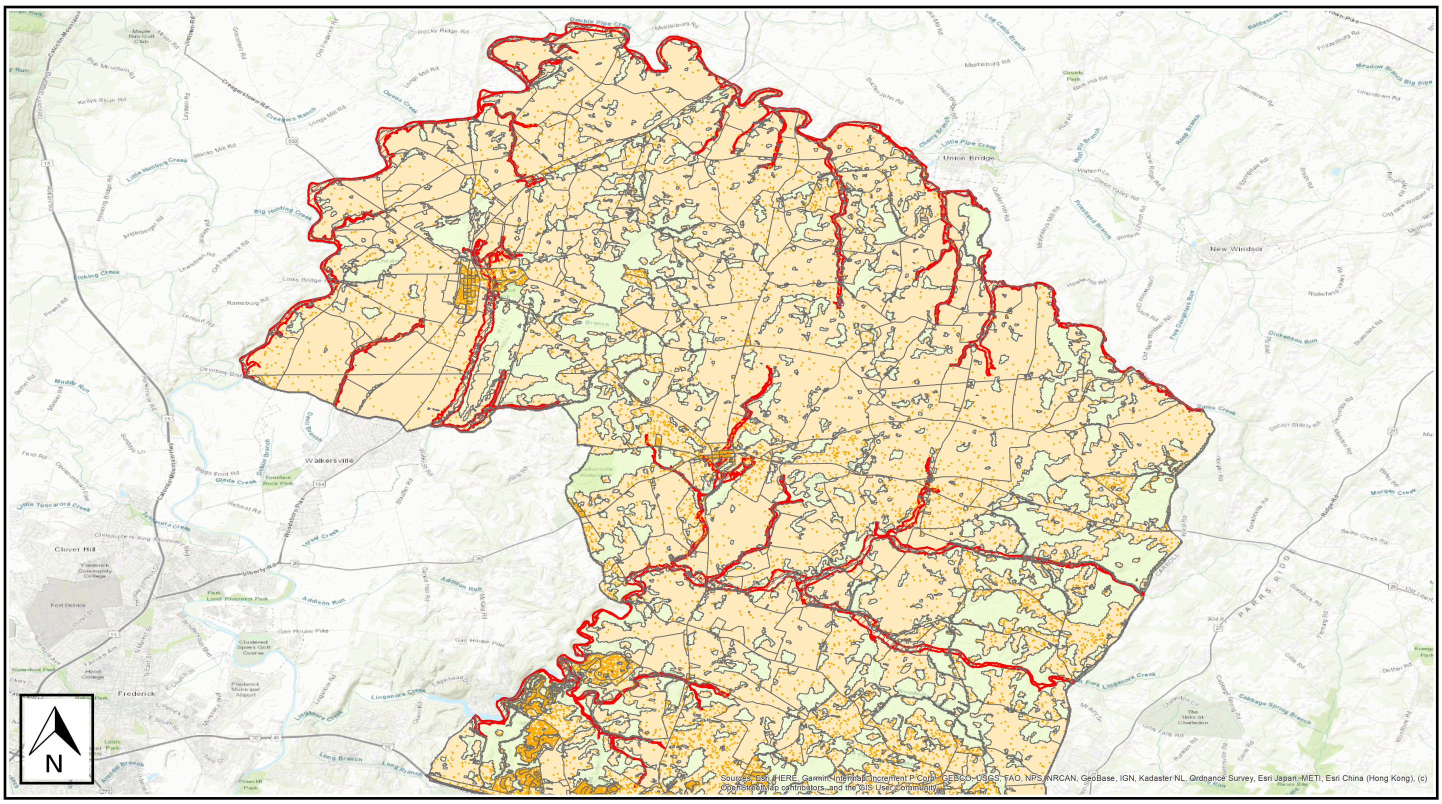
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_4
Scenario Name:	Multi
Return Period Analyzed:	25
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 15 buildings will be at least moderately damaged. This is over 50% of the total number of buildings in the scenario. There are an estimated 3 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

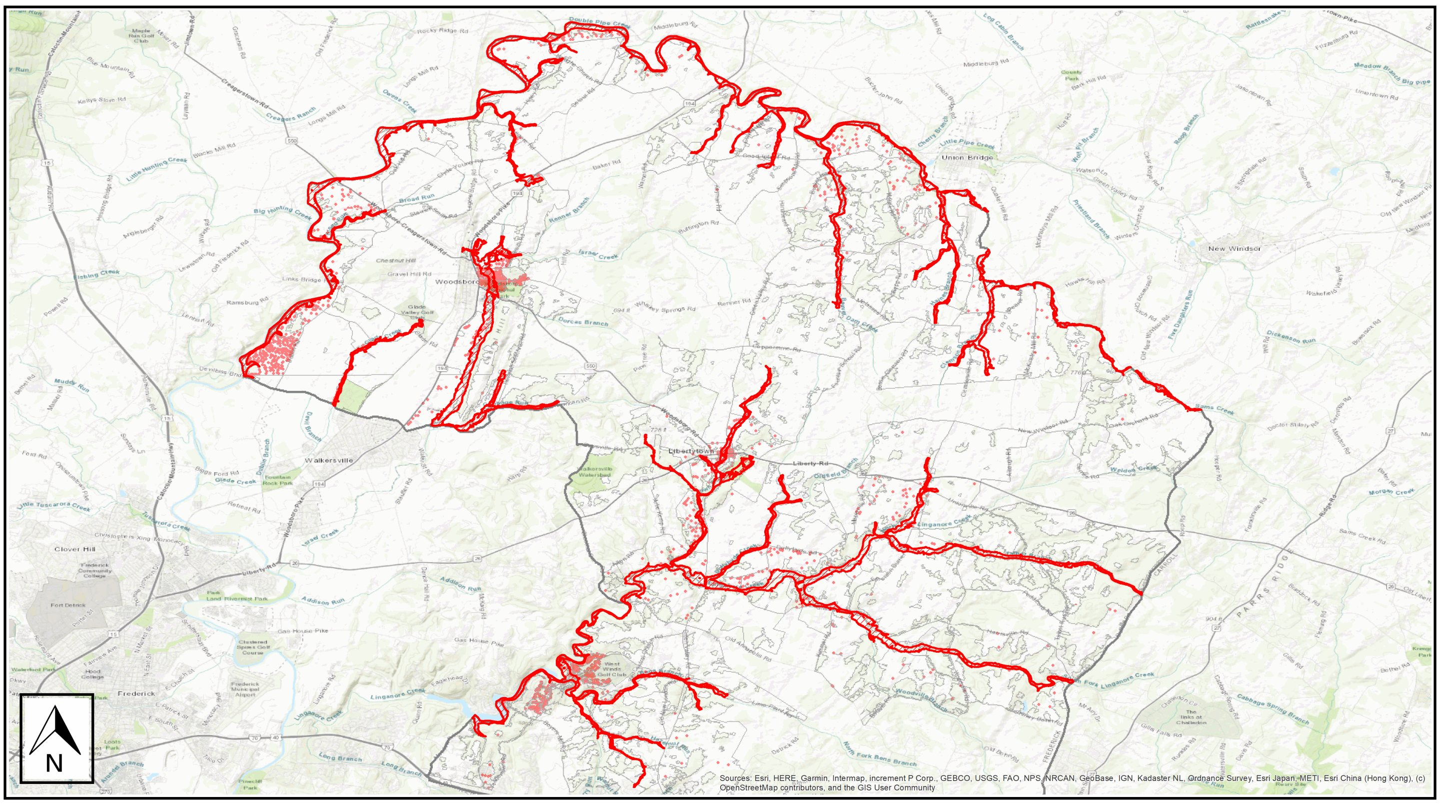


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	1	6	6	38	2	13	2	13	2	13	3	19
Total	**1**		**6**		**2**		**2**		**2**		**3**	

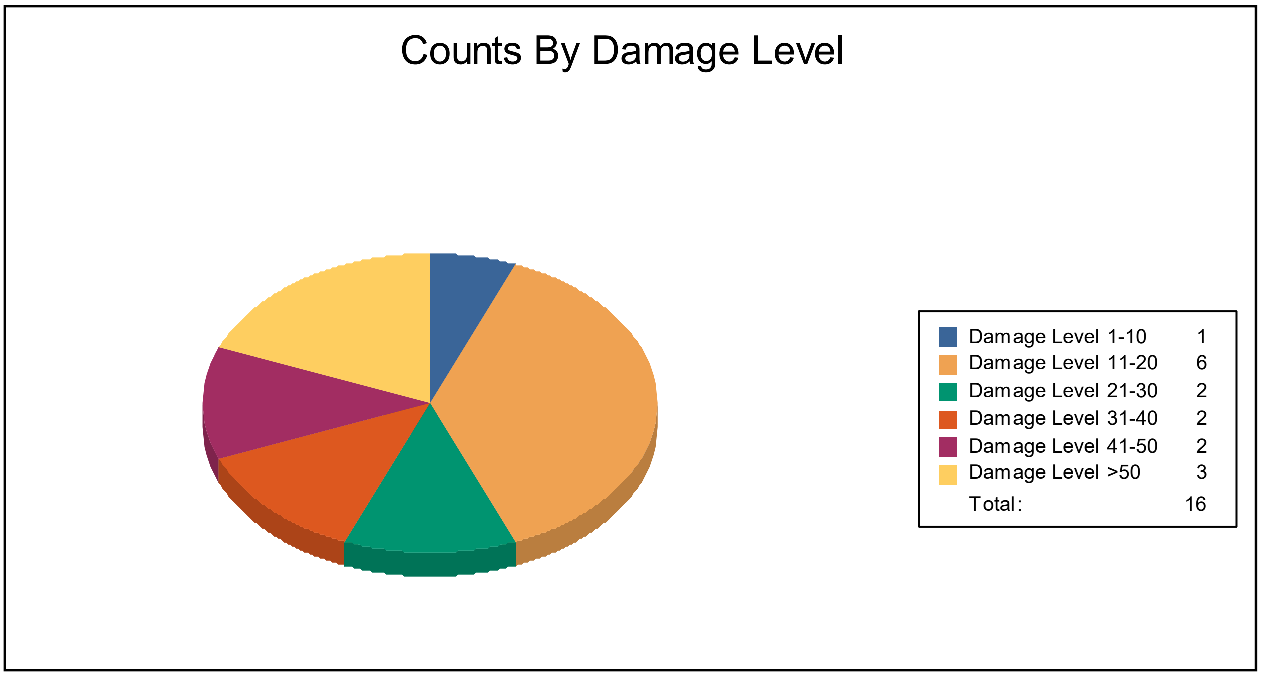


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	1	6	6	38	2	13	2	13	2	13	3	19

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Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

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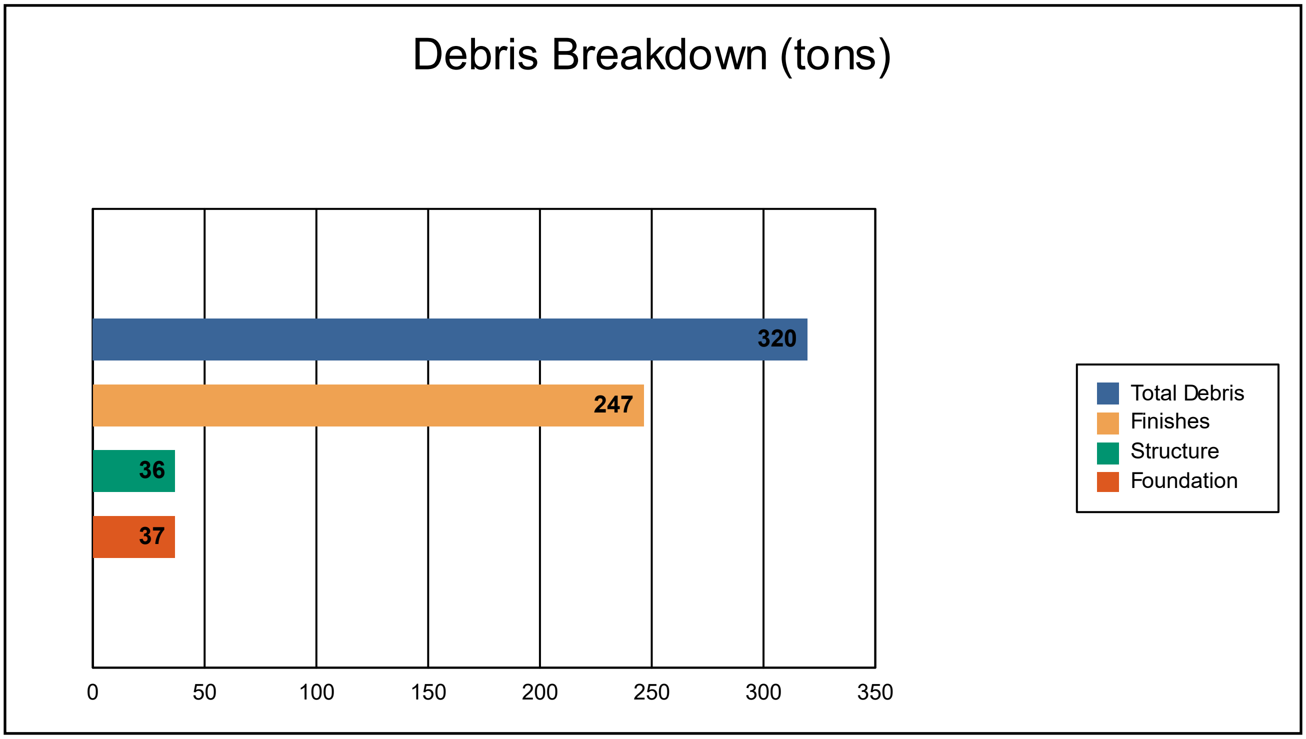
Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

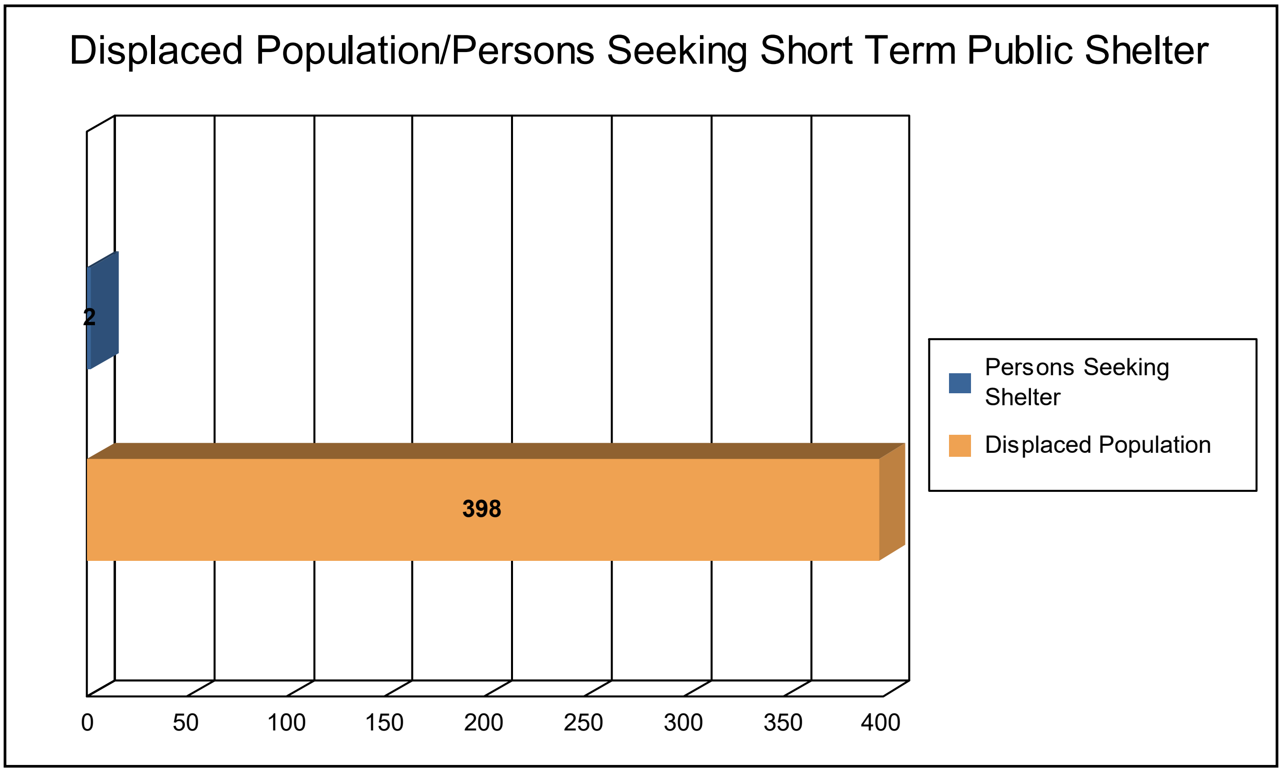


The model estimates that a total of 320 tons of debris will be generated. Of the total amount, Finishes comprises 77% of the total, Structure comprises 11% of the total, and Foundation comprises 12%. If the debris tonnage is converted into an estimated number of truckloads, it will require 13 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 133 households (or 398 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 2 people (out of a total population of 27,180) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 30.82 million dollars, which represents 2.31 % of the total replacement value of the scenario buildings.

Building-Related Losses

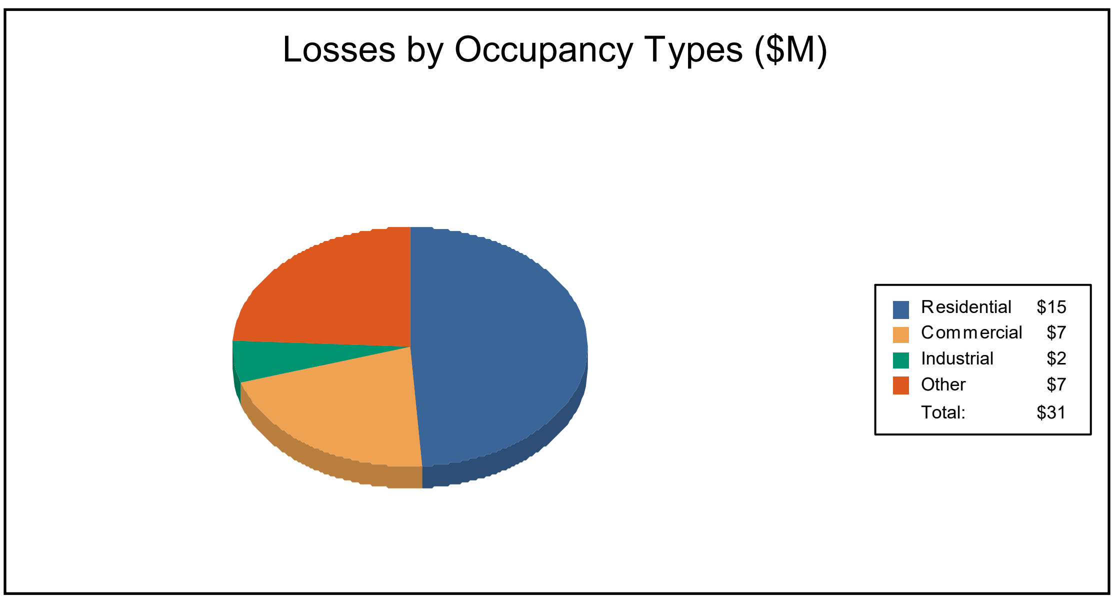
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 18.18 million dollars. 41% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 48.95% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	8.33	0.49	0.44	0.26	9.52
	Content	4.27	1.66	0.93	1.63	8.48
	Inventory	0.00	0.01	0.17	0.01	0.19
	Subtotal	**12.60**	**2.17**	**1.53**	**1.89**	**18.18**
Business Interruption						
	Income	0.00	2.07	0.03	0.71	2.81
	Relocation	1.95	0.22	0.03	0.28	2.47
	Rental Income	0.54	0.16	0.00	0.02	0.72
	Wage	0.00	2.00	0.05	4.59	6.63
	Subtotal	**2.49**	**4.44**	**0.11**	**5.60**	**12.63**
ALL	**Total**	**15.09**	**6.61**	**1.64**	**7.49**	**30.82**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	27,180	3,499,625	445,540	3,945,165
Total	**27,180**	**3,499,625**	**445,540**	**3,945,165**
Total Study Region	**27,180**	**3,499,625**	**445,540**	**3,945,165**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_5

Flood Scenario: Multi

Print Date: Thursday, August 5, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 173 square miles and contains 1,430 census blocks. The region contains over 9 thousand households and has a total population of 24,832 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 9,774 buildings in the region with a total building replacement value (excluding contents) of 3,437 million dollars. Approximately 90.65% of the buildings (and 84.66% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 9,774 buildings in the region which have an aggregate total replacement value of 3,437 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,909,982	84.7%
Commercial	227,400	6.6%
Industrial	98,717	2.9%
Agricultural	22,332	0.6%
Religion	118,912	3.5%
Government	39,615	1.2%
Education	20,149	0.6%
Total	**3,437,107**	**100%**

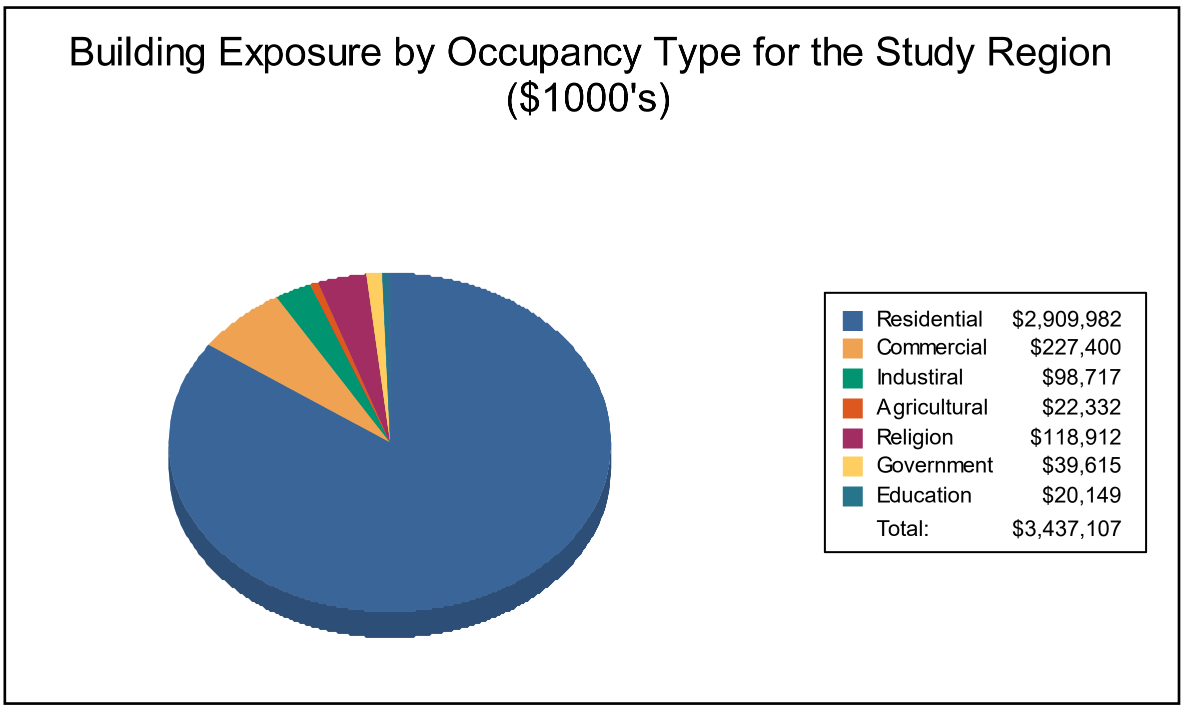
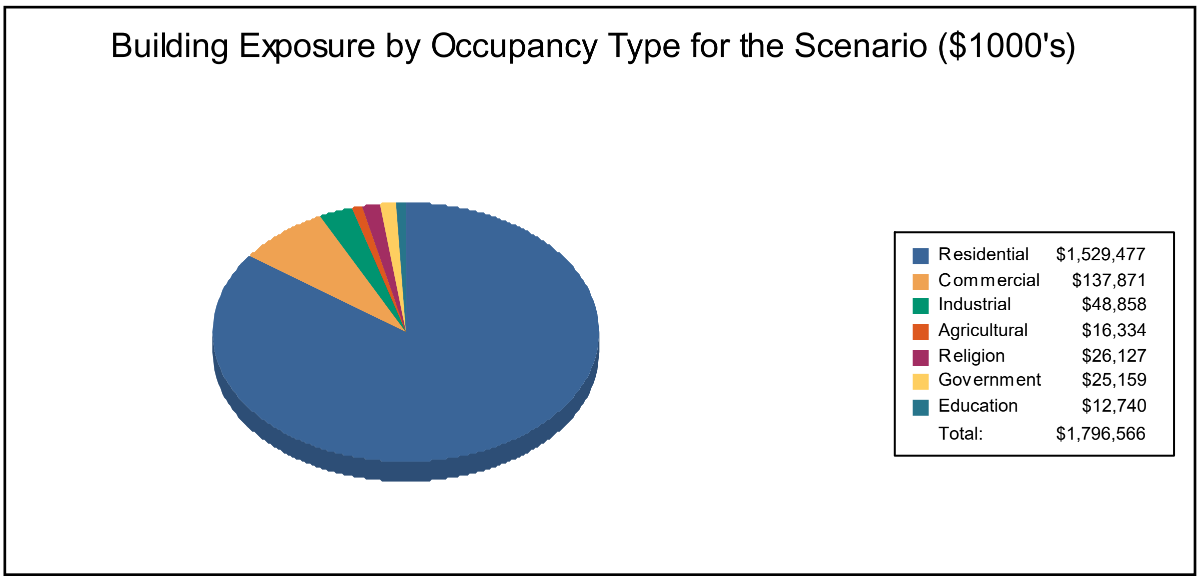


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,529,477	85.1%
Commercial	137,871	7.7%
Industrial	48,858	2.7%
Agricultural	16,334	0.9%
Religion	26,127	1.5%
Government	25,159	1.4%
Education	12,740	0.7%
Total	**1,796,566**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 11 schools, 7 fire stations, 2 police stations and no emergency operation centers.

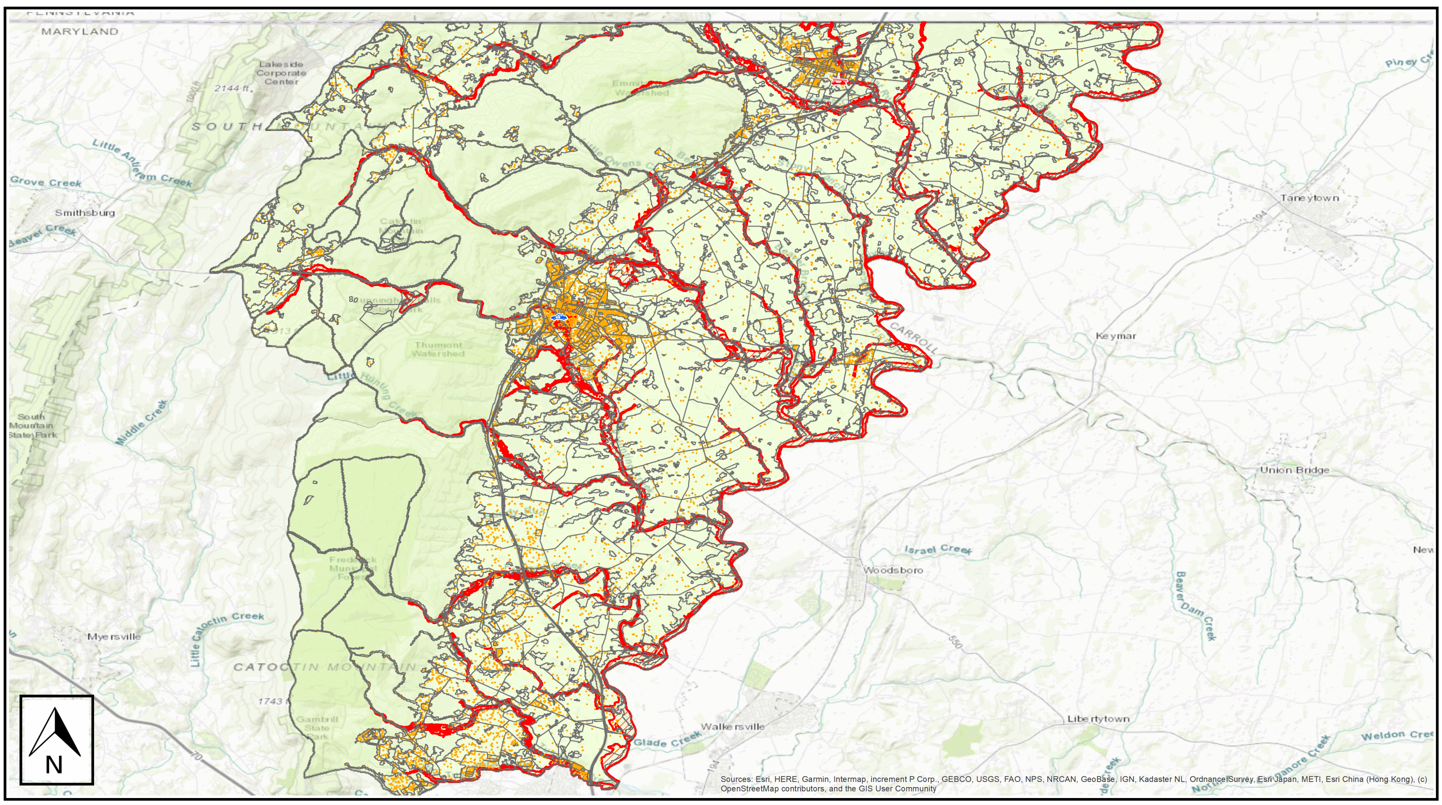
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_5
Scenario Name:	Multi
Return Period Analyzed:	25
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 16 buildings will be at least moderately damaged. This is over 56% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

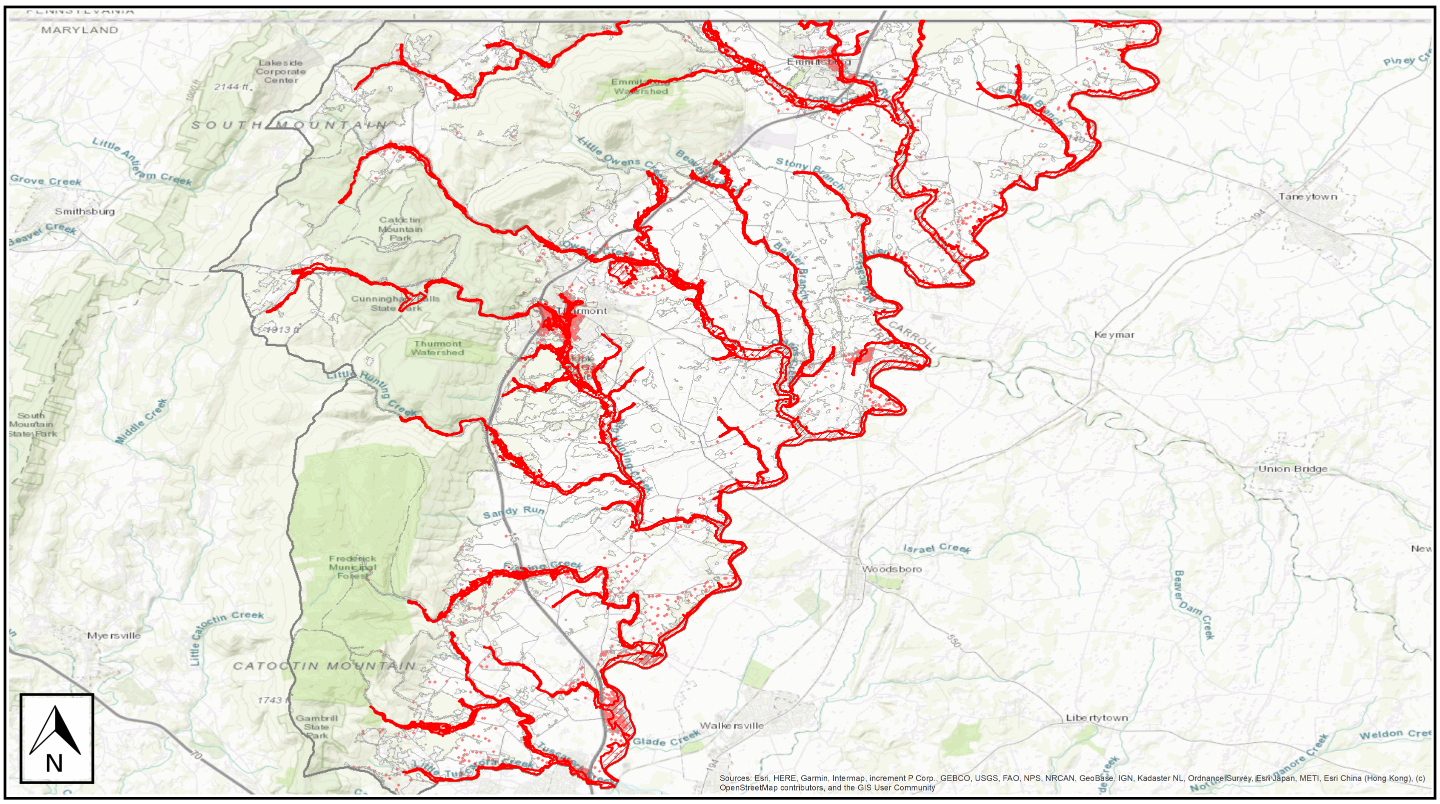


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	15	48	15	48	1	3	0	0	0	0	0	0
Total	**15**		**15**		**1**		**0**		**0**		**0**	

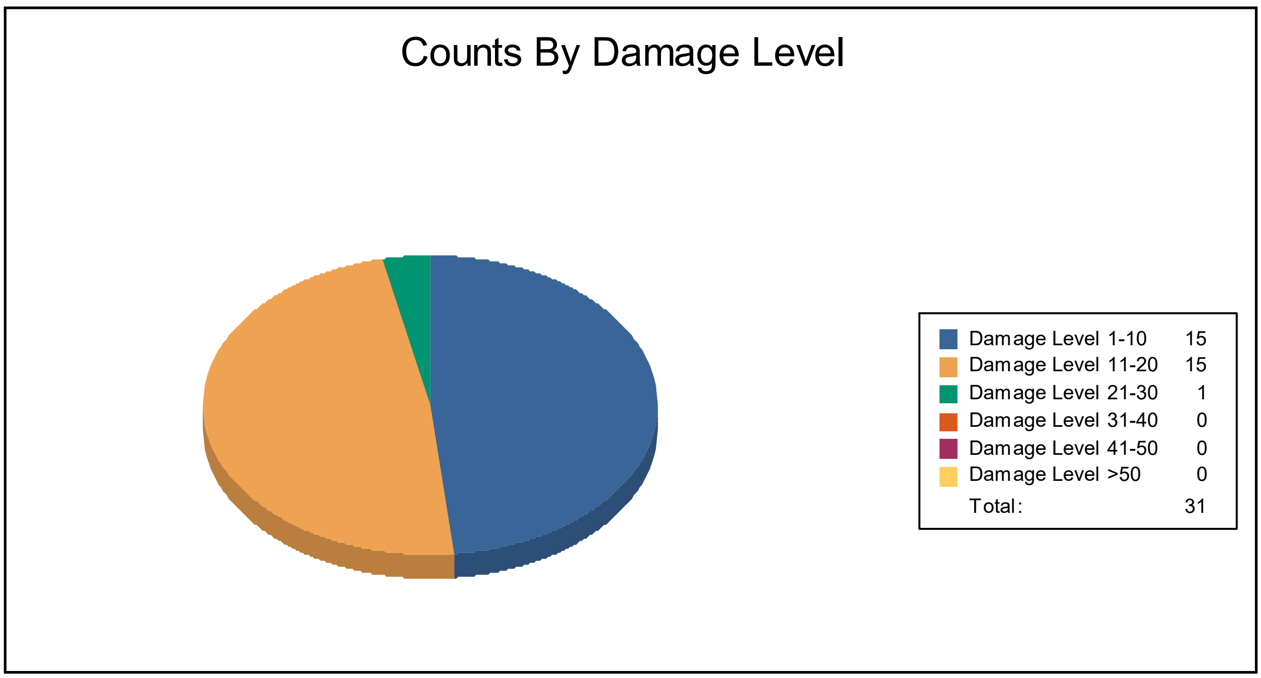


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	4	50	4	50	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	11	48	11	48	1	4	0	0	0	0	0	0

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	7	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	11	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

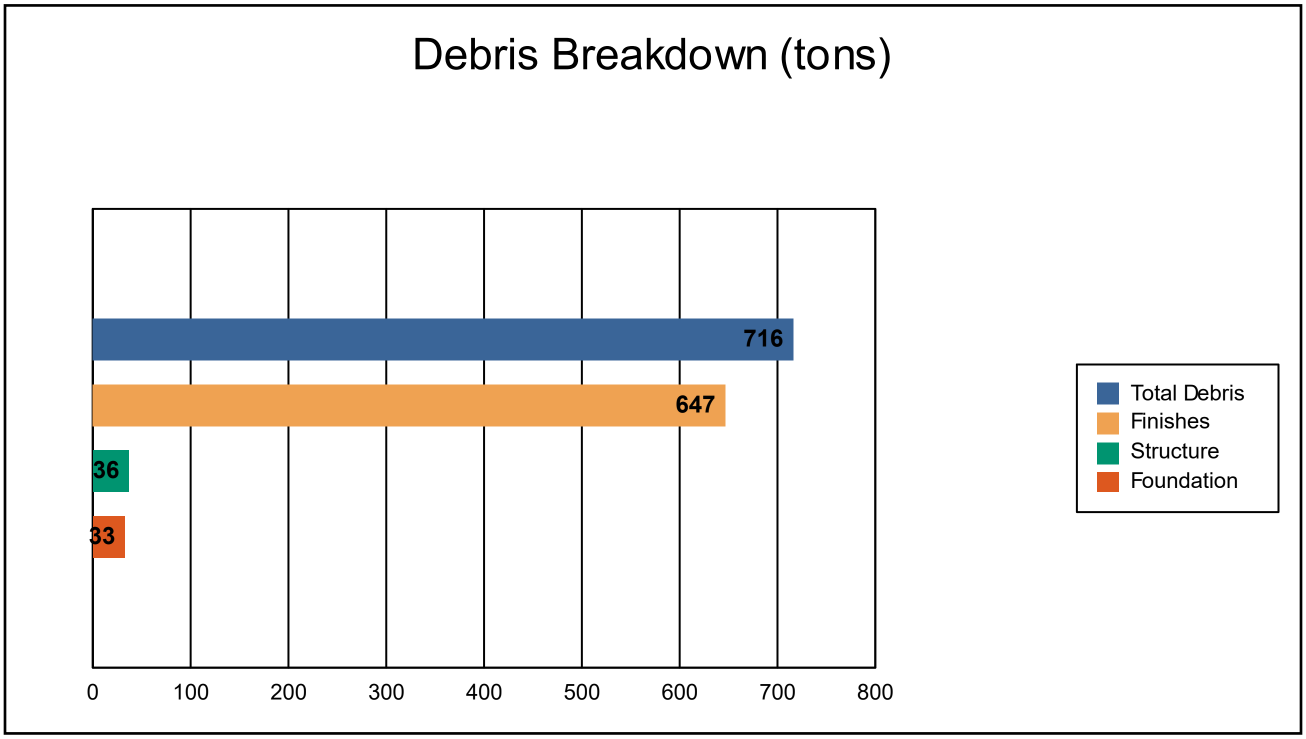
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

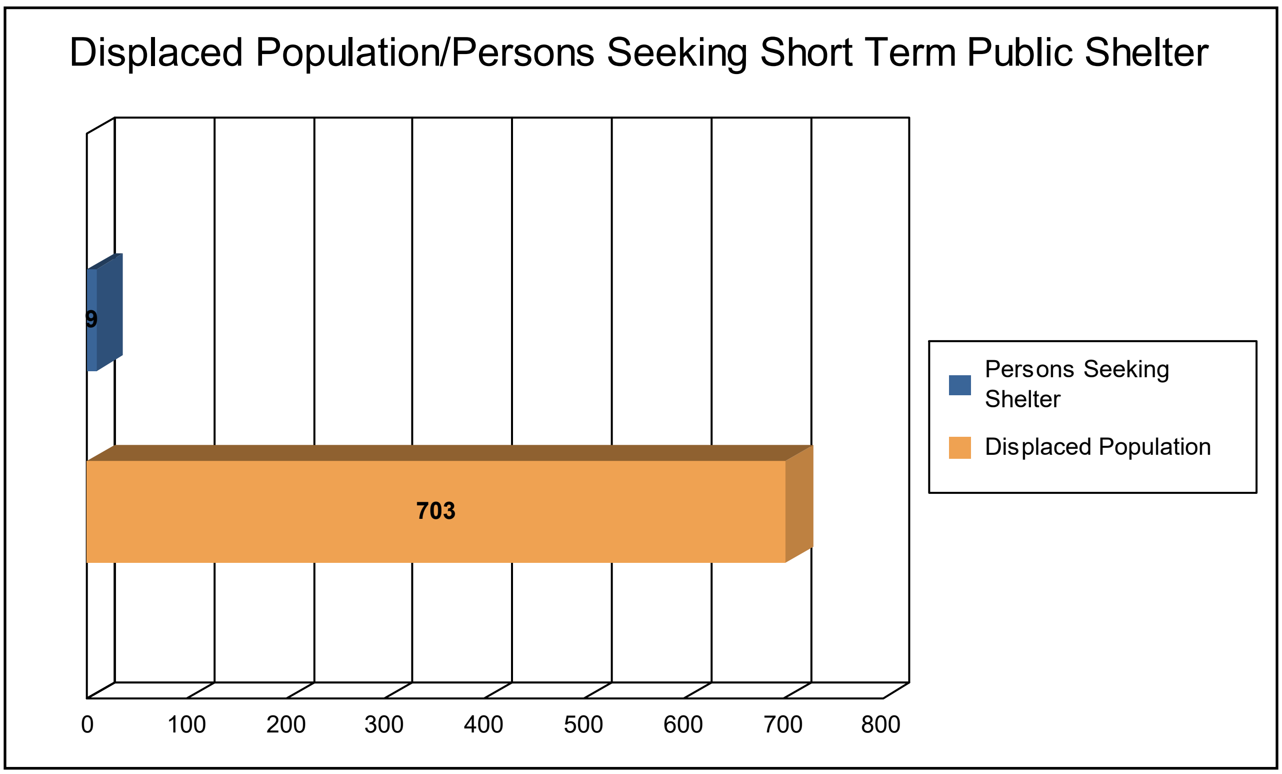


The model estimates that a total of 716 tons of debris will be generated. Of the total amount, Finishes comprises 90% of the total, Structure comprises 5% of the total, and Foundation comprises 5%. If the debris tonnage is converted into an estimated number of truckloads, it will require 29 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 234 households (or 703 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 9 people (out of a total population of 24,832) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 57.63 million dollars, which represents 3.21 % of the total replacement value of the scenario buildings.

Building-Related Losses

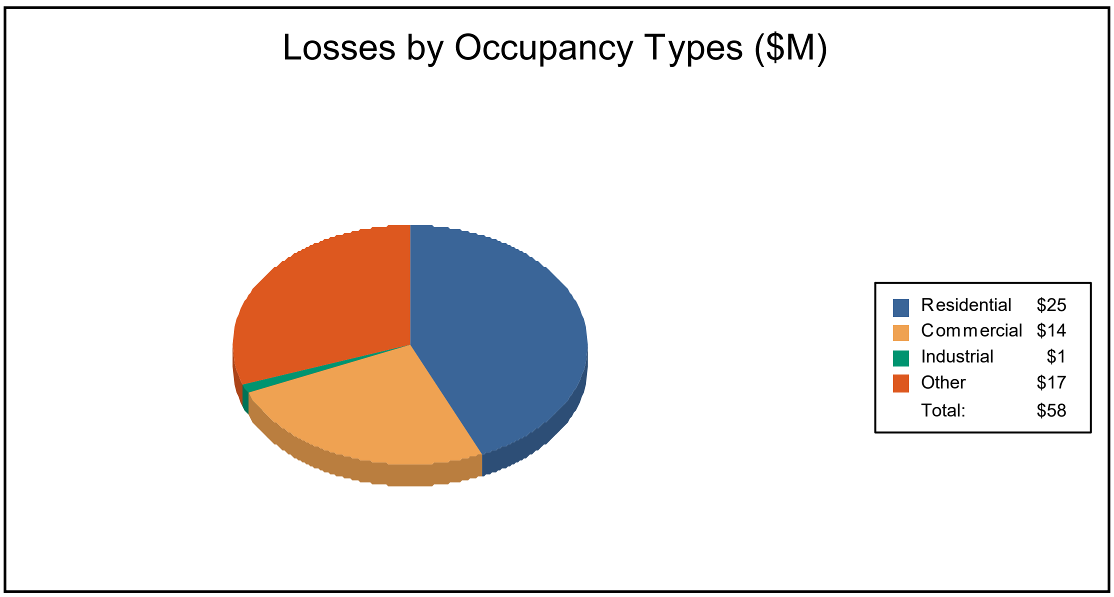
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 25.10 million dollars. 56% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 43.22% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	11.27	1.00	0.31	0.34	12.92
	Content	6.22	3.58	0.50	1.72	12.02
	Inventory	0.00	0.05	0.07	0.05	0.16
	Subtotal	**17.49**	**4.62**	**0.88**	**2.11**	**25.10**
Business Interruption						
	Income	0.69	4.43	0.01	0.77	5.90
	Relocation	3.64	0.51	0.00	0.37	4.53
	Rental Income	1.46	0.39	0.00	0.03	1.88
	Wage	1.63	4.47	0.03	14.09	20.22
	Subtotal	**7.41**	**9.80**	**0.04**	**15.27**	**32.53**
ALL	**Total**	**24.91**	**14.42**	**0.92**	**17.38**	**57.63**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Maryland				
Frederick	24,832	2,909,982	527,125	3,437,107
Total	**24,832**	**2,909,982**	**527,125**	**3,437,107**
Total Study Region	**24,832**	**2,909,982**	**527,125**	**3,437,107**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_1

Flood Scenario: Mulit

Print Date: Monday, August 2, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 154 square miles and contains 1,492 census blocks. The region contains over 13 thousand households and has a total population of 34,951 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 13,924 buildings in the region with a total building replacement value (excluding contents) of 4,884 million dollars. Approximately 92.06% of the buildings (and 89.46% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 13,924 buildings in the region which have an aggregate total replacement value of 4,884 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,369,448	89.5%
Commercial	298,832	6.1%
Industrial	83,521	1.7%
Agricultural	23,904	0.5%
Religion	65,399	1.3%
Government	17,551	0.4%
Education	25,330	0.5%
Total	**4,883,985**	**100%**

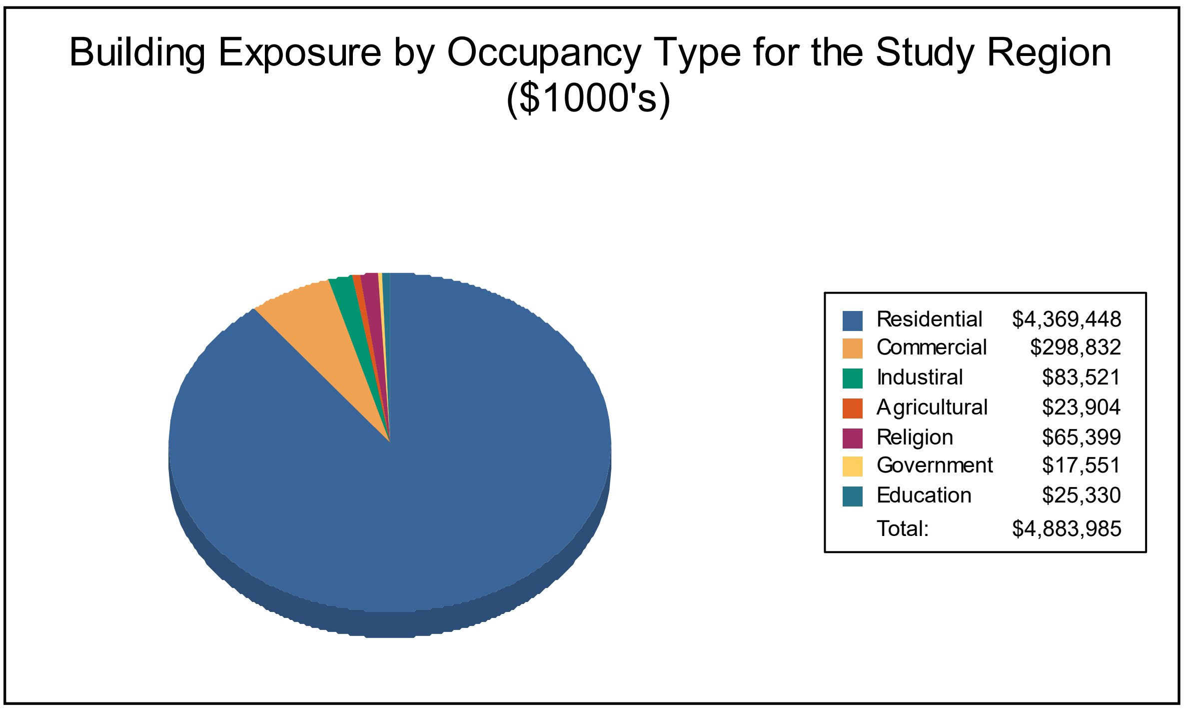
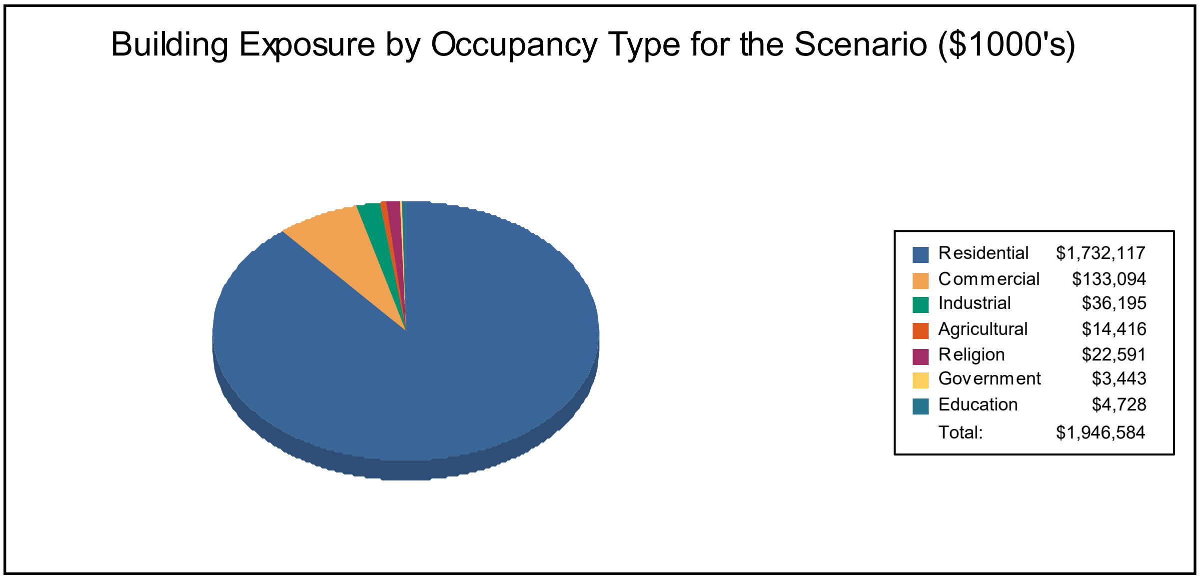


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,732,117	89.0%
Commercial	133,094	6.8%
Industrial	36,195	1.9%
Agricultural	14,416	0.7%
Religion	22,591	1.2%
Government	3,443	0.2%
Education	4,728	0.2%
Total	**1,946,584**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 14 schools, 6 fire stations, 2 police stations and no emergency operation centers.

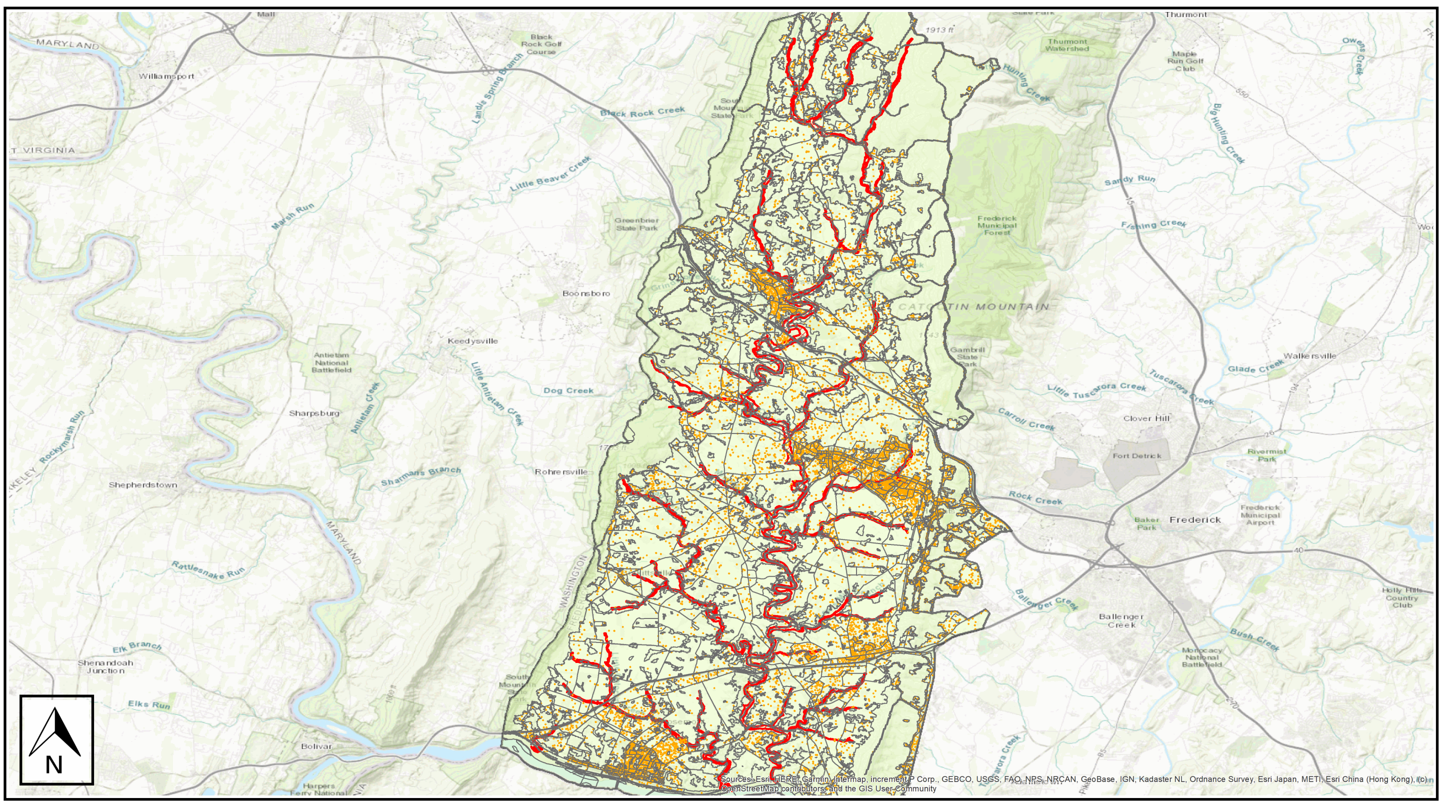
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_1
Scenario Name:	Mulit
Return Period Analyzed:	50
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 8 buildings will be at least moderately damaged. This is over 76% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

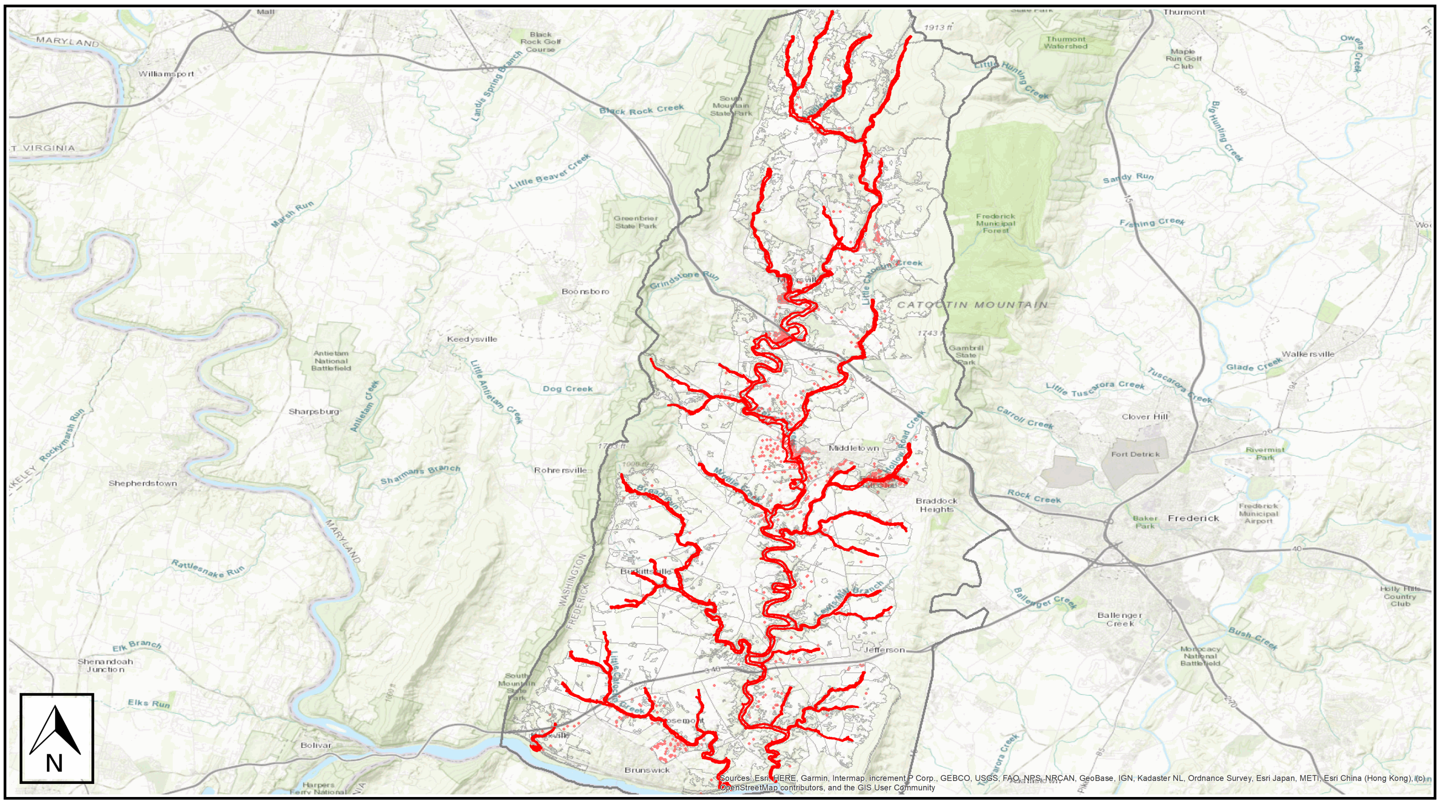


Table 3: Expected Building Damage by Occupancy

Occupancy	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	>50 Count	>50 (%)
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	5	38	8	62	0	0	0	0	0	0	0	0
Total	**5**		**8**		**0**		**0**		**0**		**0**	

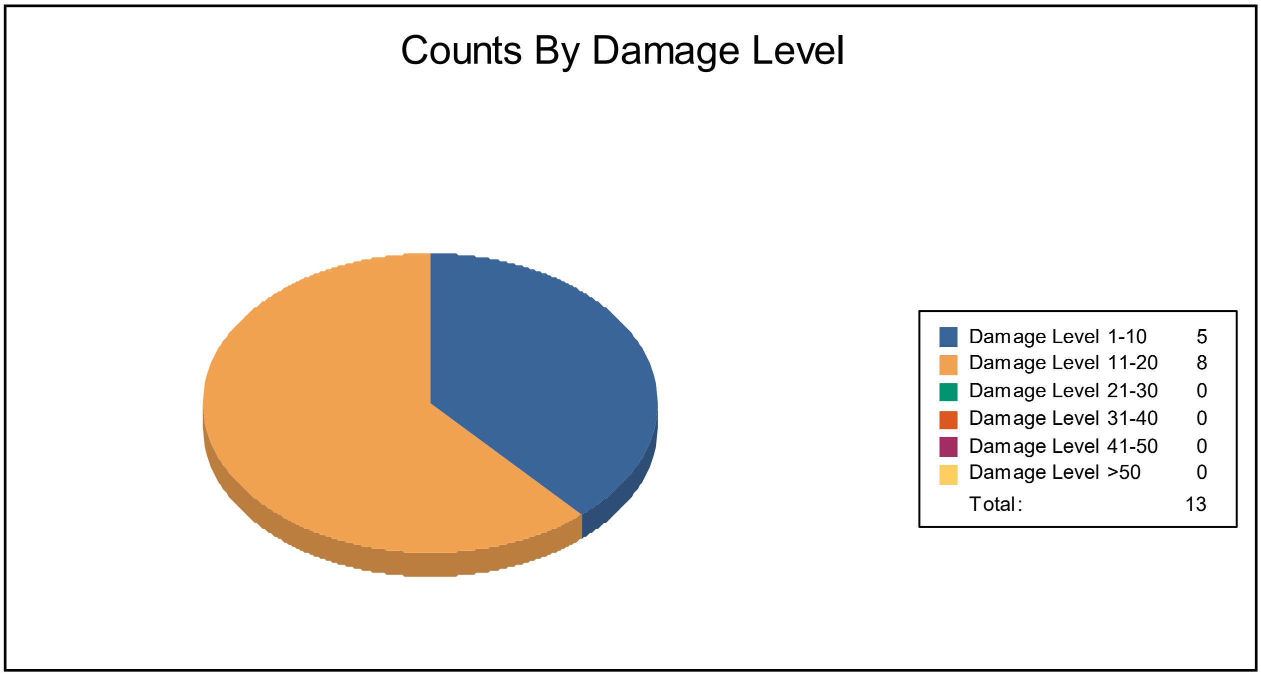


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	5	38	8	62	0	0	0	0	0	0	0	0

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Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	6	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	14	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

FEMA

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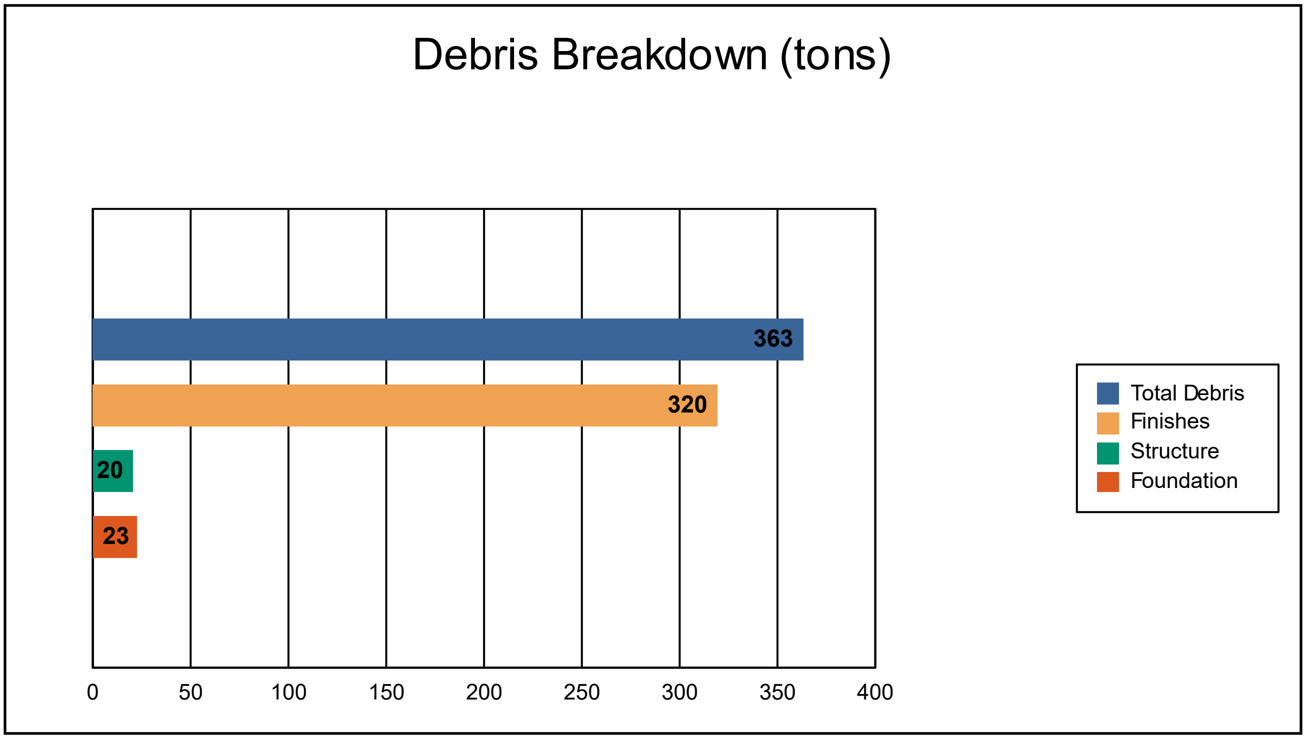
Increasing Resilience Together

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.



The model estimates that a total of 363 tons of debris will be generated. Of the total amount, Finishes comprises 88% of the total, Structure comprises 6% of the total, and Foundation comprises 6%. If the debris tonnage is converted into an estimated number of truckloads, it will require 15 truckloads (@25 tons/truck) to remove the debris generated by the flood.

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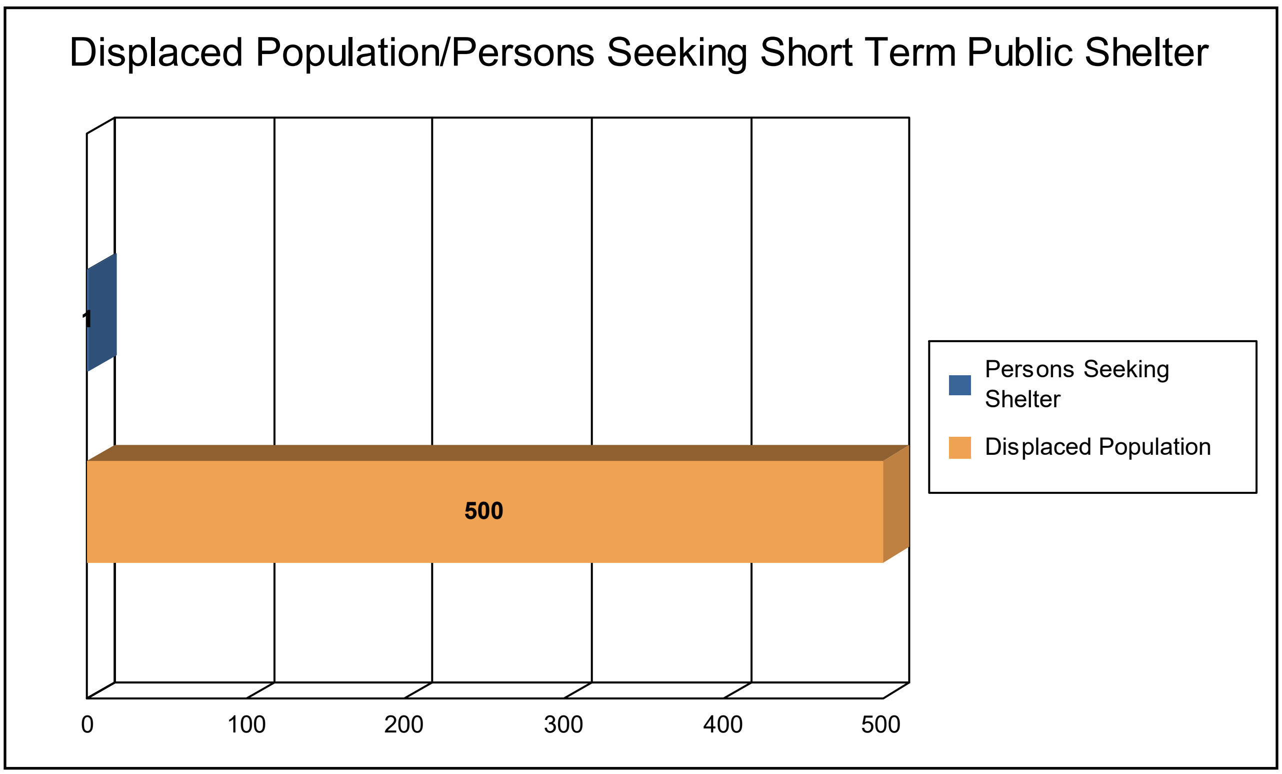
Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 167 households (or 500 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1 people (out of a total population of 34,951) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 37.28 million dollars, which represents 1.91 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 21.33 million dollars. 43% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 50.84% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

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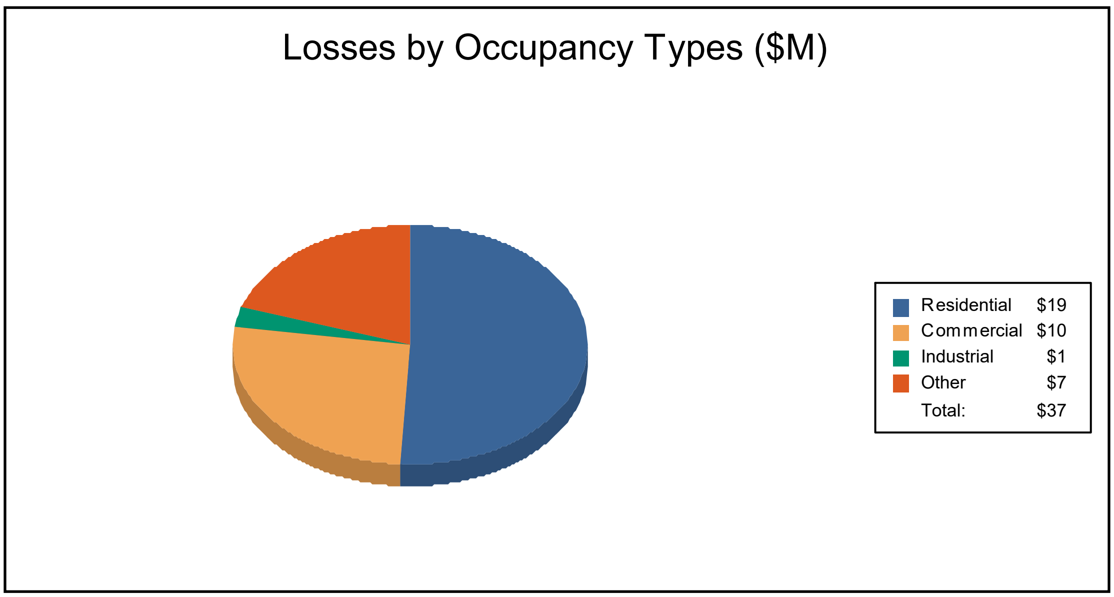
Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	10.52	0.78	0.29	0.17	11.75
	Content	5.41	2.50	0.52	1.05	9.47
	Inventory	0.00	0.02	0.08	0.01	0.10
	Subtotal	**15.93**	**3.29**	**0.88**	**1.23**	**21.33**
Business Interruption						
	Income	0.04	3.13	0.01	0.31	3.49
	Relocation	2.24	0.34	0.01	0.13	2.72
	Rental Income	0.64	0.17	0.00	0.01	0.82
	Wage	0.11	3.03	0.02	5.77	8.92
	Subtotal	**3.03**	**6.67**	**0.03**	**6.22**	**15.95**
ALL	**Total**	**18.95**	**9.96**	**0.91**	**7.46**	**37.28**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Frederick	34,951	4,369,448	514,537	4,883,985
Total	**34,951**	**4,369,448**	**514,537**	**4,883,985**
Total Study Region	**34,951**	**4,369,448**	**514,537**	**4,883,985**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_2

Flood Scenario: Multi

Print Date: Tuesday, August 3, 2021

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 128 square miles and contains 1,470 census blocks. The region contains over 13 thousand households and has a total population of 39,698 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 14,322 buildings in the region with a total building replacement value (excluding contents) of 6,331 million dollars. Approximately 92.32% of the buildings (and 82.33% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 14,322 buildings in the region which have an aggregate total replacement value of 6,331 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	5,212,418	82.3%
Commercial	386,876	6.1%
Industrial	595,666	9.4%
Agricultural	33,020	0.5%
Religion	58,625	0.9%
Government	25,544	0.4%
Education	18,866	0.3%
Total	**6,331,015**	**100%**

Building Exposure by Occupancy Type for the Study Region ($1000's)

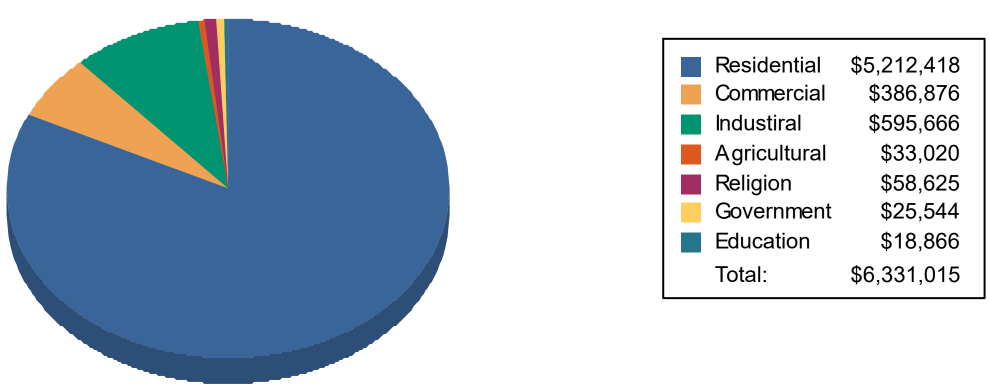
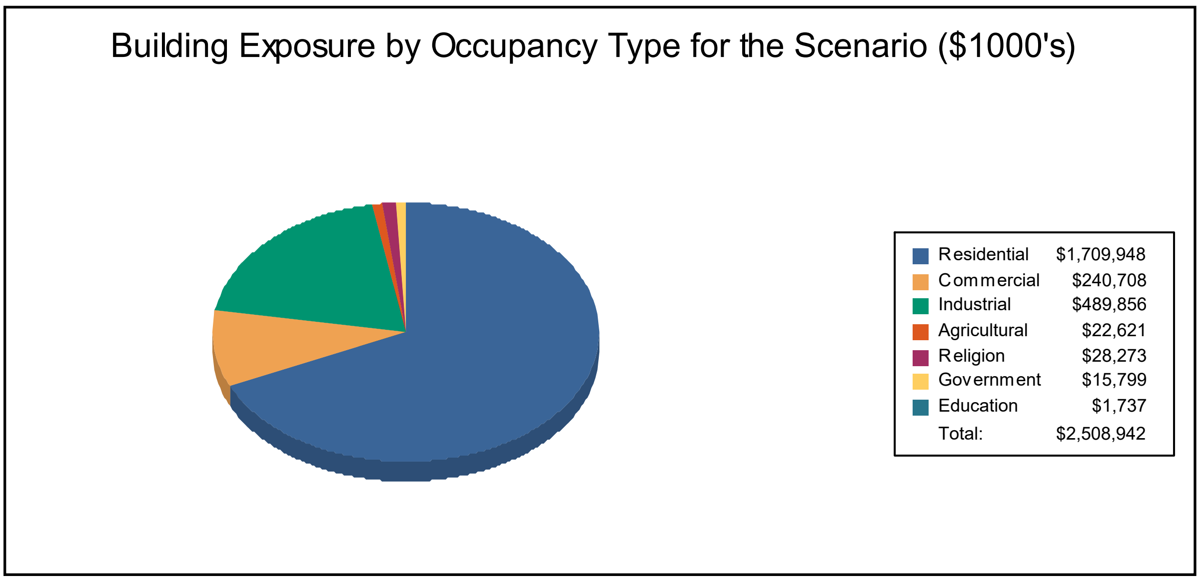


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,709,948	68.2%
Commercial	240,708	9.6%
Industrial	489,856	19.5%
Agricultural	22,621	0.9%
Religion	28,273	1.1%
Government	15,799	0.6%
Education	1,737	0.1%
Total	**2,508,942**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

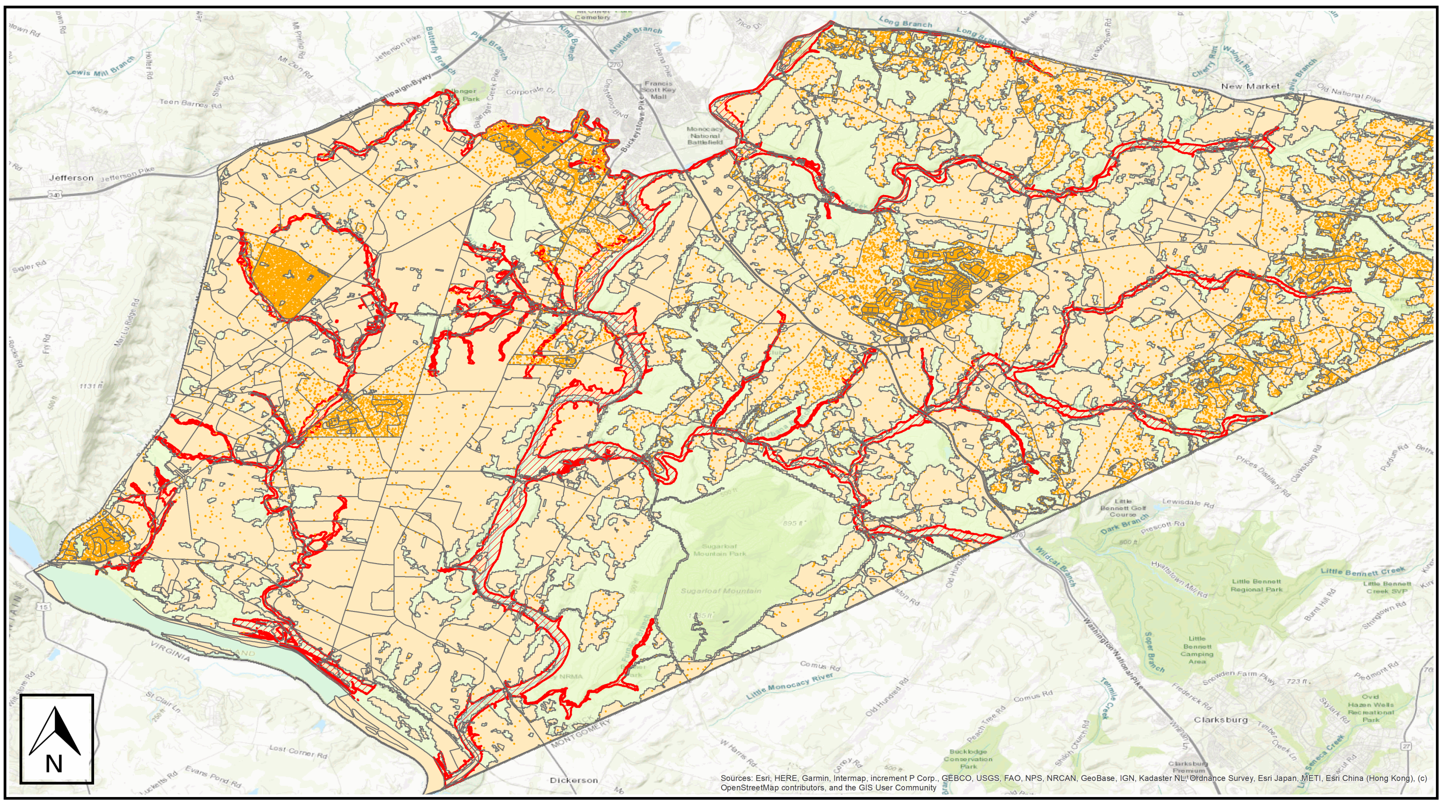
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_2
Scenario Name:	Multi
Return Period Analyzed:	50
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 91 buildings will be at least moderately damaged. This is over 43% of the total number of buildings in the scenario. There are an estimated 28 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

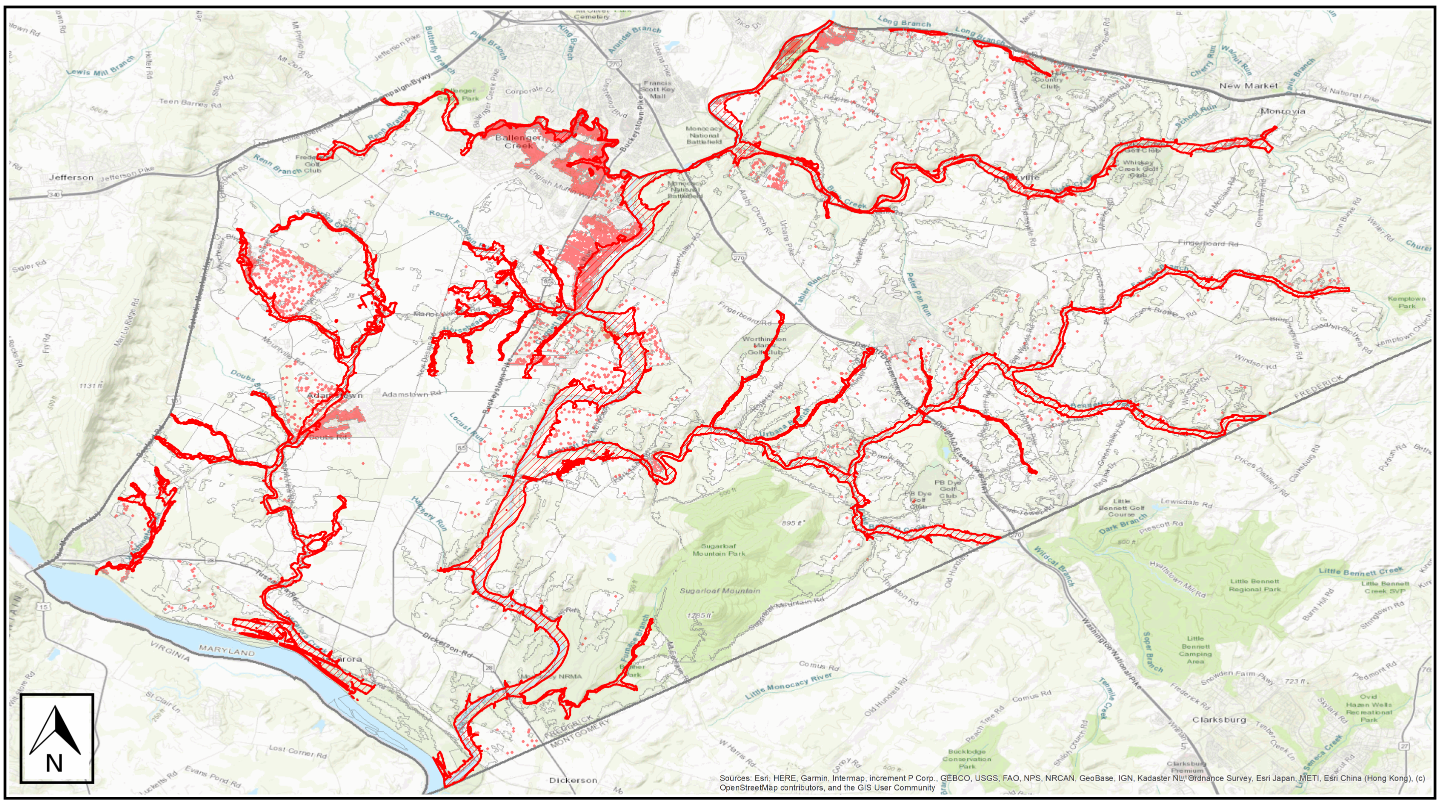


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	12	12	22	21	14	14	17	17	10	10	28	27
Total	**12**		**22**		**14**		**17**		**10**		**28**	

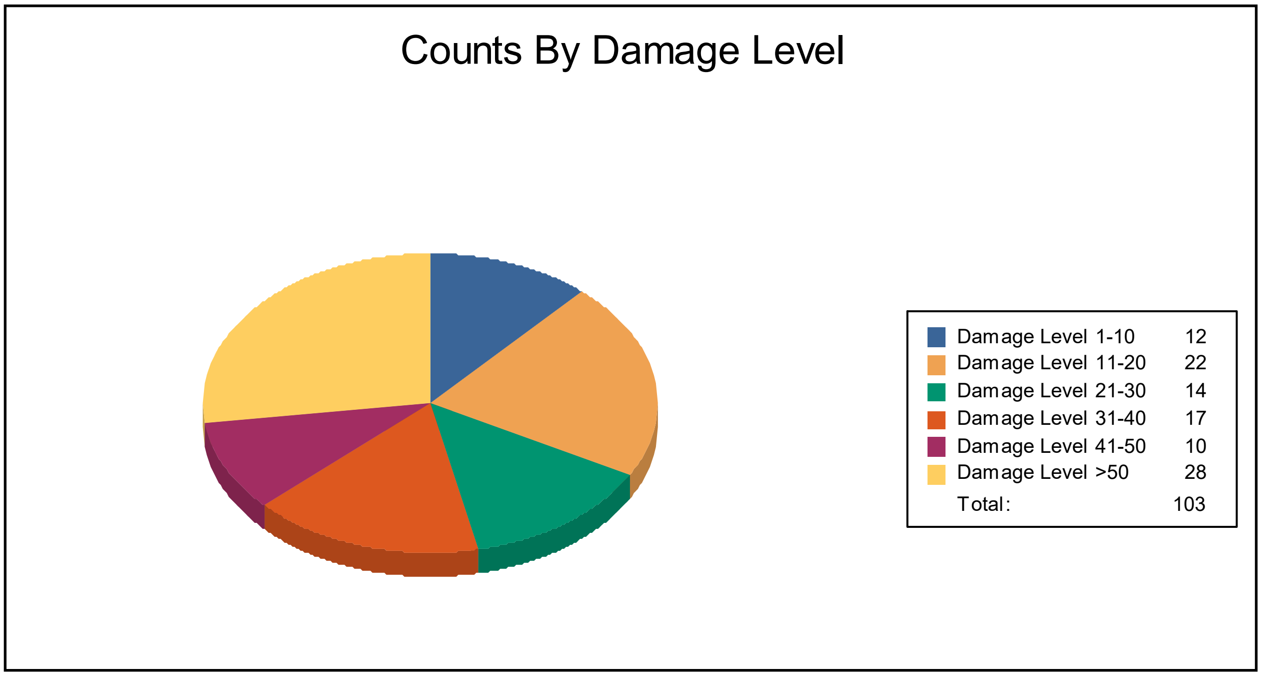


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	3	11	6	22	4	15	4	15	3	11	7	26
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	9	12	16	21	10	13	13	17	7	9	21	28

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

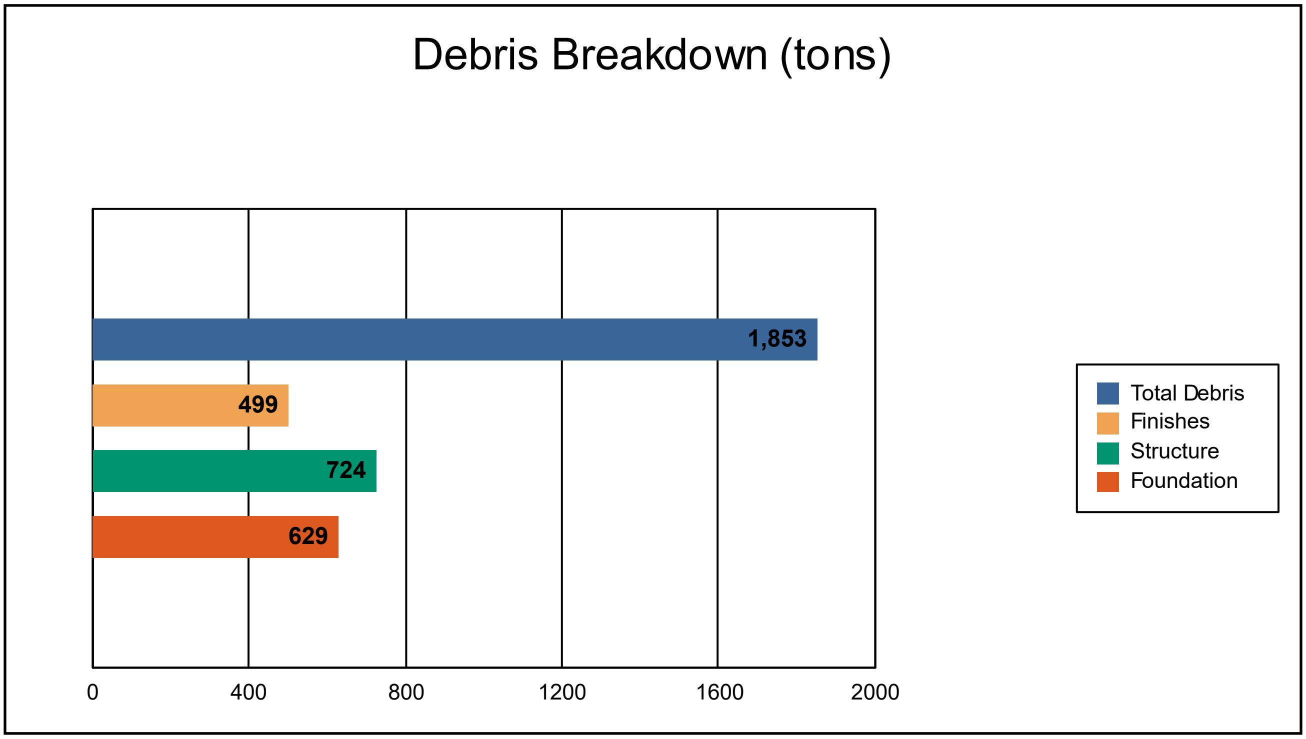
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

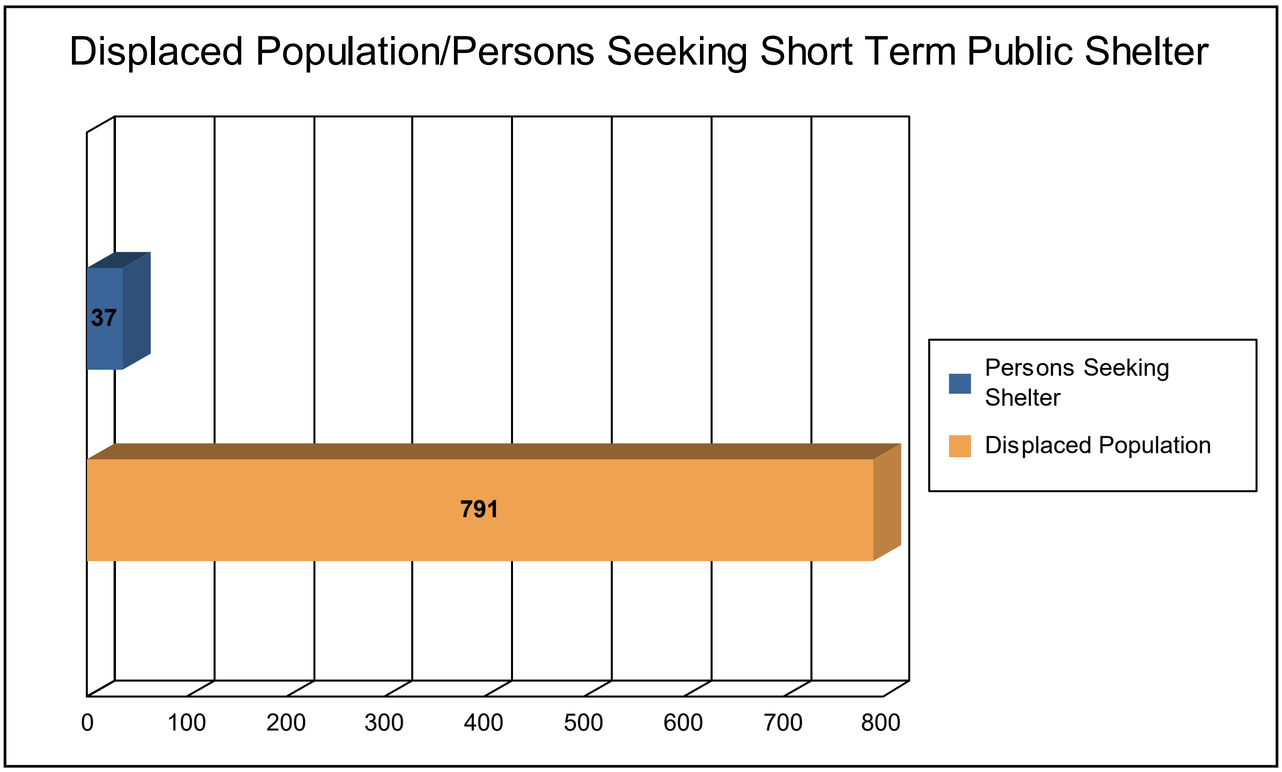


The model estimates that a total of 1,853 tons of debris will be generated. Of the total amount, Finishes comprises 27% of the total, Structure comprises 39% of the total, and Foundation comprises 34%. If the debris tonnage is converted into an estimated number of truckloads, it will require 75 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 264 households (or 791 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 37 people (out of a total population of 39,698) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 105.19 million dollars, which represents 4.19 % of the total replacement value of the scenario buildings.

Building-Related Losses

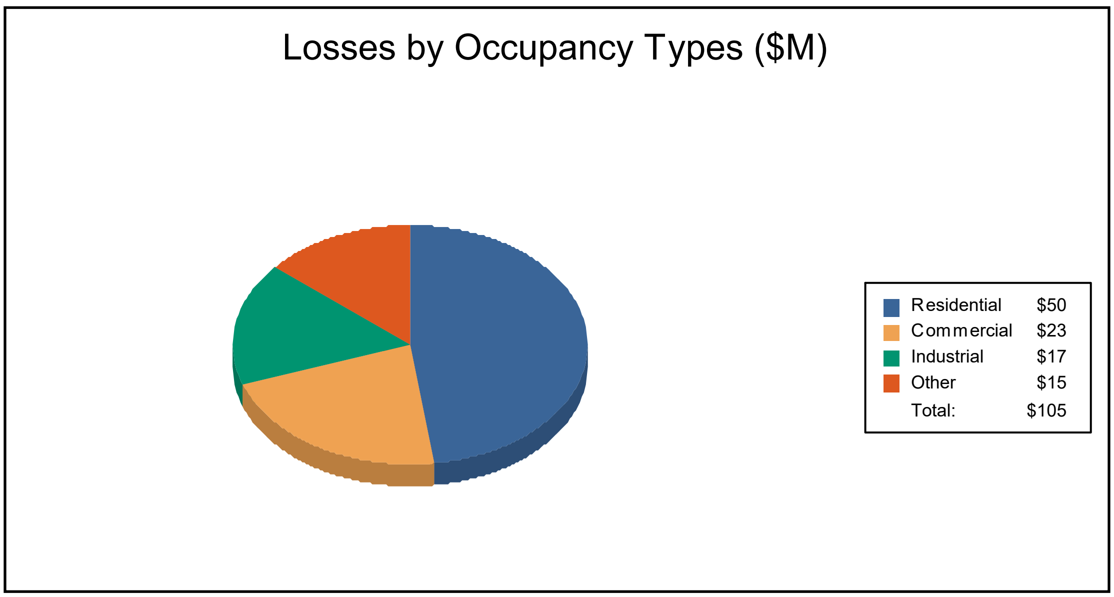
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 74.90 million dollars. 29% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 47.73% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	28.26	3.40	4.00	1.02	36.68
	Content	14.73	8.03	10.25	3.24	36.24
	Inventory	0.00	0.23	1.56	0.20	1.99
	Subtotal	**42.99**	**11.66**	**15.80**	**4.45**	**74.90**
Business Interruption						
	Income	0.25	5.19	0.49	0.74	6.66
	Relocation	4.67	0.83	0.30	0.16	5.95
	Rental Income	1.73	0.62	0.07	0.00	2.42
	Wage	0.59	4.94	0.50	9.24	15.27
	Subtotal	**7.22**	**11.57**	**1.36**	**10.14**	**30.29**
ALL	**Total**	**50.21**	**23.23**	**17.16**	**14.59**	**105.19**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Maryland				
Frederick	39,698	5,212,418	1,118,597	6,331,015
Total	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**
Total Study Region	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_3

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 73 square miles and contains 2,890 census blocks. The region contains over 41 thousand households and has a total population of 106,724 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 36,786 buildings in the region with a total building replacement value (excluding contents) of 15,635 million dollars. Approximately 90.42% of the buildings (and 78.16% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 36,786 buildings in the region which have an aggregate total replacement value of 15,635 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	12,220,022	78.2%
Commercial	2,296,995	14.7%
Industrial	454,425	2.9%
Agricultural	26,557	0.2%
Religion	222,953	1.4%
Government	170,628	1.1%
Education	243,455	1.6%
Total	**15,635,035**	**100%**

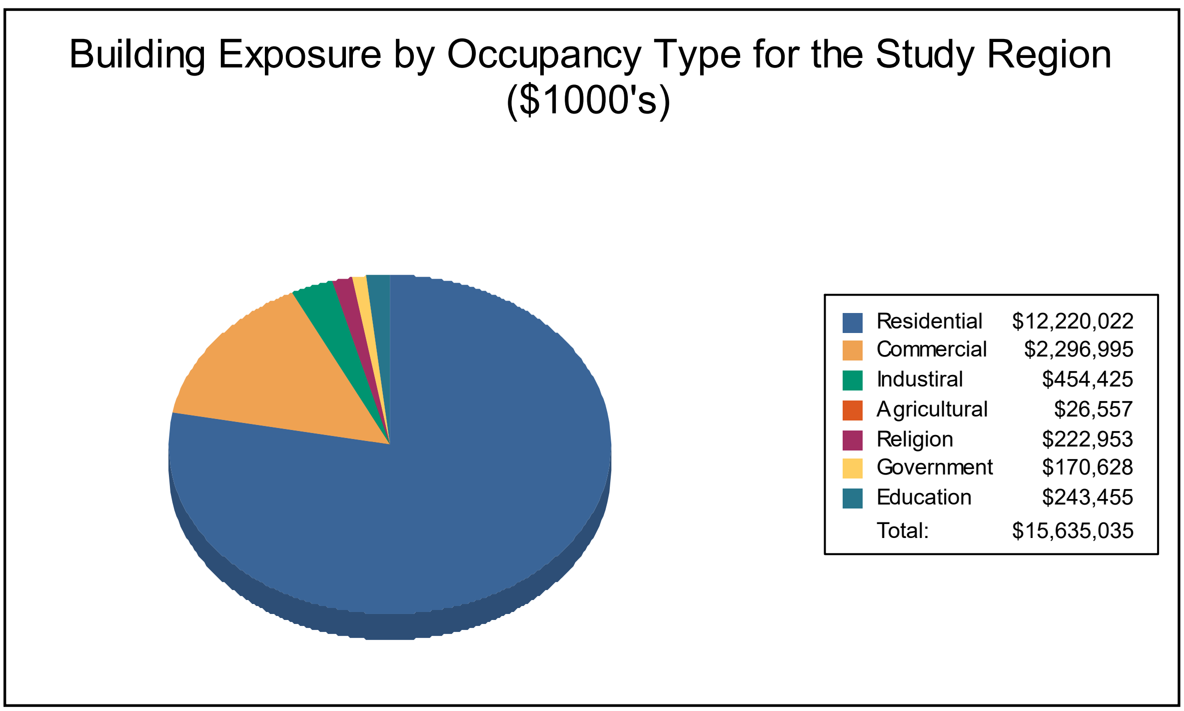
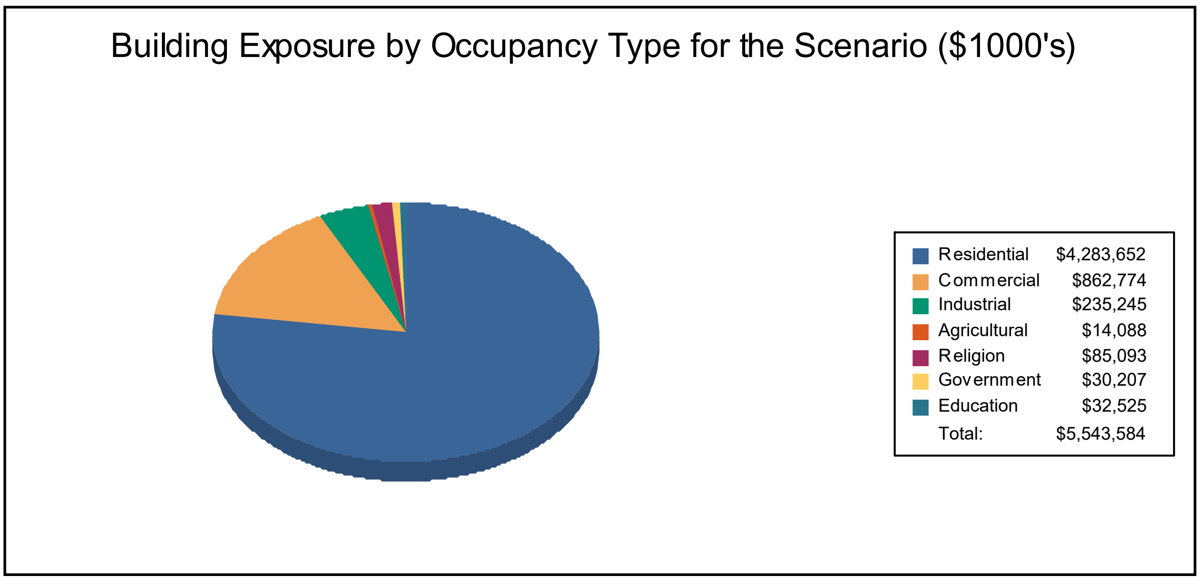


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,283,652	77.3%
Commercial	862,774	15.6%
Industrial	235,245	4.2%
Agricultural	14,088	0.3%
Religion	85,093	1.5%
Government	30,207	0.5%
Education	32,525	0.6%
Total	**5,543,584**	**100%**



Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 48 schools, 10 fire stations, 7 police stations and 2 emergency operation centers.

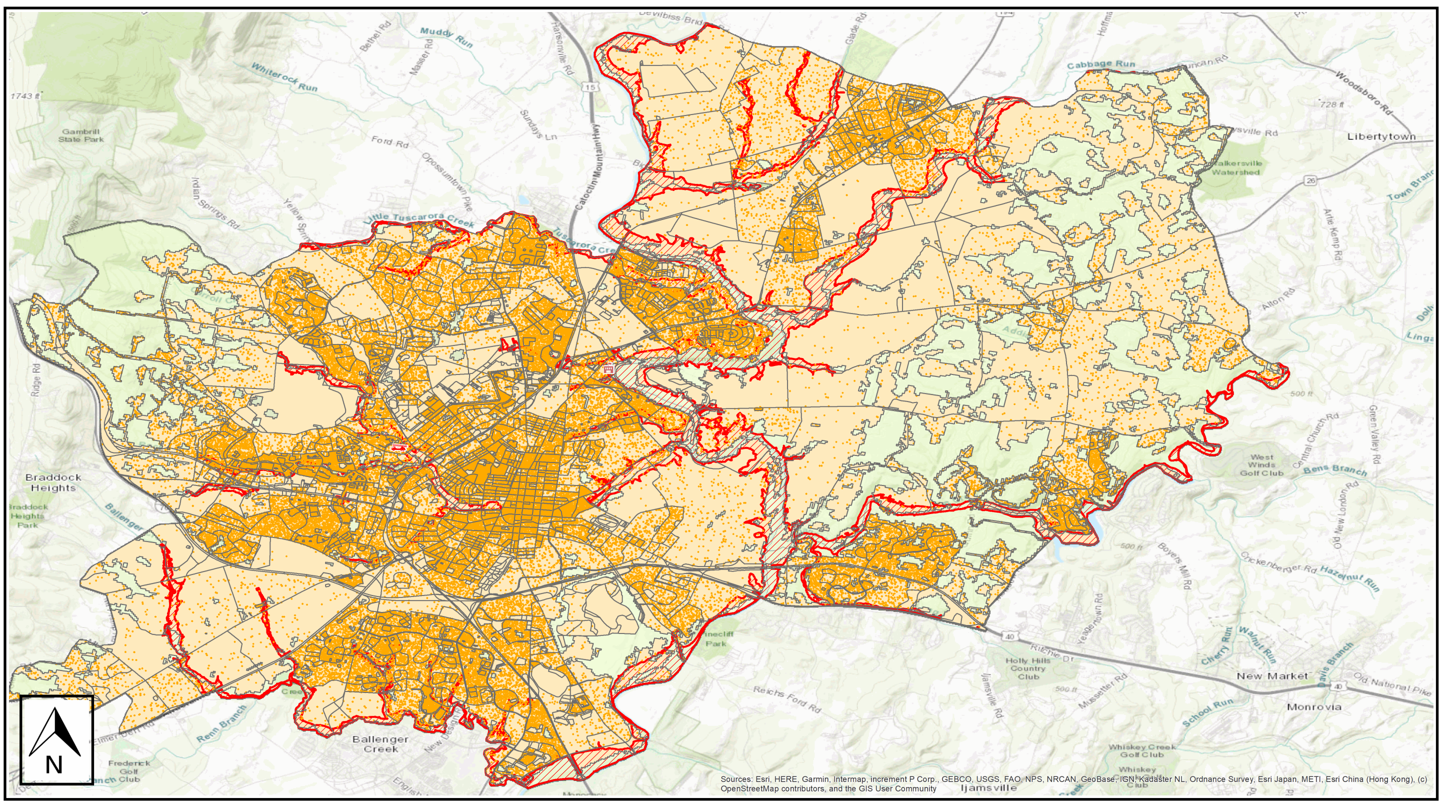
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_3
Scenario Name:	Multi
Return Period Analyzed:	50
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 389 buildings will be at least moderately damaged. This is over 55% of the total number of buildings in the scenario. There are an estimated 76 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

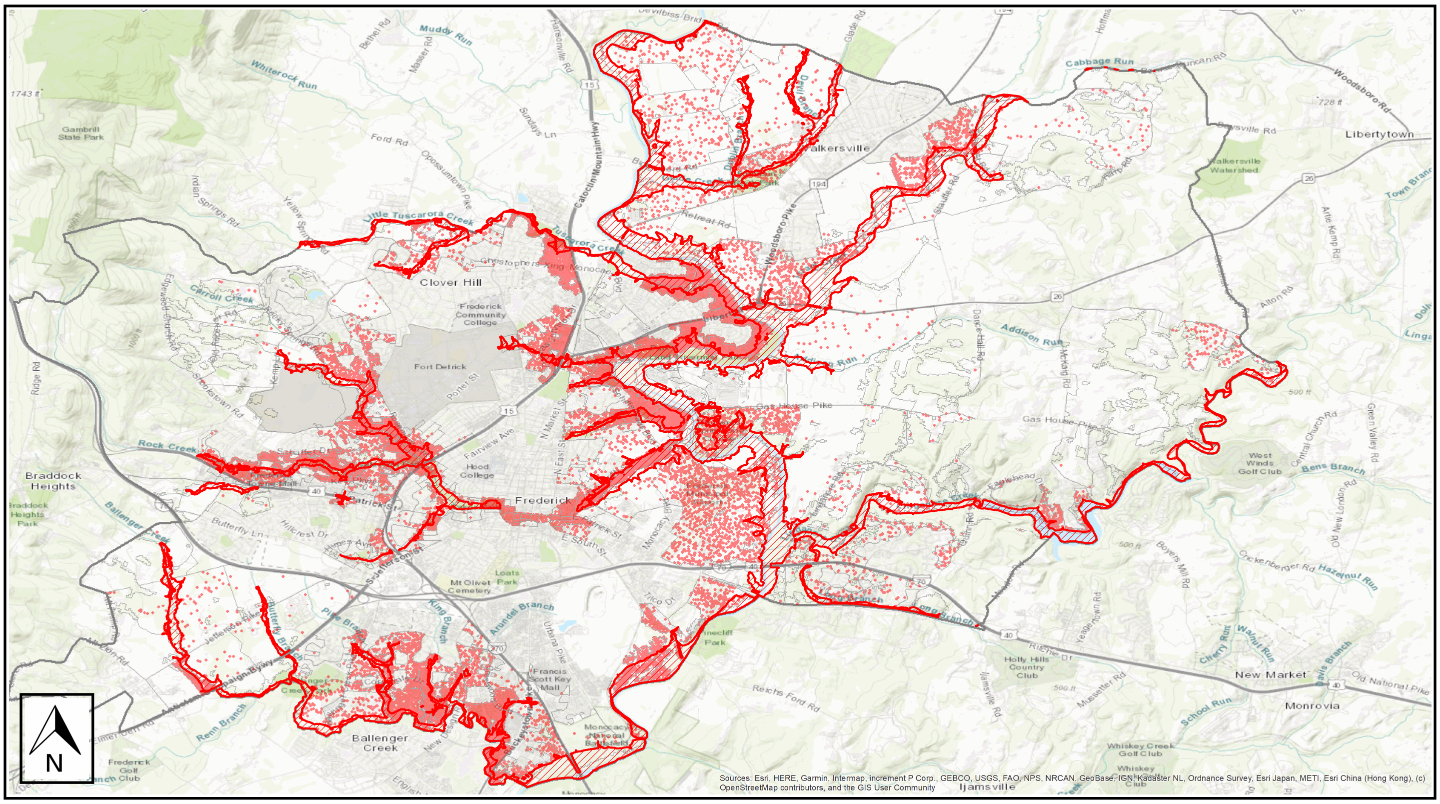


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	6	100	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	101	21	159	33	68	14	53	11	27	6	76	16
Total	**101**		**165**		**68**		**53**		**27**		**76**	

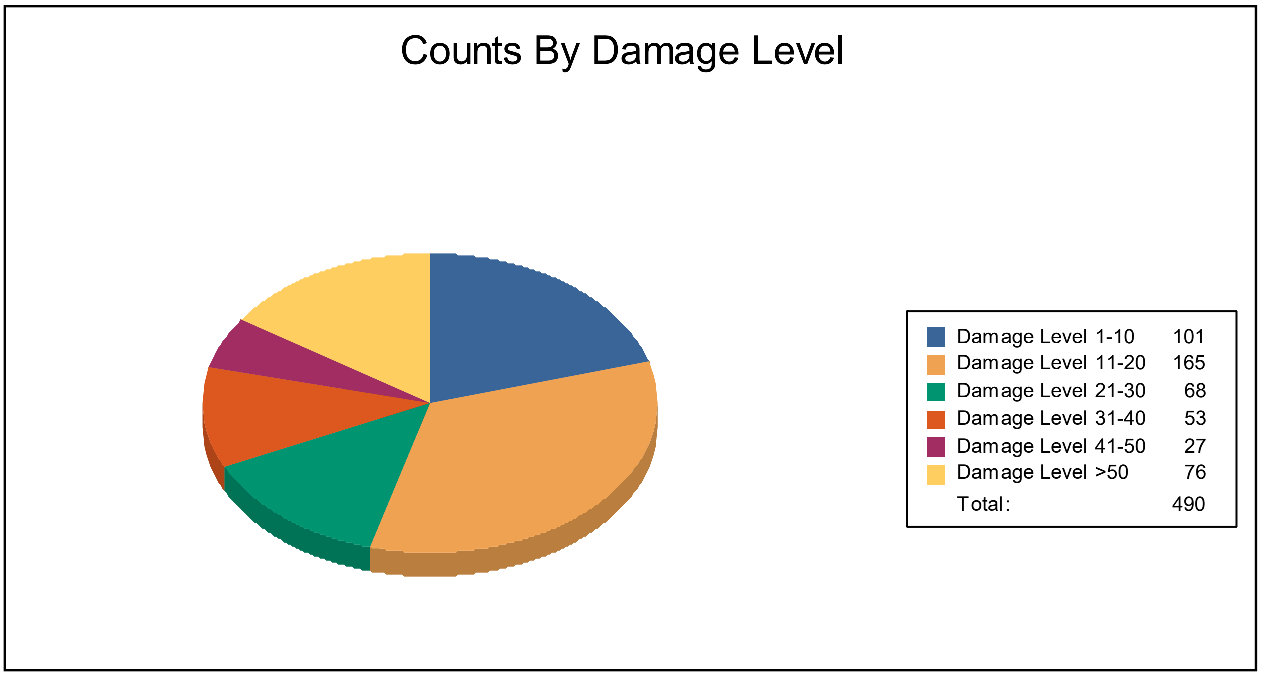


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	26	20	44	34	20	15	17	13	6	5	18	14
Steel	0	0	2	100	0	0	0	0	0	0	0	0
Wood	75	21	116	33	48	14	36	10	21	6	58	16

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 308 hospital beds available for use. On the day of the scenario flood event, the model estimates that 308 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	2	0	0	0
Fire Stations	10	1	0	0
Hospitals	1	0	0	0
Police Stations	7	0	0	0
Schools	48	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

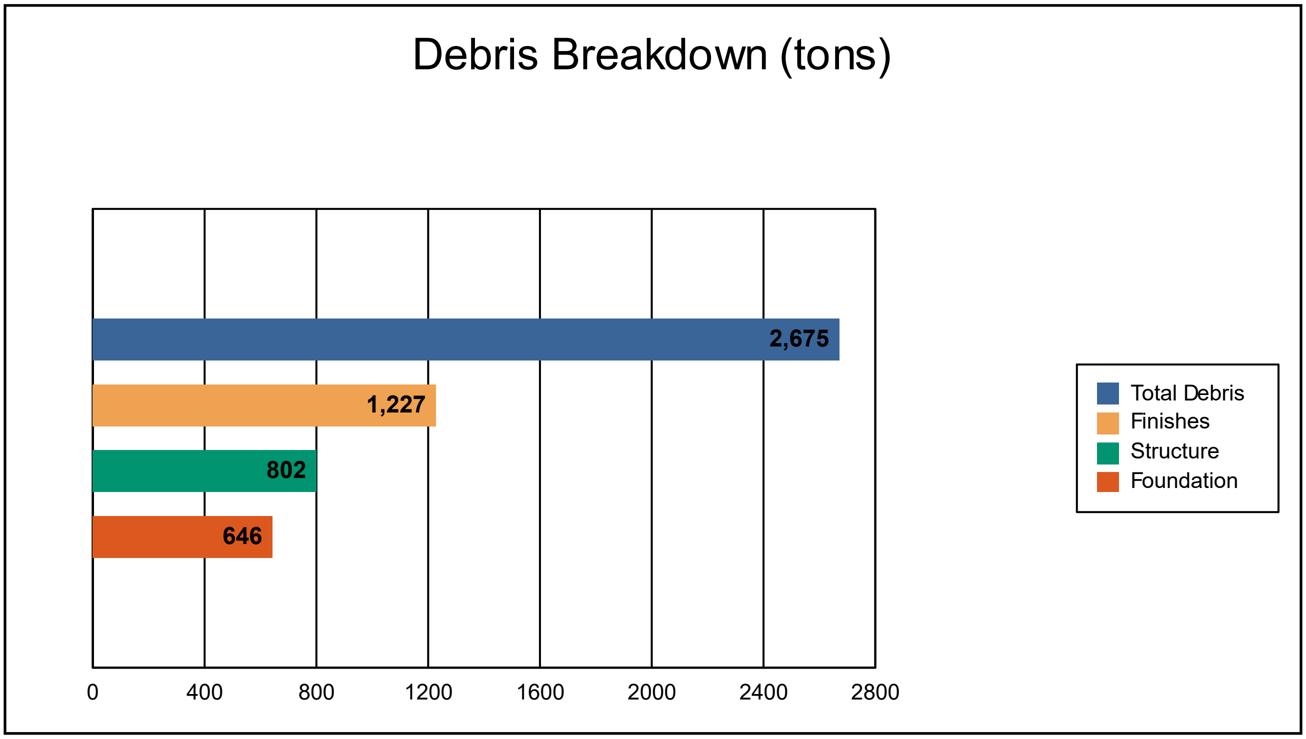
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

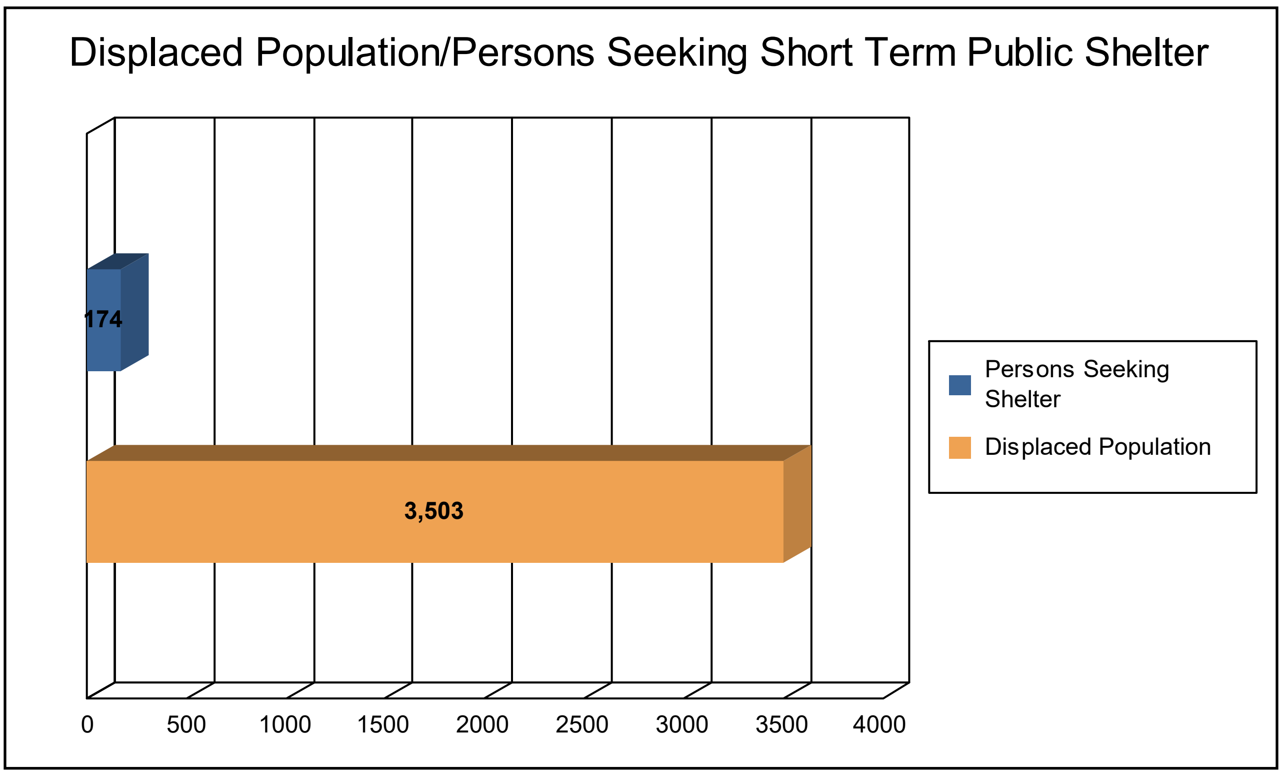


The model estimates that a total of 2,675 tons of debris will be generated. Of the total amount, Finishes comprises 46% of the total, Structure comprises 30% of the total, and Foundation comprises 24%. If the debris tonnage is converted into an estimated number of truckloads, it will require 107 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 1,168 households (or 3,503 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 174 people (out of a total population of 106,724) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 401.28 million dollars, which represents 7.24 % of the total replacement value of the scenario buildings.

Building-Related Losses

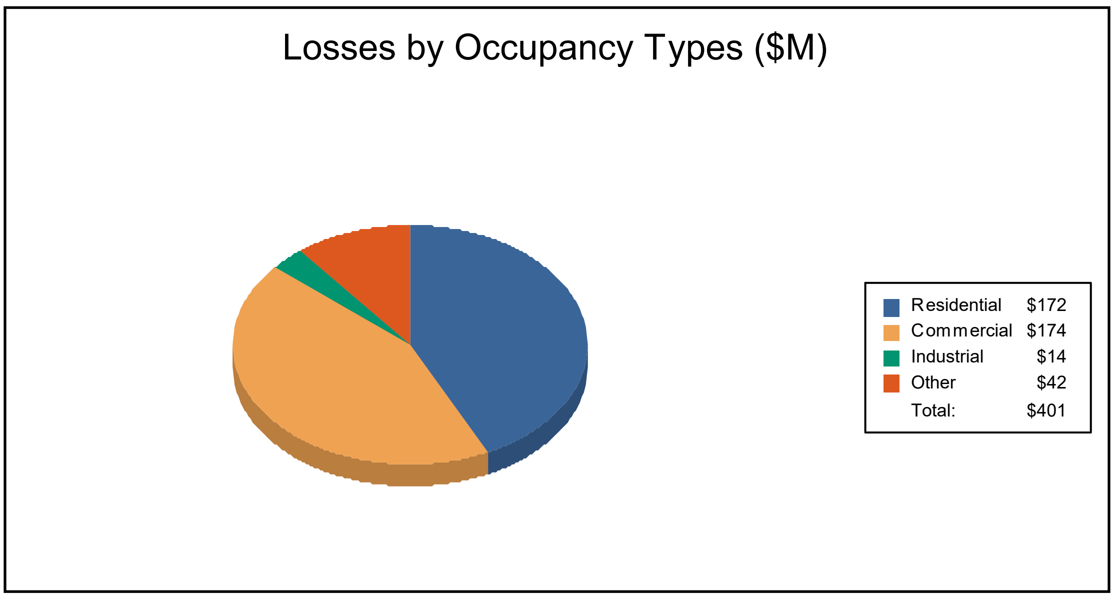
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 238.15 million dollars. 41% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 42.80% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	89.16	22.09	3.86	1.86	116.97
	Content	48.26	53.55	7.72	9.68	119.20
	Inventory	0.00	0.69	1.22	0.08	1.98
	Subtotal	**137.41**	**76.32**	**12.80**	**11.62**	**238.15**
Business Interruption						
	Income	1.30	41.17	0.22	3.14	45.83
	Relocation	21.24	9.90	0.20	1.34	32.69
	Rental Income	8.73	6.94	0.04	0.22	15.93
	Wage	3.08	39.53	0.40	25.67	68.68
	Subtotal	**34.35**	**97.55**	**0.86**	**30.37**	**163.13**
ALL	**Total**	**171.77**	**173.87**	**13.66**	**41.99**	**401.28**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	106,724	12,220,022	3,415,013	15,635,035
Total	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**
Total Study Region	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_4

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 138 square miles and contains 1,074 census blocks. The region contains over 9 thousand households and has a total population of 27,180 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 10,335 buildings in the region with a total building replacement value (excluding contents) of 3,945 million dollars. Approximately 91.67% of the buildings (and 88.71% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 10,335 buildings in the region which have an aggregate total replacement value of 3,945 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	3,499,625	88.7%
Commercial	238,367	6.0%
Industrial	89,655	2.3%
Agricultural	29,561	0.7%
Religion	45,679	1.2%
Government	5,013	0.1%
Education	37,265	0.9%
Total	**3,945,165**	**100%**

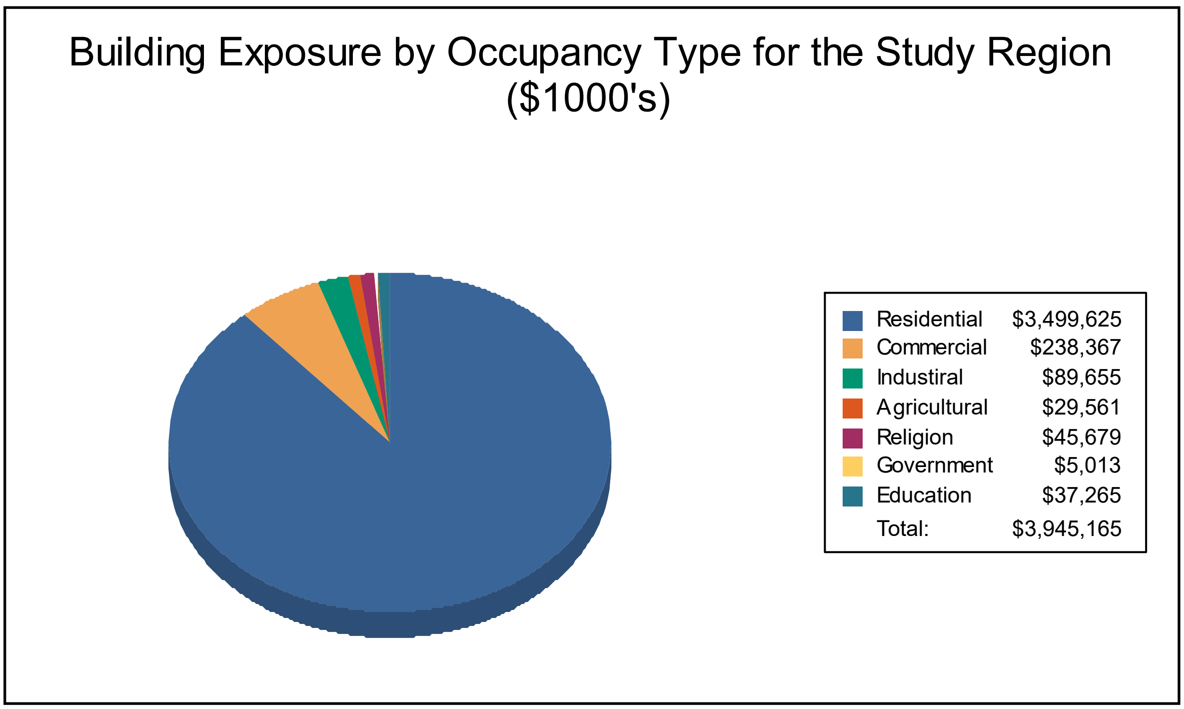
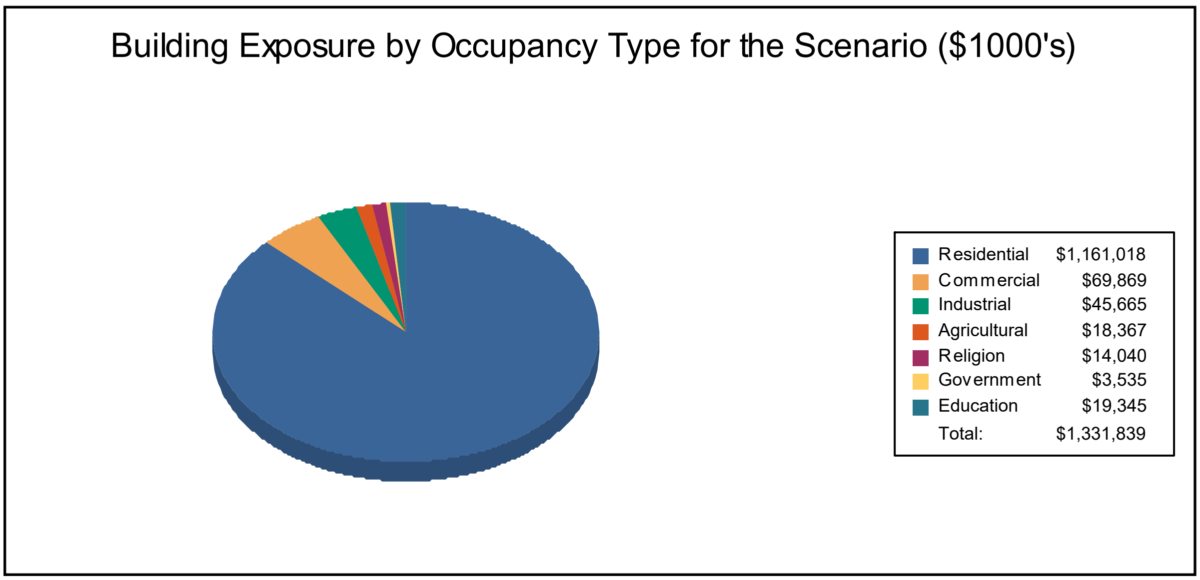


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,161,018	87.2%
Commercial	69,869	5.2%
Industrial	45,665	3.4%
Agricultural	18,367	1.4%
Religion	14,040	1.1%
Government	3,535	0.3%
Education	19,345	1.5%
Total	**1,331,839**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

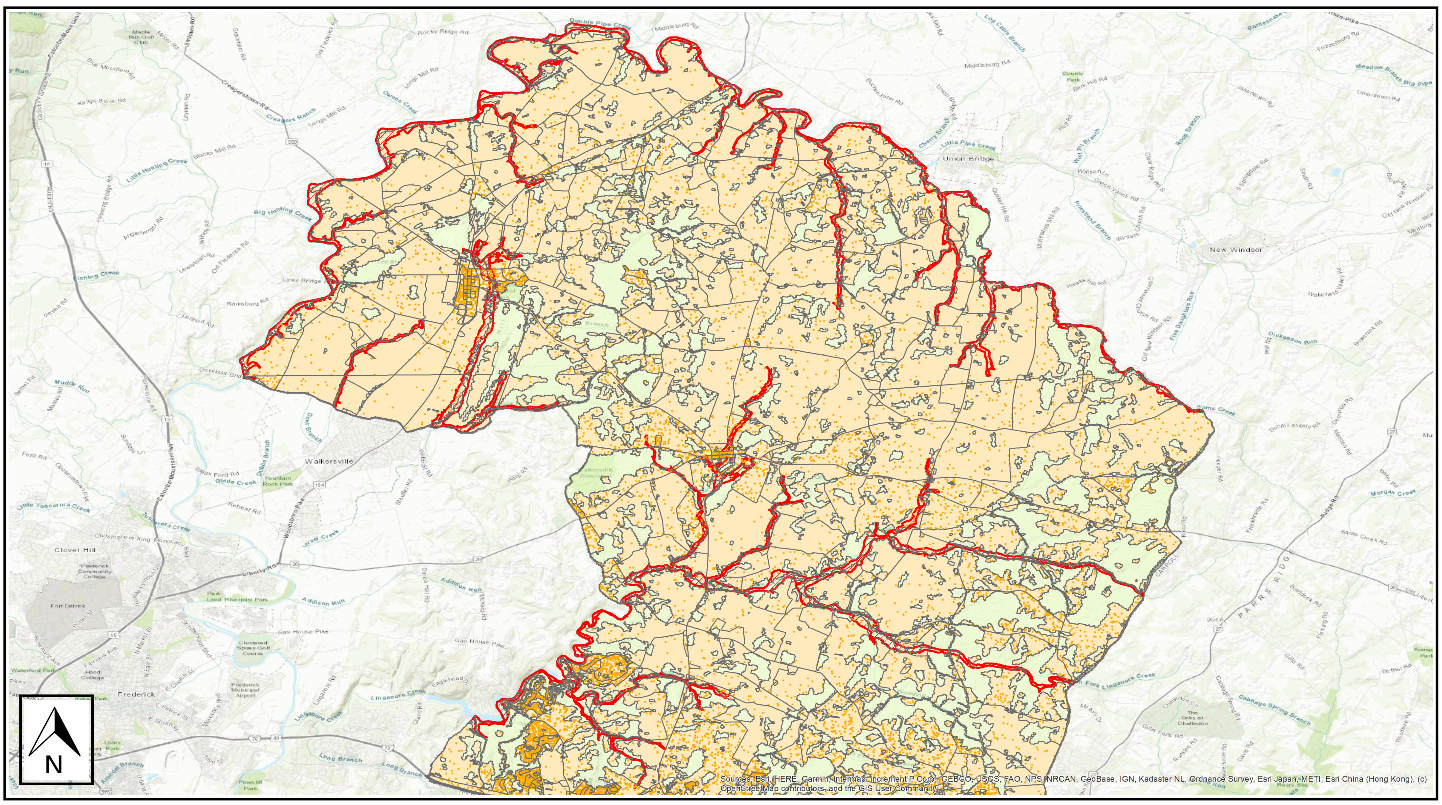
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_4
Scenario Name:	Multi
Return Period Analyzed:	50
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 15 buildings will be at least moderately damaged. This is over 45% of the total number of buildings in the scenario. There are an estimated 4 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

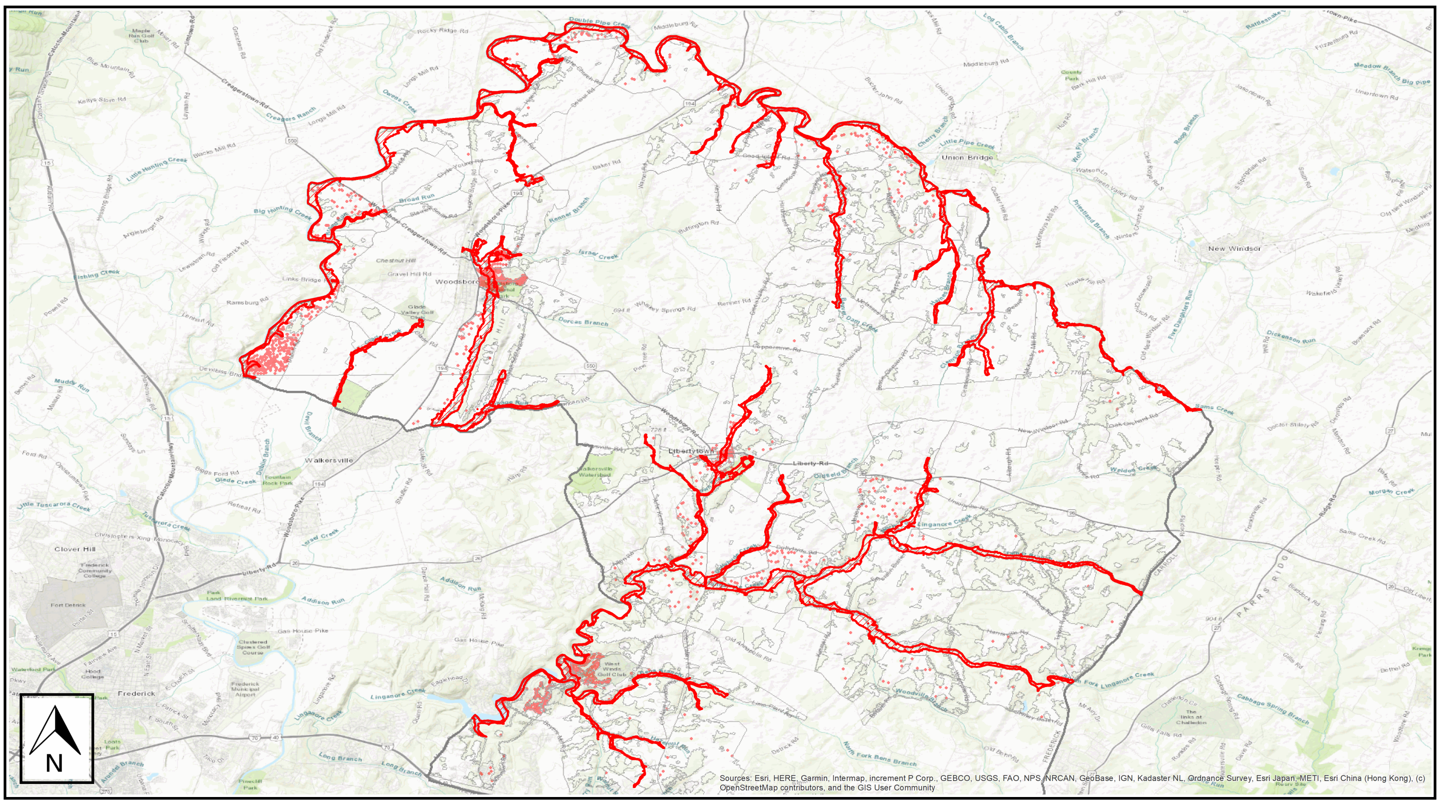


Table 3: Expected Building Damage by Occupancy

Occupancy	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	1	6	6	38	2	13	2	13	1	6	4	25
Total	**1**		**6**		**2**		**2**		**1**		**4**	

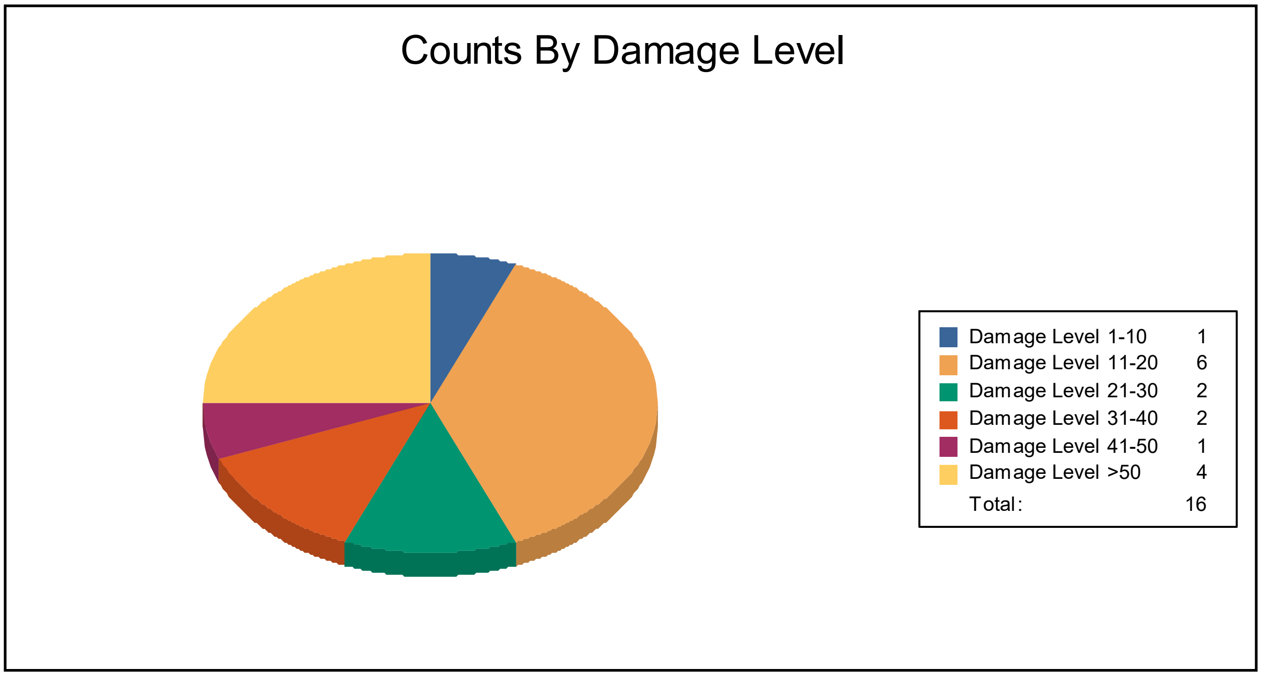


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	1	6	6	38	2	13	2	13	1	6	4	25

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

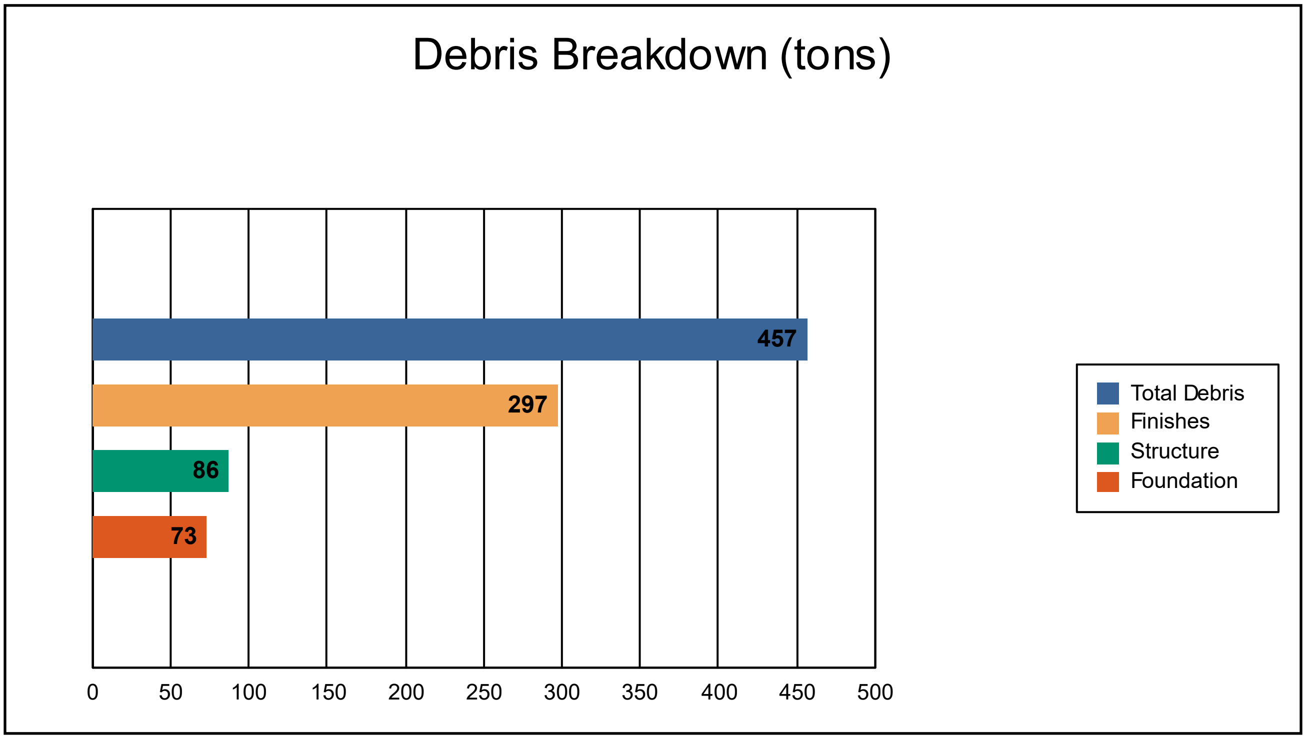
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

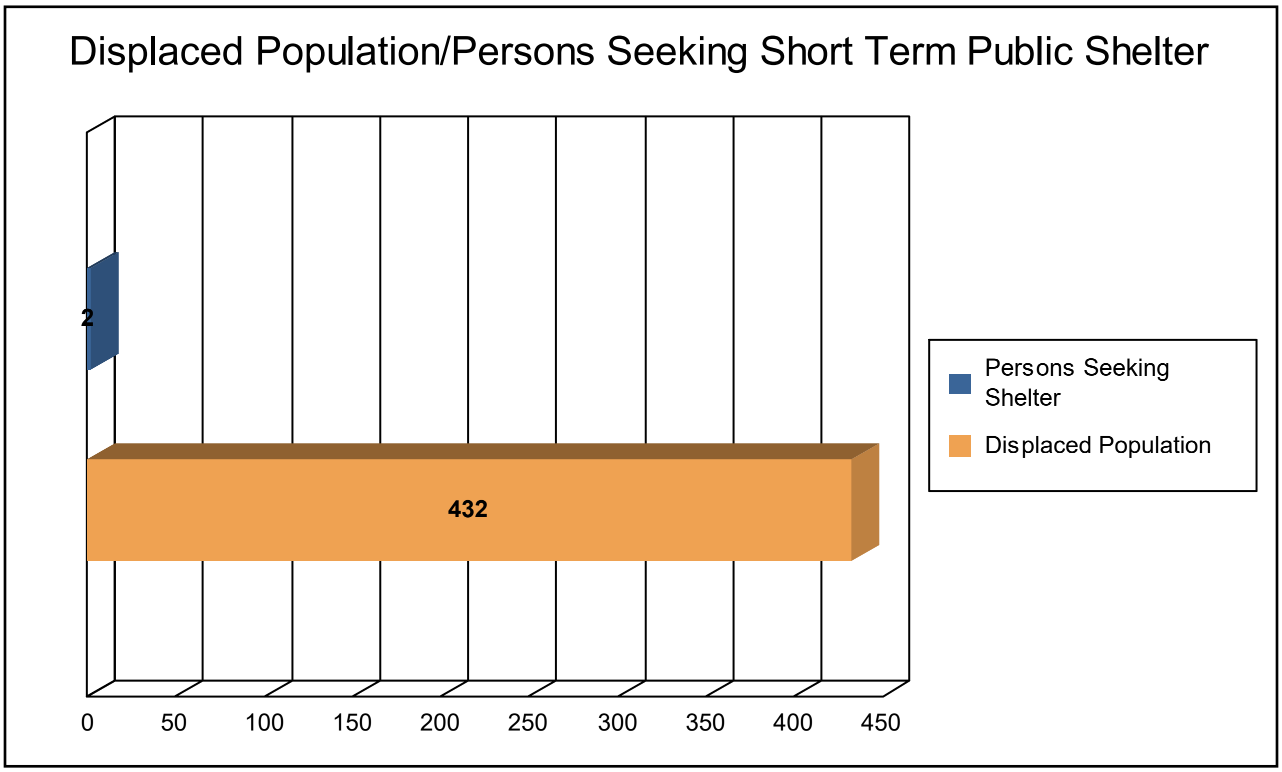


The model estimates that a total of 457 tons of debris will be generated. Of the total amount, Finishes comprises 65% of the total, Structure comprises 19% of the total, and Foundation comprises 16%. If the debris tonnage is converted into an estimated number of truckloads, it will require 19 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 144 households (or 432 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 2 people (out of a total population of 27,180) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 37.23 million dollars, which represents 2.80 % of the total replacement value of the scenario buildings.

Building-Related Losses

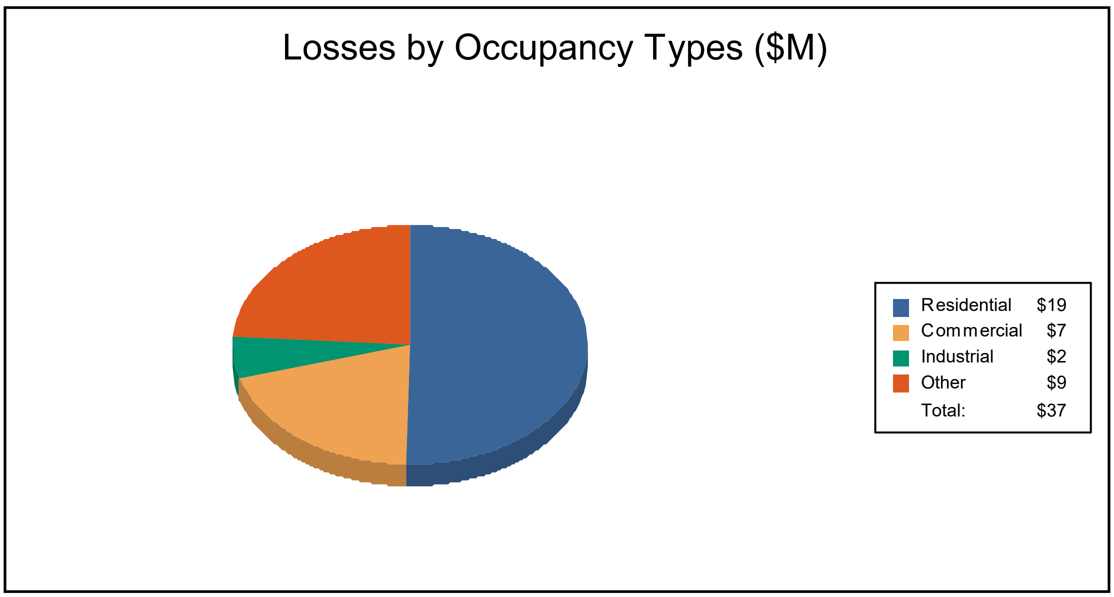
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 23.11 million dollars. 38% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 50.36% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	10.58	0.63	0.57	0.33	12.11
	Content	5.40	2.09	1.24	2.03	10.75
	Inventory	0.00	0.02	0.22	0.01	0.25
	Subtotal	**15.98**	**2.74**	**2.03**	**2.37**	**23.11**
Business Interruption						
	Income	0.00	2.23	0.03	0.79	3.05
	Relocation	2.16	0.21	0.03	0.31	2.71
	Rental Income	0.61	0.15	0.00	0.02	0.79
	Wage	0.00	2.15	0.05	5.37	7.57
	Subtotal	**2.77**	**4.73**	**0.11**	**6.50**	**14.11**
ALL	**Total**	**18.75**	**7.47**	**2.14**	**8.87**	**37.23**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Frederick	27,180	3,499,625	445,540	3,945,165
Total	**27,180**	**3,499,625**	**445,540**	**3,945,165**
Total Study Region	**27,180**	**3,499,625**	**445,540**	**3,945,165**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_5

Flood Scenario: Multi

Print Date: Thursday, August 5, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 173 square miles and contains 1,430 census blocks. The region contains over 9 thousand households and has a total population of 24,832 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 9,774 buildings in the region with a total building replacement value (excluding contents) of 3,437 million dollars. Approximately 90.65% of the buildings (and 84.66% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 9,774 buildings in the region which have an aggregate total replacement value of 3,437 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,909,982	84.7%
Commercial	227,400	6.6%
Industrial	98,717	2.9%
Agricultural	22,332	0.6%
Religion	118,912	3.5%
Government	39,615	1.2%
Education	20,149	0.6%
Total	**3,437,107**	**100%**

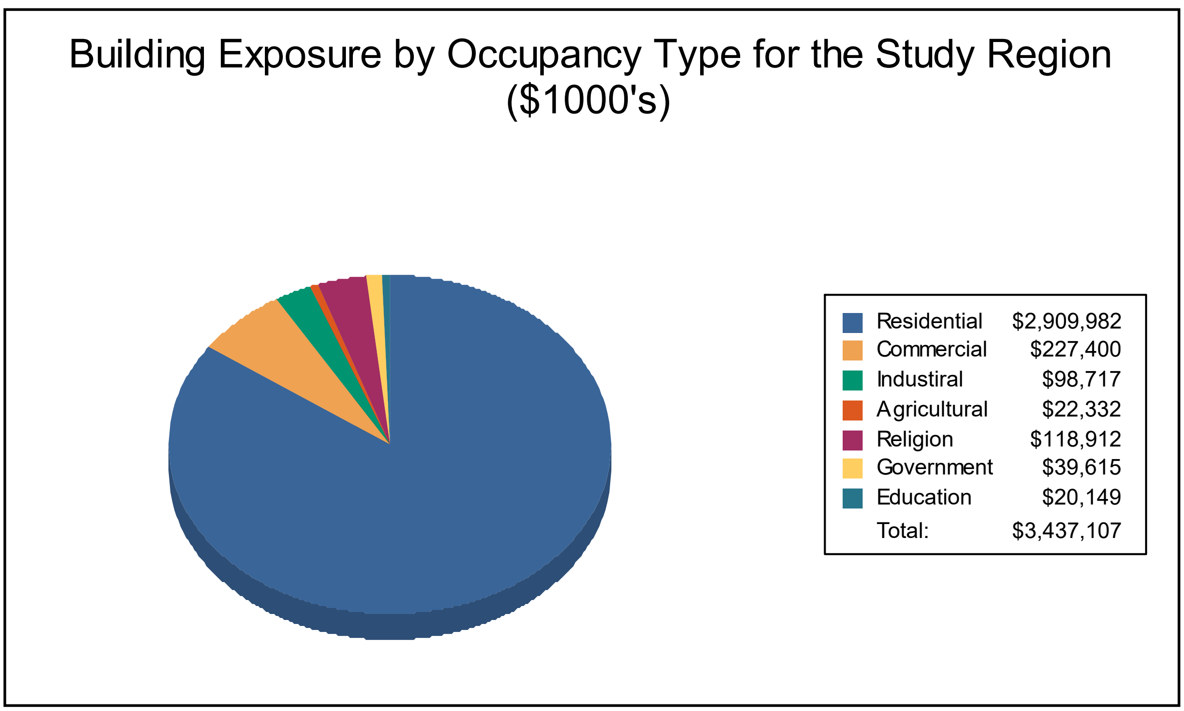
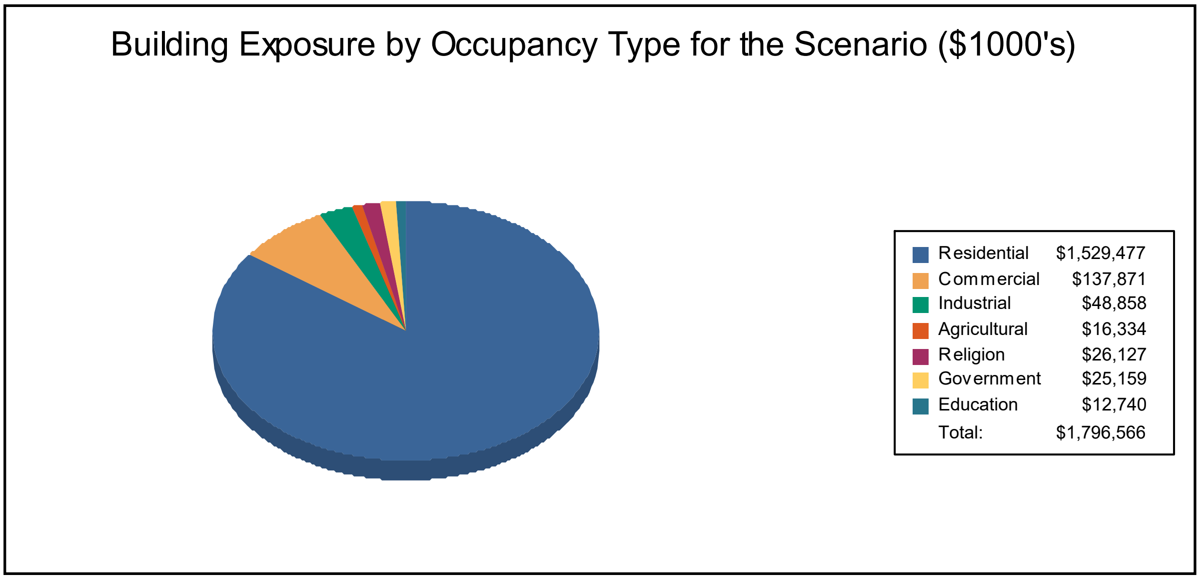


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,529,477	85.1%
Commercial	137,871	7.7%
Industrial	48,858	2.7%
Agricultural	16,334	0.9%
Religion	26,127	1.5%
Government	25,159	1.4%
Education	12,740	0.7%
Total	**1,796,566**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 11 schools, 7 fire stations, 2 police stations and no emergency operation centers.

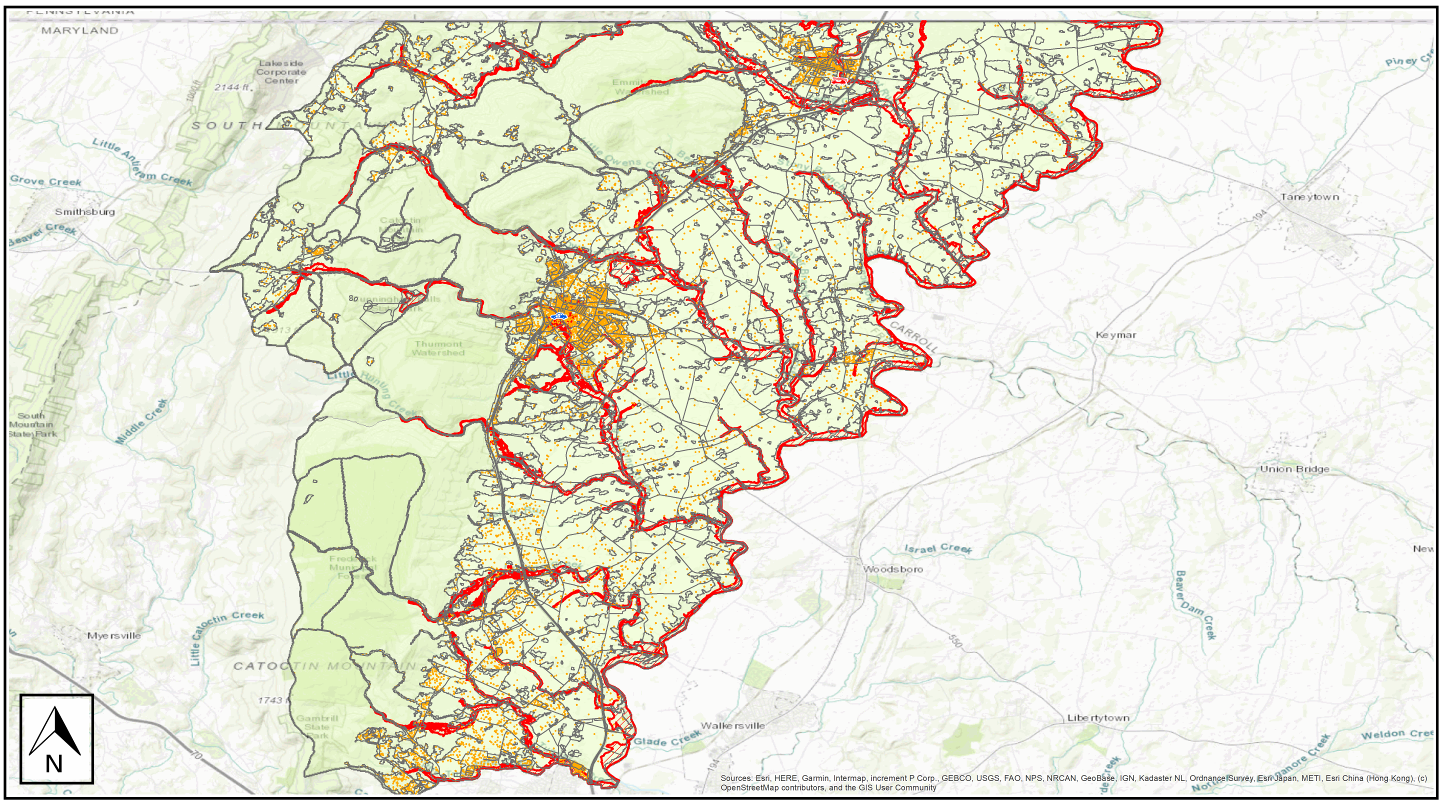
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_5
Scenario Name:	Multi
Return Period Analyzed:	50
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 23 buildings will be at least moderately damaged. This is over 63% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

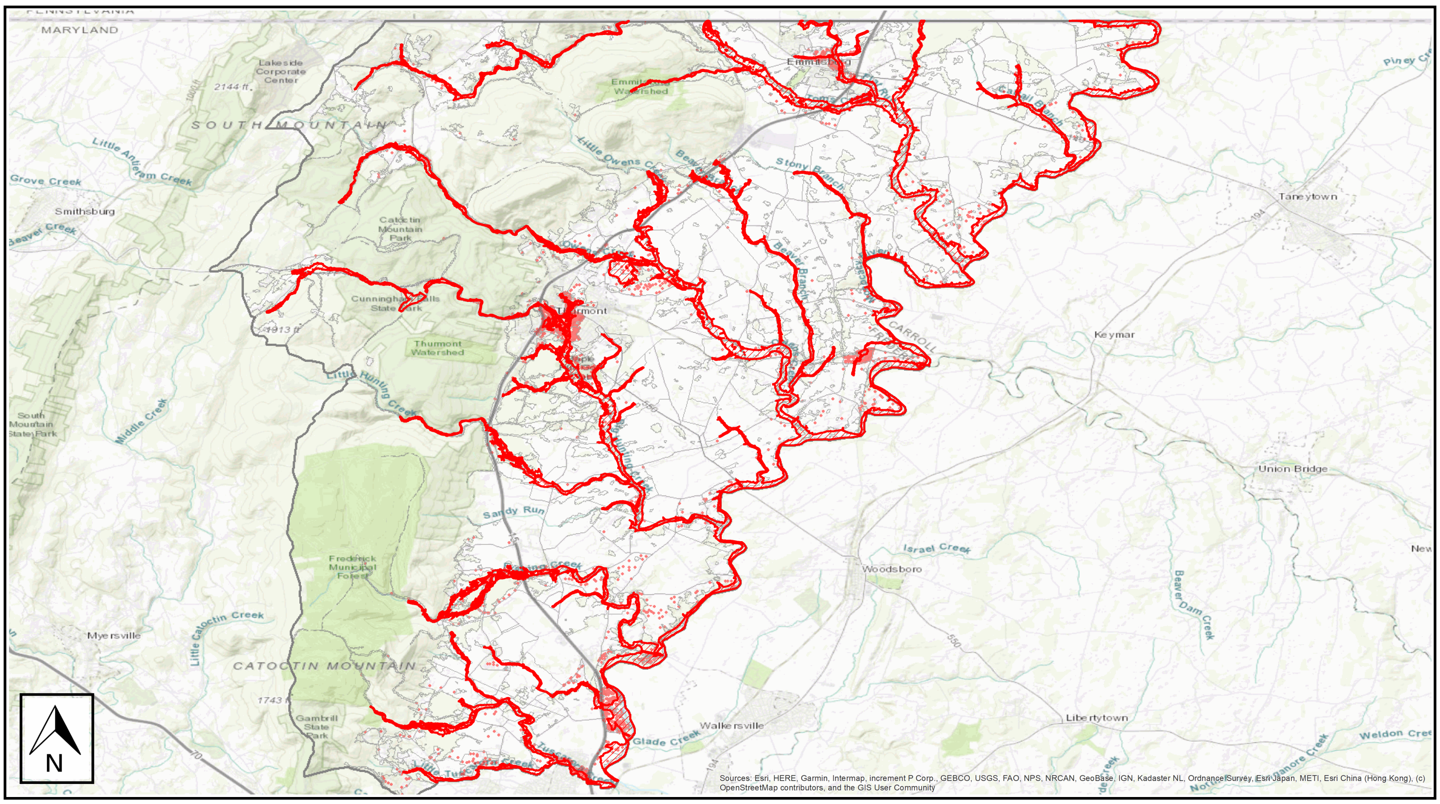


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	19	45	20	48	3	7	0	0	0	0	0	0
Total	**19**		**20**		**3**		**0**		**0**		**0**	

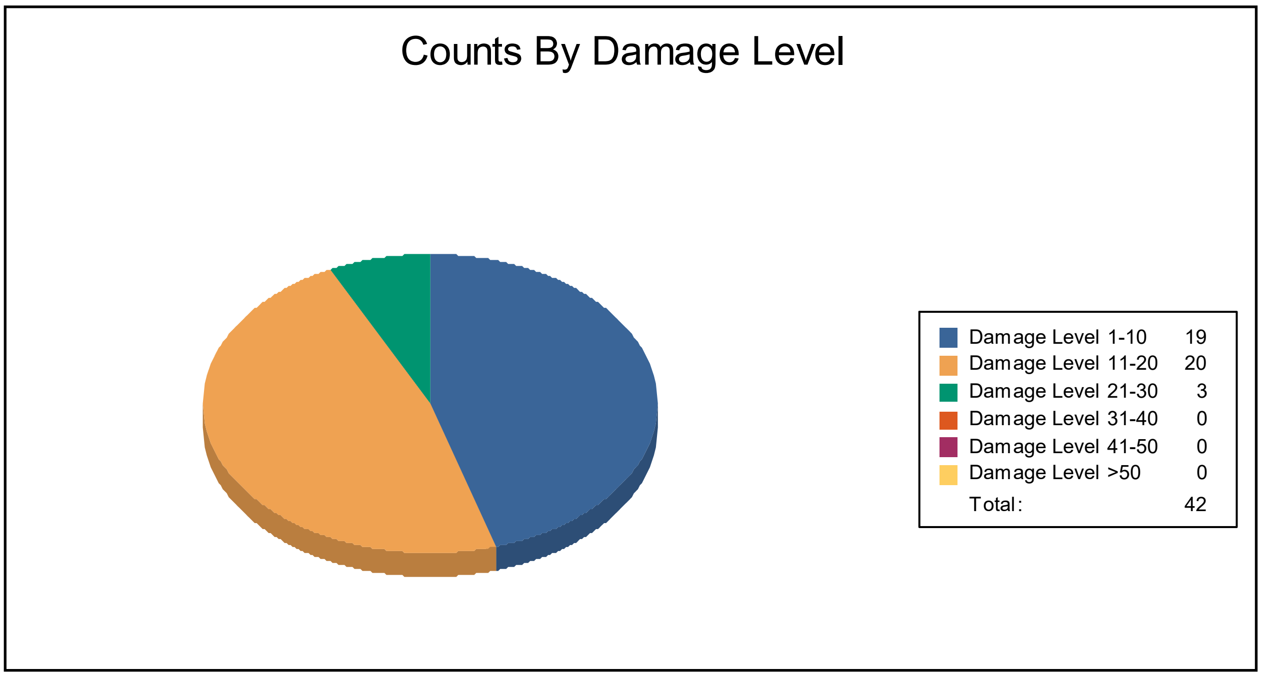


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	5	45	6	55	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	14	45	14	45	3	10	0	0	0	0	0	0

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	7	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	11	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

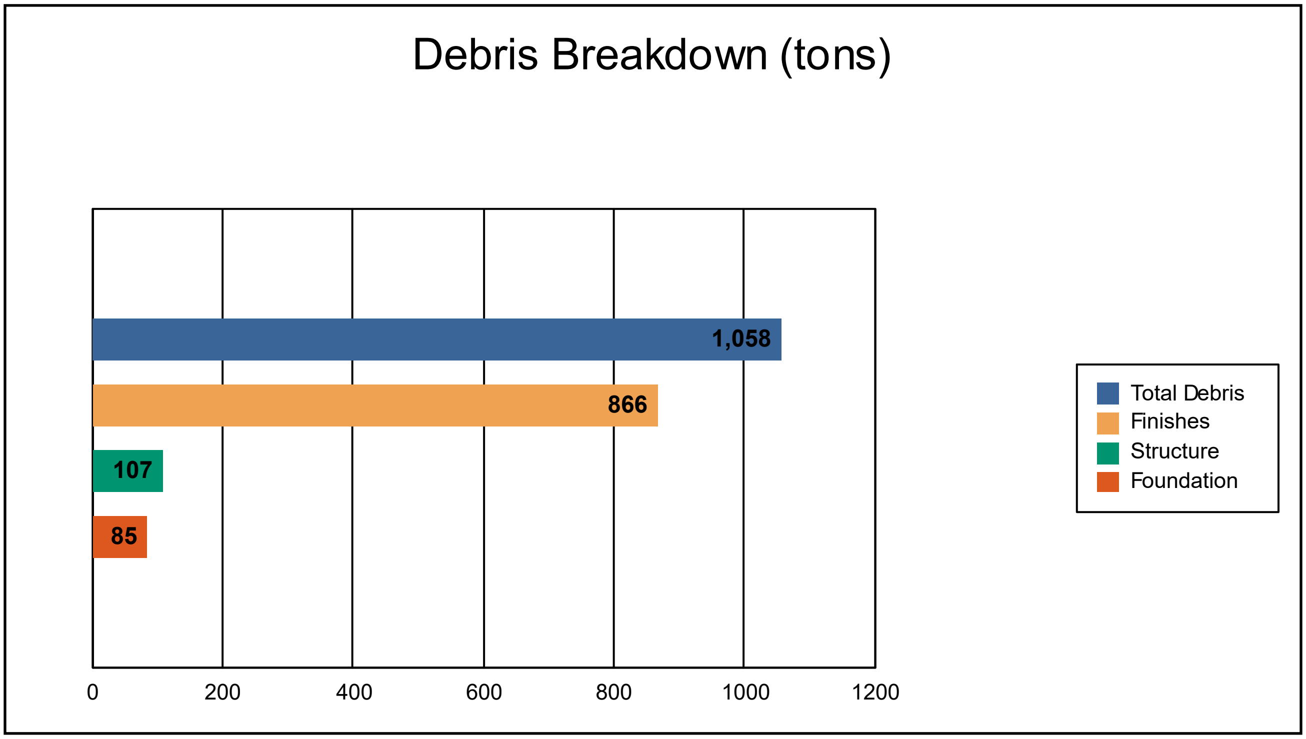
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

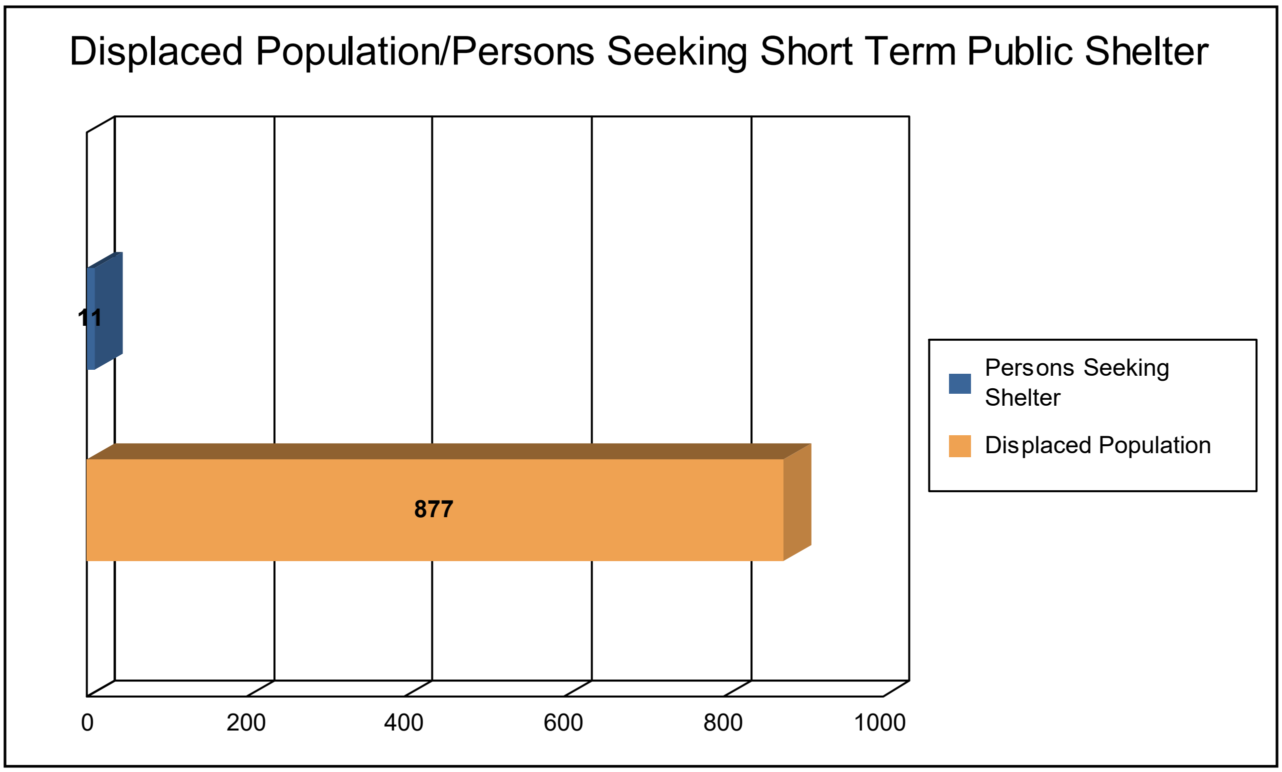


The model estimates that a total of 1,058 tons of debris will be generated. Of the total amount, Finishes comprises 82% of the total, Structure comprises 10% of the total, and Foundation comprises 8%. If the debris tonnage is converted into an estimated number of truckloads, it will require 43 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 292 households (or 877 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 11 people (out of a total population of 24,832) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 78.07 million dollars, which represents 4.35 % of the total replacement value of the scenario buildings.

Building-Related Losses

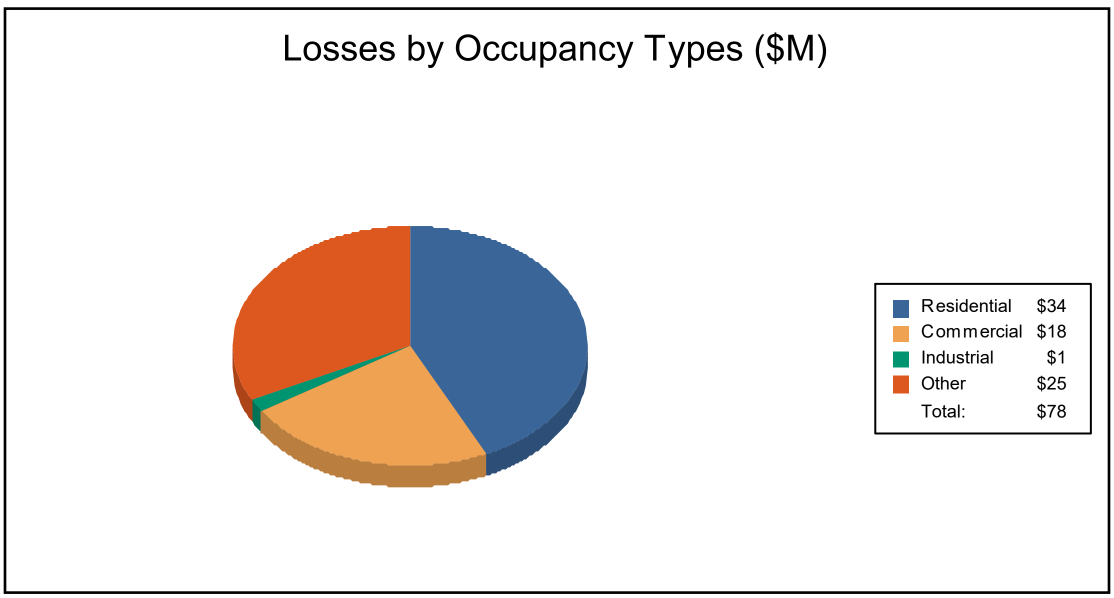
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 34.95 million dollars. 55% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 43.06% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	15.84	1.37	0.44	0.52	18.17
	Content	8.77	4.62	0.71	2.48	16.58
	Inventory	0.00	0.06	0.09	0.06	0.21
	Subtotal	**24.61**	**6.05**	**1.24**	**3.05**	**34.95**
Business Interruption						
	Income	0.74	5.28	0.01	0.91	6.94
	Relocation	4.69	0.63	0.01	0.47	5.80
	Rental Income	1.82	0.48	0.00	0.04	2.34
	Wage	1.76	5.35	0.04	20.88	28.03
	Subtotal	**9.01**	**11.75**	**0.06**	**22.30**	**43.12**
ALL	**Total**	**33.62**	**17.80**	**1.30**	**25.36**	**78.07**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Frederick	24,832	2,909,982	527,125	3,437,107
Total	**24,832**	**2,909,982**	**527,125**	**3,437,107**
Total Study Region	**24,832**	**2,909,982**	**527,125**	**3,437,107**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_1

Flood Scenario: Mulit

Print Date: Monday, August 2, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 154 square miles and contains 1,492 census blocks. The region contains over 13 thousand households and has a total population of 34,951 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 13,924 buildings in the region with a total building replacement value (excluding contents) of 4,884 million dollars. Approximately 92.06% of the buildings (and 89.46% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 13,924 buildings in the region which have an aggregate total replacement value of 4,884 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,369,448	89.5%
Commercial	298,832	6.1%
Industrial	83,521	1.7%
Agricultural	23,904	0.5%
Religion	65,399	1.3%
Government	17,551	0.4%
Education	25,330	0.5%
Total	**4,883,985**	**100%**

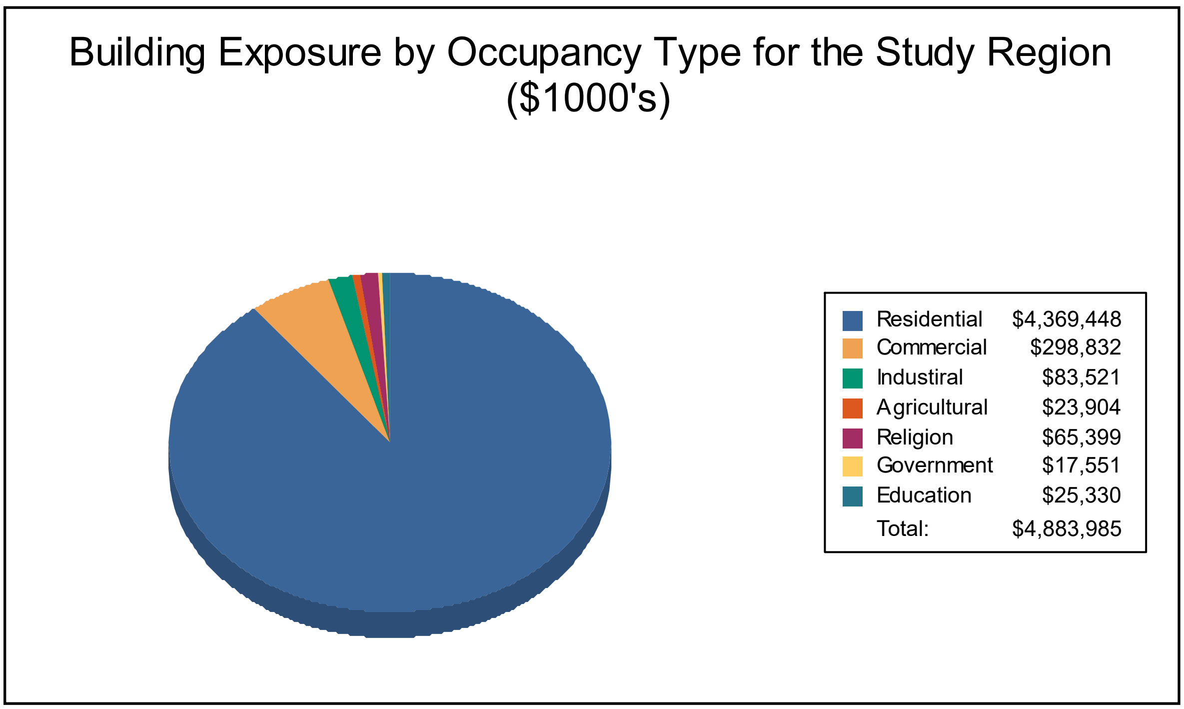
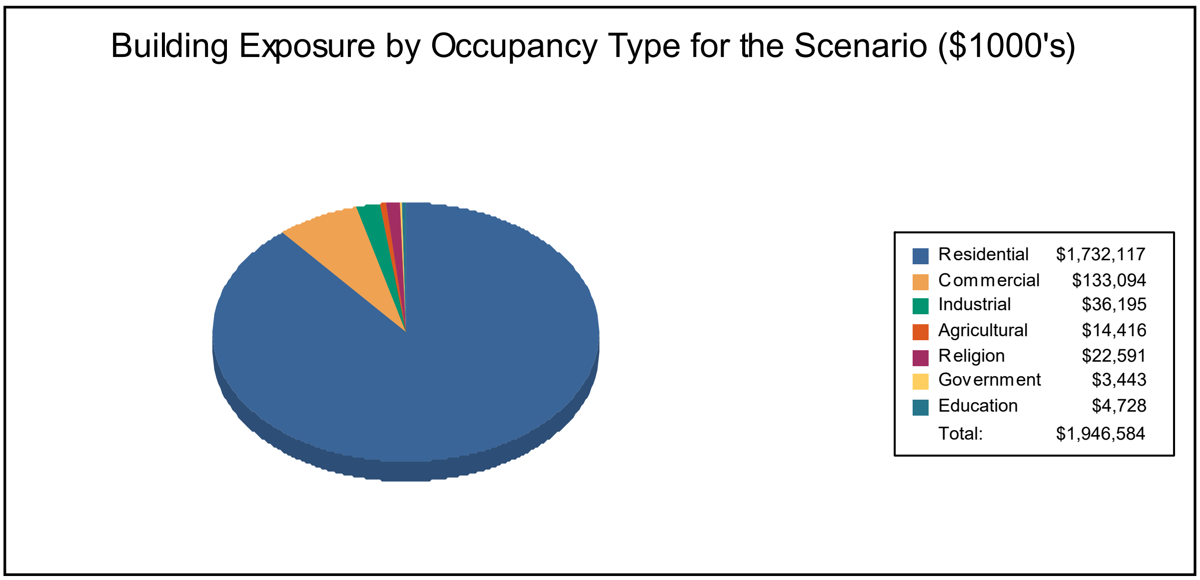


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	**Exposure ($1000)**	**Percent of Total**
Residential	1,732,117	89.0%
Commercial	133,094	6.8%
Industrial	36,195	1.9%
Agricultural	14,416	0.7%
Religion	22,591	1.2%
Government	3,443	0.2%
Education	4,728	0.2%
Total	**1,946,584**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 14 schools, 6 fire stations, 2 police stations and no emergency operation centers.

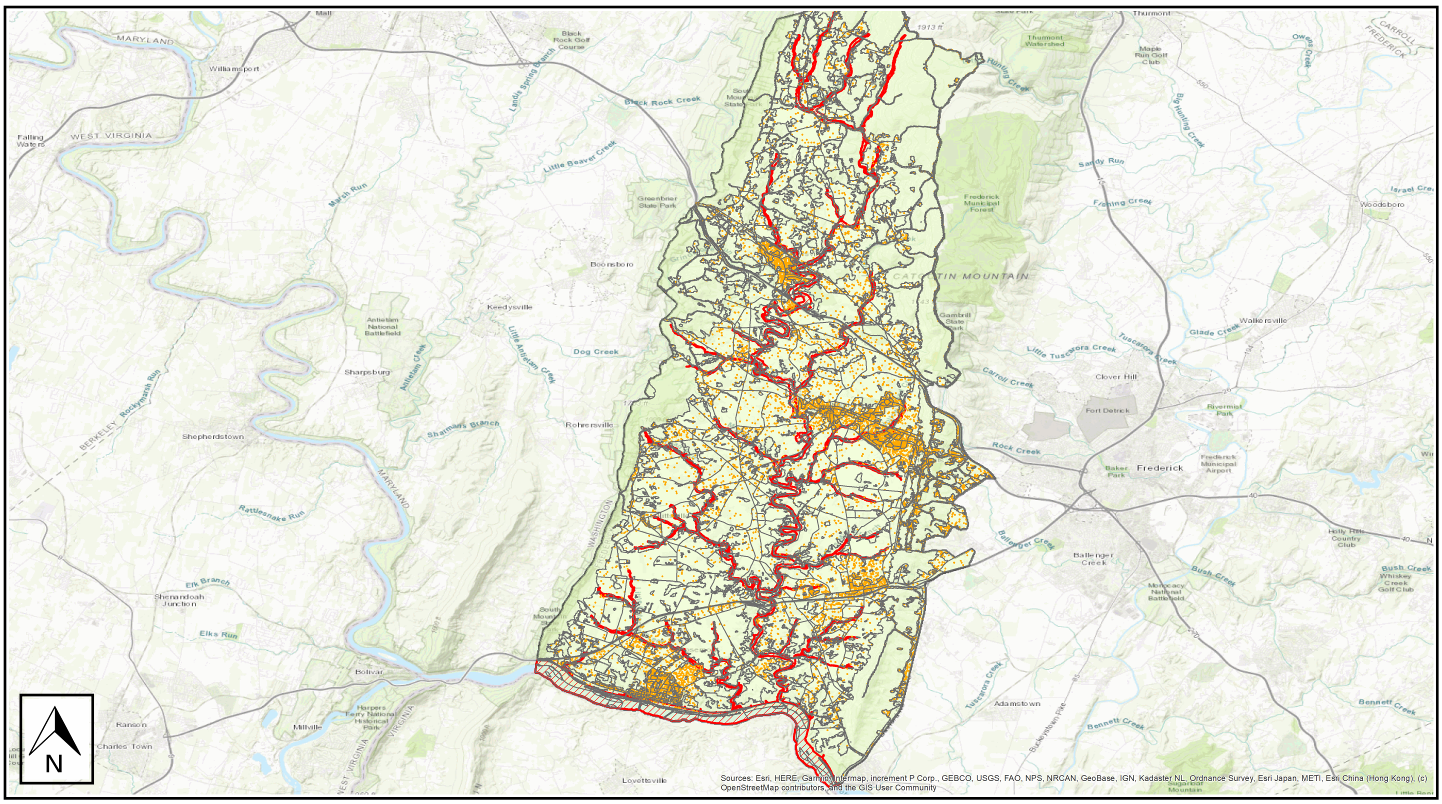
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_1
Scenario Name:	Mulit
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 7 buildings will be at least moderately damaged. This is over 64% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

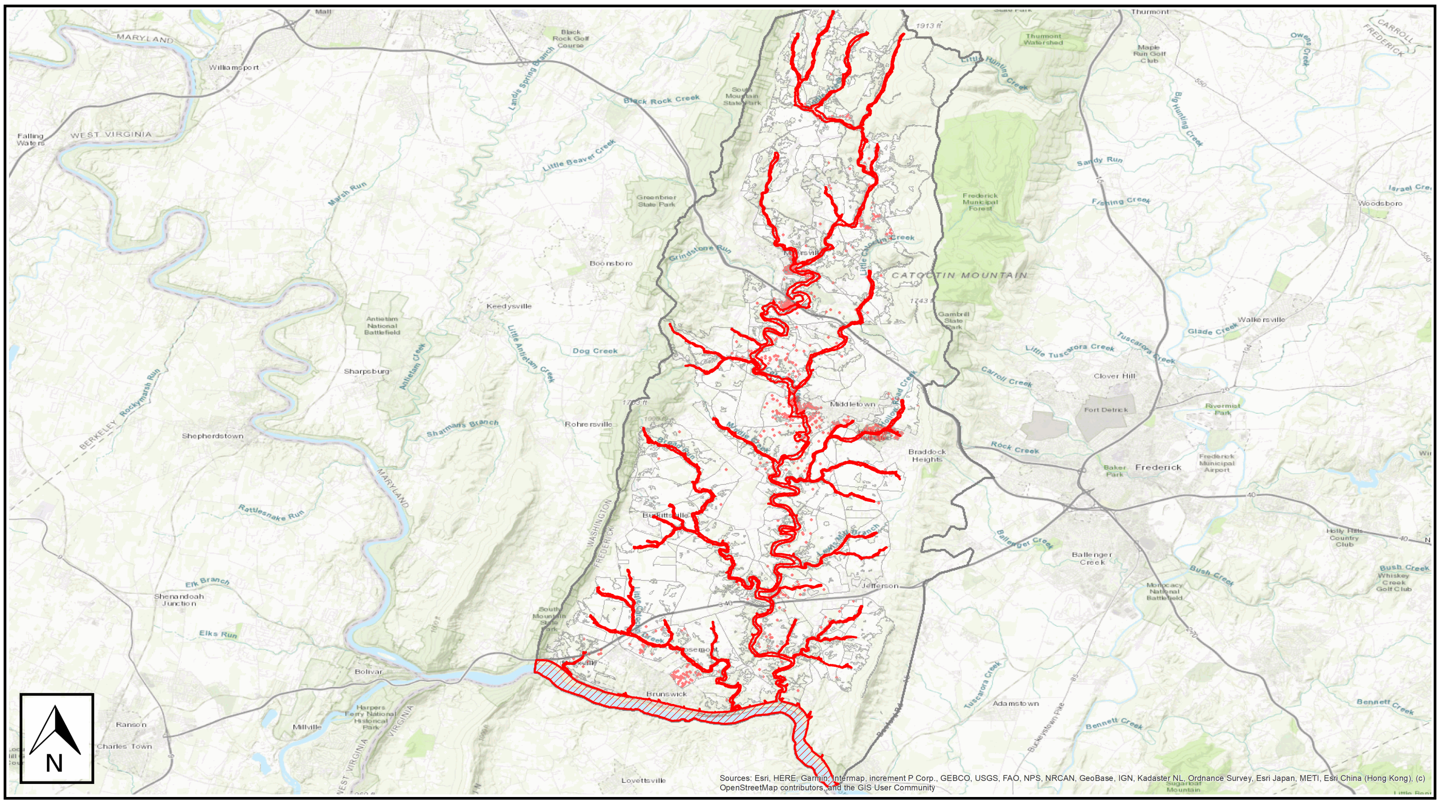


Table 3: Expected Building Damage by Occupancy

Occupancy	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	>50 Count	>50 (%)
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	3	30	5	50	1	10	1	10	0	0	0	0
Total	**3**		**5**		**1**		**1**		**0**		**0**	

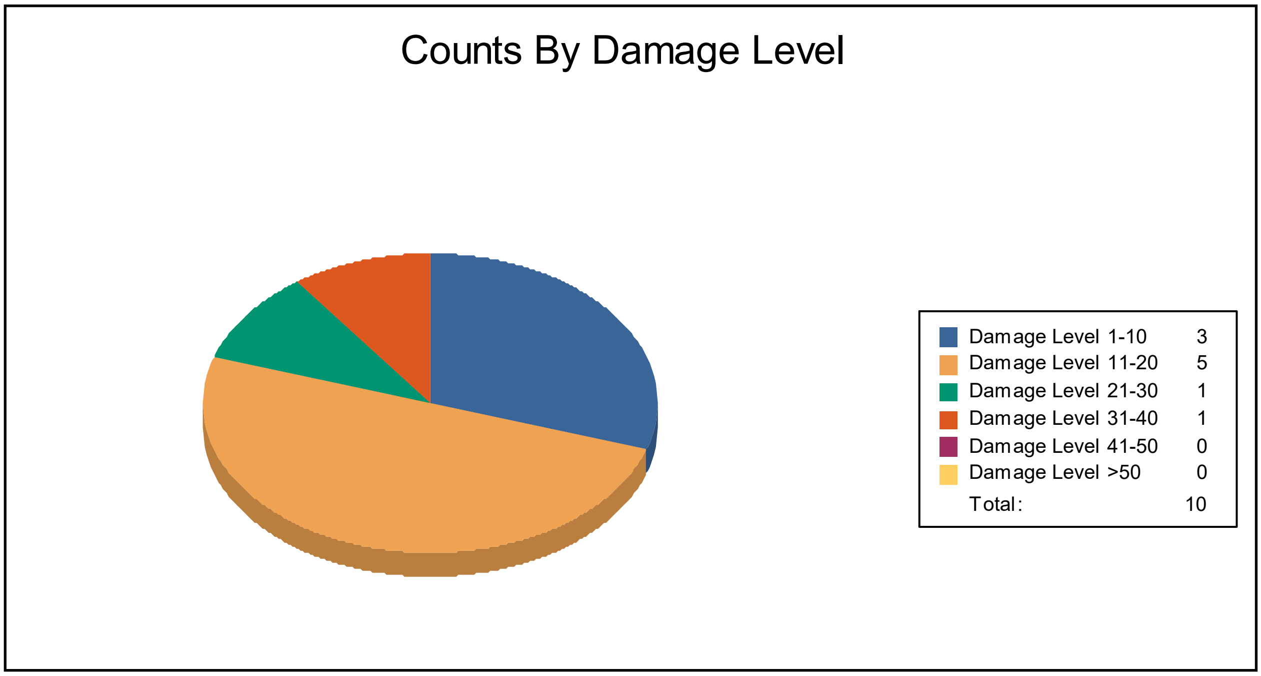


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	3	30	5	50	1	10	1	10	0	0	0	0

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	6	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	14	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

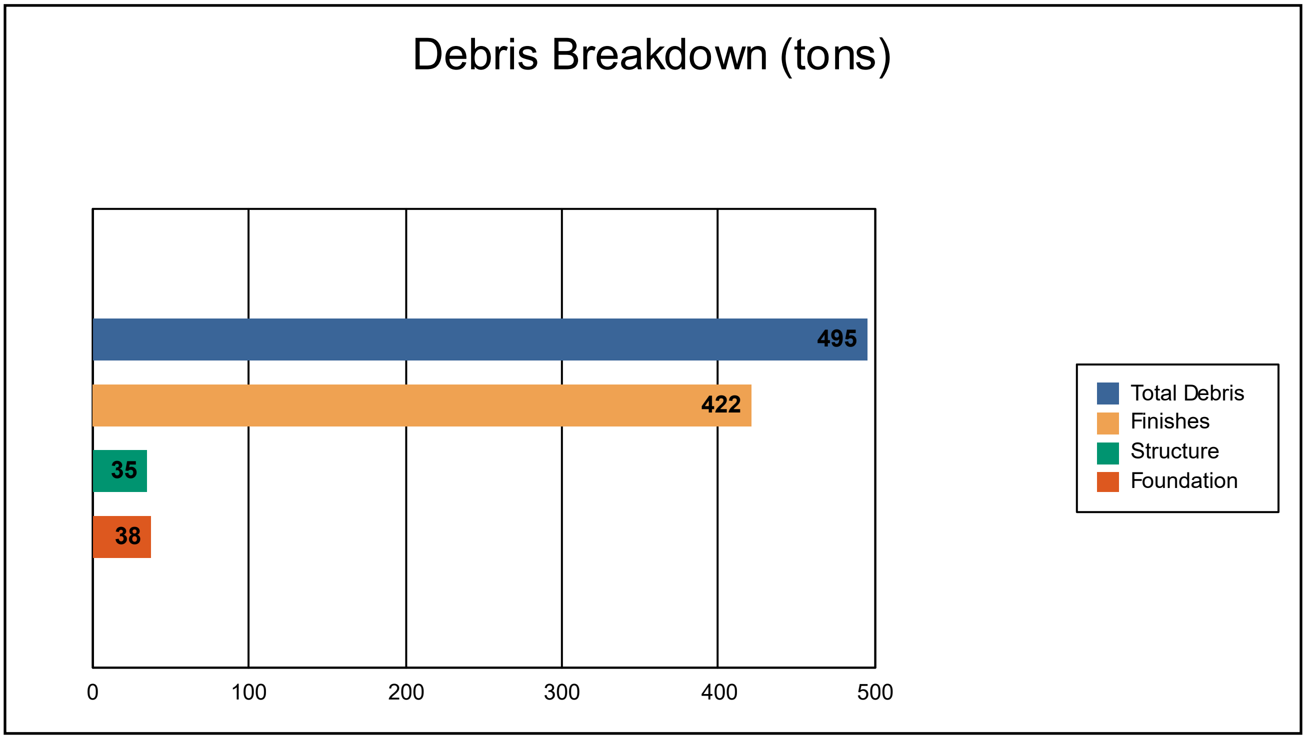
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

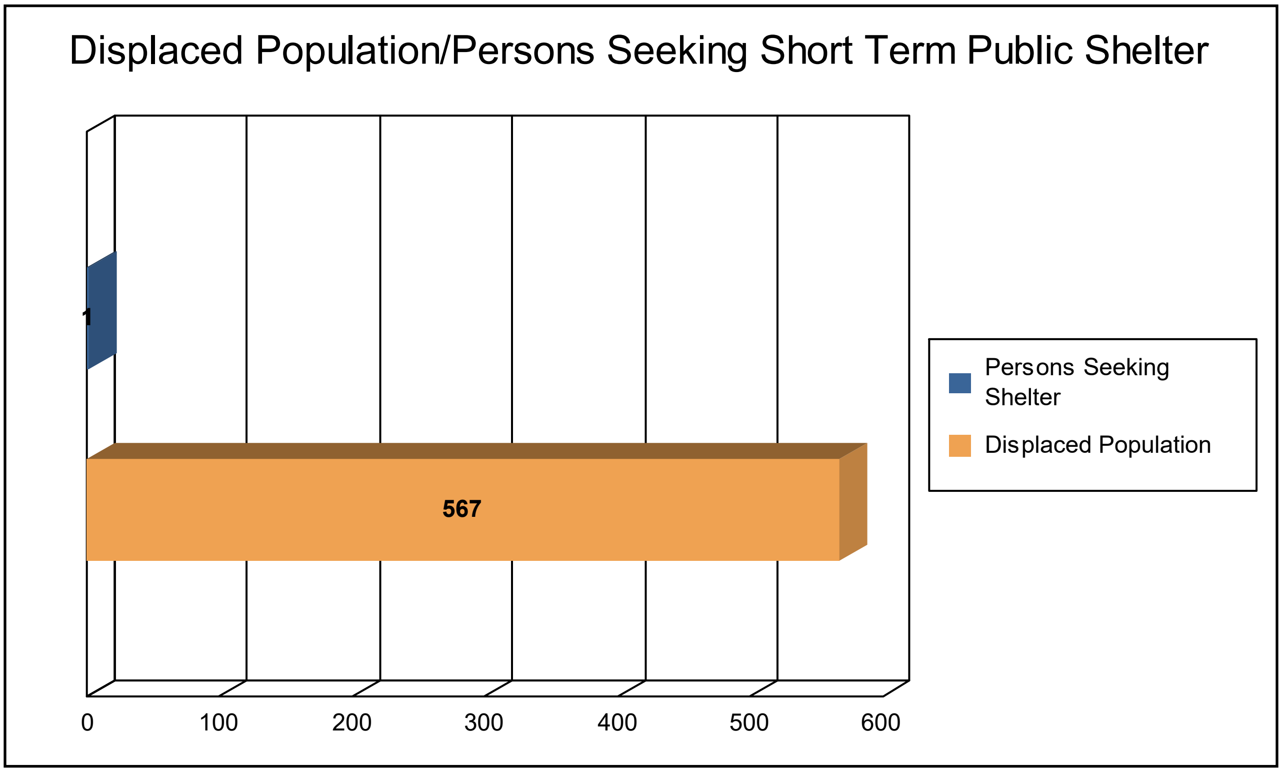


The model estimates that a total of 495 tons of debris will be generated. Of the total amount, Finishes comprises 85% of the total, Structure comprises 7% of the total, and Foundation comprises 8%. If the debris tonnage is converted into an estimated number of truckloads, it will require 20 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 189 households (or 567 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1 people (out of a total population of 34,951) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 46.79 million dollars, which represents 2.40 % of the total replacement value of the scenario buildings.

Building-Related Losses

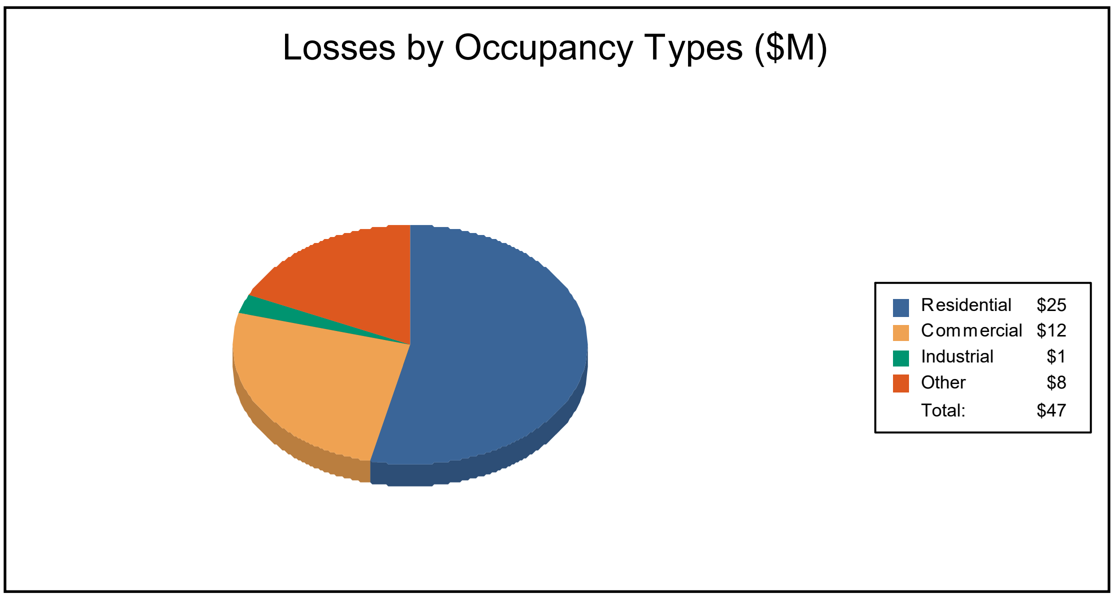
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 28.76 million dollars. 39% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 53.54% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	14.22	1.10	0.40	0.22	15.94
	Content	7.29	3.28	0.75	1.35	12.67
	Inventory	0.00	0.02	0.11	0.01	0.15
	Subtotal	**21.51**	**4.40**	**1.27**	**1.58**	**28.76**
Business Interruption						
	Income	0.06	3.56	0.01	0.35	3.98
	Relocation	2.58	0.37	0.01	0.13	3.09
	Rental Income	0.74	0.18	0.00	0.01	0.93
	Wage	0.16	3.46	0.02	6.41	10.04
	Subtotal	**3.54**	**7.56**	**0.04**	**6.89**	**18.03**
ALL	**Total**	**25.05**	**11.97**	**1.30**	**8.47**	**46.79**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	34,951	4,369,448	514,537	4,883,985
Total	**34,951**	**4,369,448**	**514,537**	**4,883,985**
Total Study Region	**34,951**	**4,369,448**	**514,537**	**4,883,985**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_2

Flood Scenario: Multi

Print Date: Tuesday, August 3, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 128 square miles and contains 1,470 census blocks. The region contains over 13 thousand households and has a total population of 39,698 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 14,322 buildings in the region with a total building replacement value (excluding contents) of 6,331 million dollars. Approximately 92.32% of the buildings (and 82.33% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 14,322 buildings in the region which have an aggregate total replacement value of 6,331 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	5,212,418	82.3%
Commercial	386,876	6.1%
Industrial	595,666	9.4%
Agricultural	33,020	0.5%
Religion	58,625	0.9%
Government	25,544	0.4%
Education	18,866	0.3%
Total	**6,331,015**	**100%**

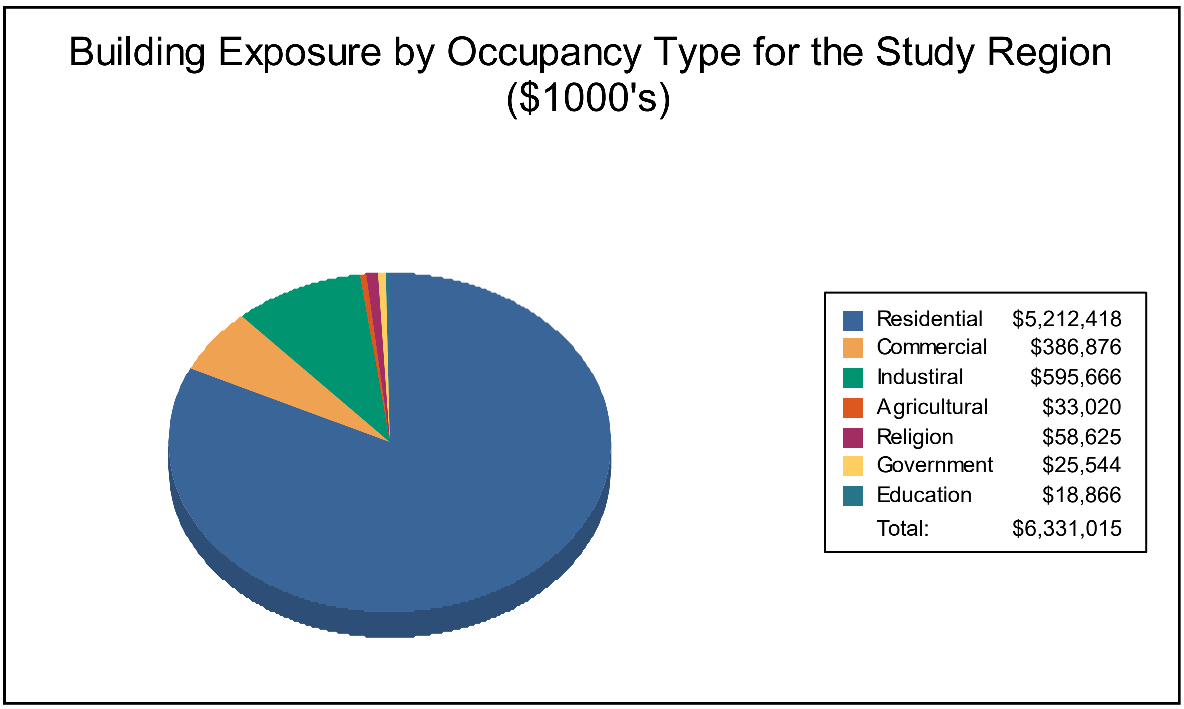
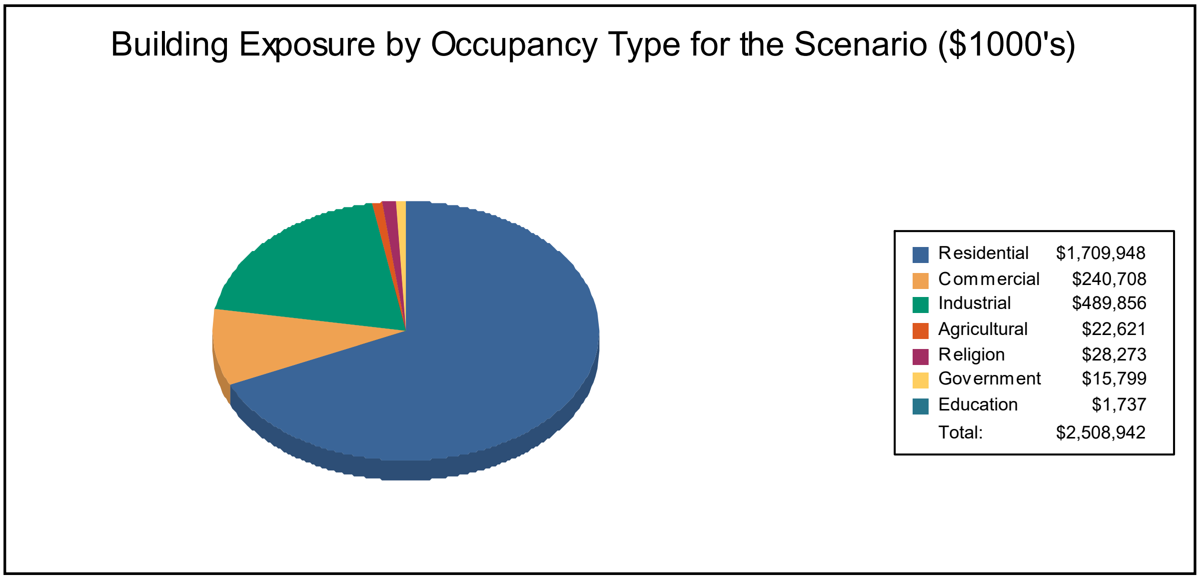


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	**Exposure ($1000)**	**Percent of Total**
Residential	1,709,948	68.2%
Commercial	240,708	9.6%
Industrial	489,856	19.5%
Agricultural	22,621	0.9%
Religion	28,273	1.1%
Government	15,799	0.6%
Education	1,737	0.1%
Total	**2,508,942**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

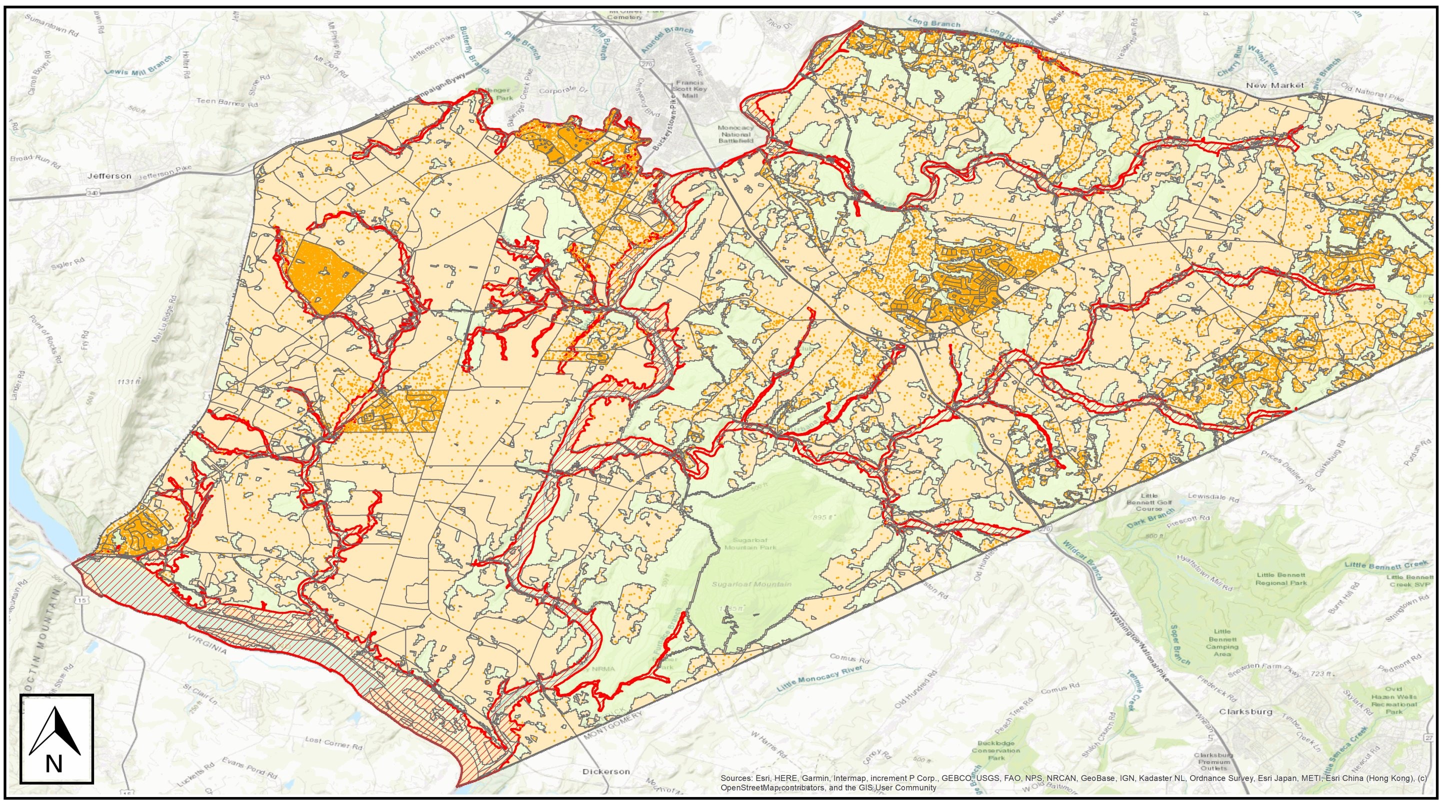
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_2
Scenario Name:	Multi
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 115 buildings will be at least moderately damaged. This is over 37% of the total number of buildings in the scenario. There are an estimated 44 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

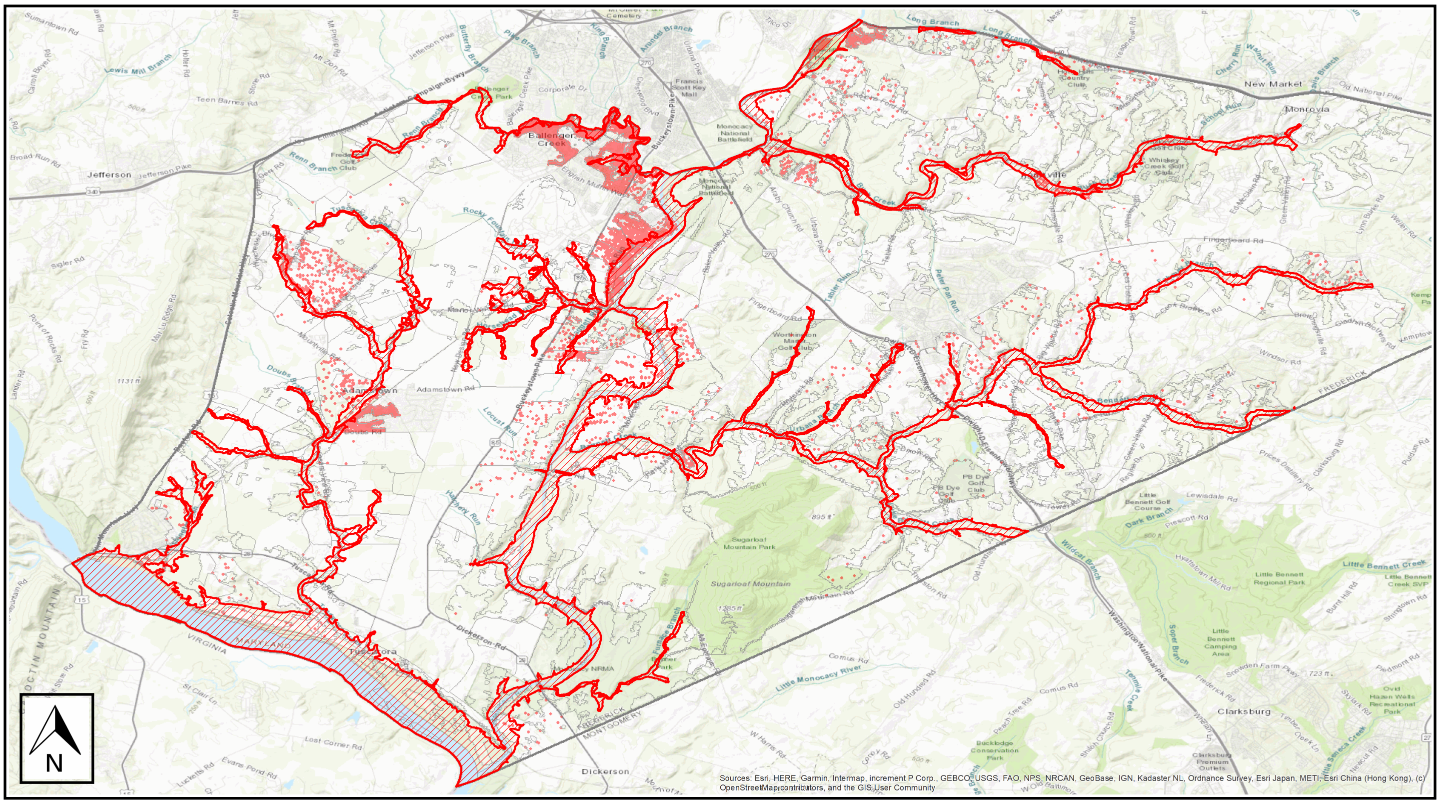


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	9	7	23	19	17	14	17	14	14	11	44	35
Total	**9**		**23**		**17**		**17**		**14**		**44**	

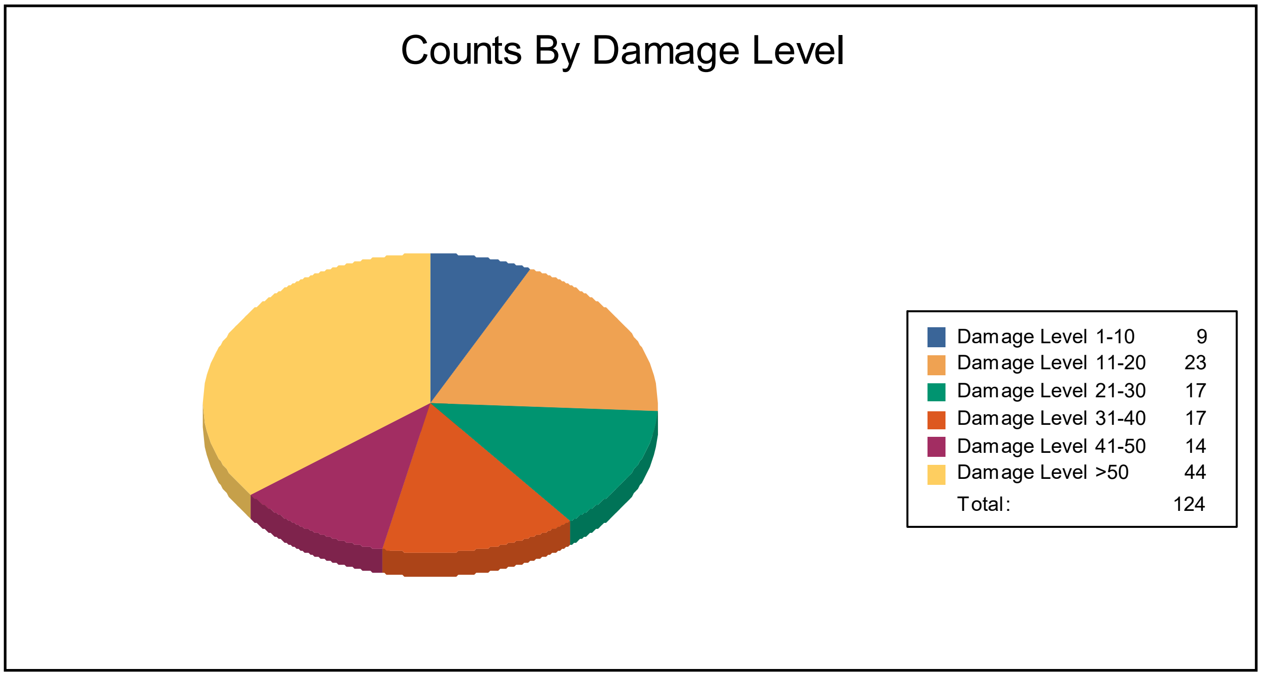


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Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	2	6	6	19	4	13	4	13	3	9	13	41
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	7	8	17	19	12	13	13	14	11	12	31	34

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

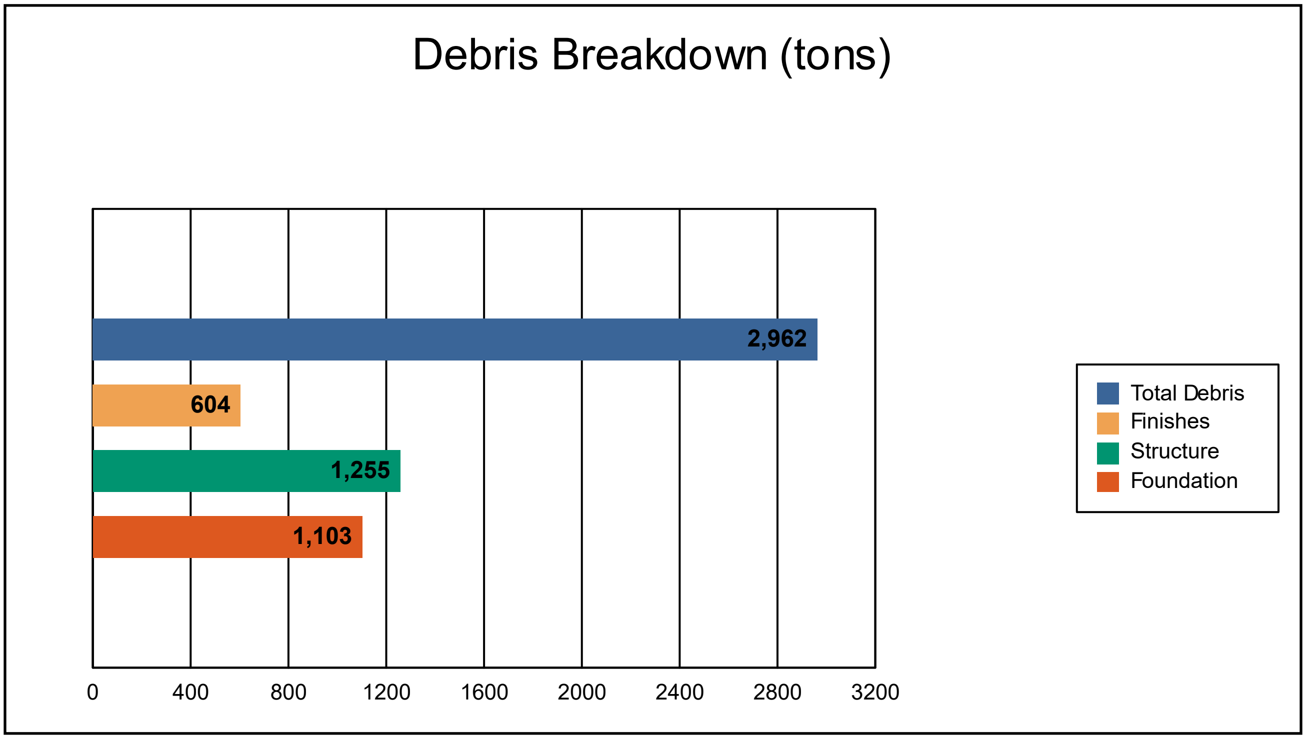
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

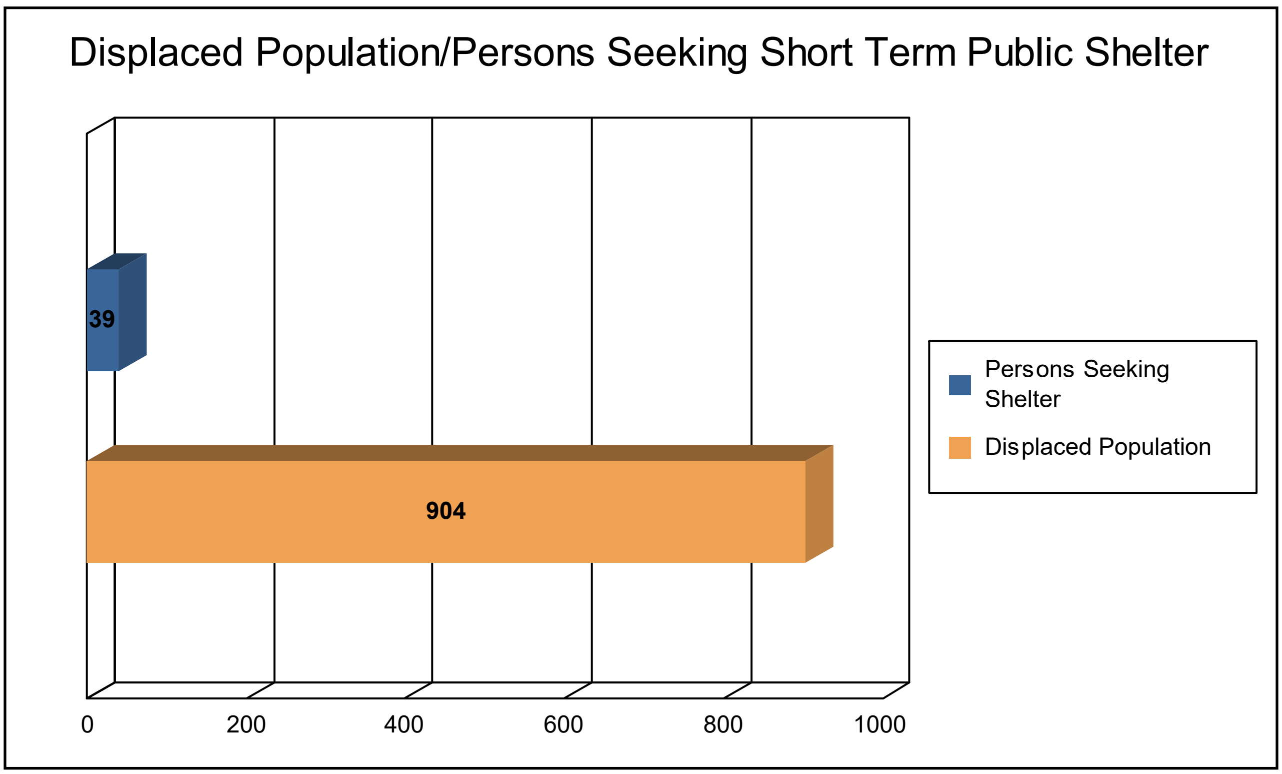


The model estimates that a total of 2,962 tons of debris will be generated. Of the total amount, Finishes comprises 20% of the total, Structure comprises 42% of the total, and Foundation comprises 37%. If the debris tonnage is converted into an estimated number of truckloads, it will require 119 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 301 households (or 904 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 39 people (out of a total population of 39,698) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 136.21 million dollars, which represents 5.43 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 99.04 million dollars. 27% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 46.36% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

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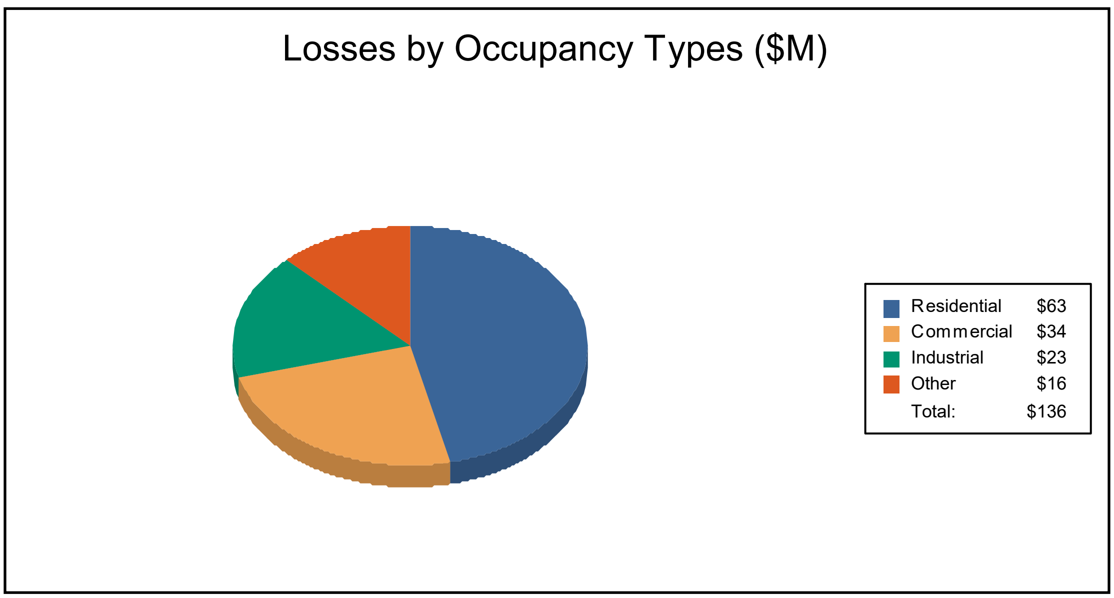
Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	35.99	5.54	5.59	1.41	48.53
	Content	18.58	11.68	13.70	3.82	47.78
	Inventory	0.00	0.40	2.10	0.23	2.73
	Subtotal	**54.58**	**17.62**	**21.39**	**5.45**	**99.04**
Business Interruption						
	Income	0.27	6.90	0.60	0.87	8.63
	Relocation	5.60	1.26	0.37	0.17	7.40
	Rental Income	2.05	0.95	0.09	0.00	3.09
	Wage	0.65	6.80	0.63	9.99	18.06
	Subtotal	**8.57**	**15.90**	**1.68**	**11.02**	**37.18**
ALL	**Total**	**63.15**	**33.52**	**23.07**	**16.47**	**136.21**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	39,698	5,212,418	1,118,597	6,331,015
Total	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**
Total Study Region	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_3

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 73 square miles and contains 2,890 census blocks. The region contains over 41 thousand households and has a total population of 106,724 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 36,786 buildings in the region with a total building replacement value (excluding contents) of 15,635 million dollars. Approximately 90.42% of the buildings (and 78.16% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 36,786 buildings in the region which have an aggregate total replacement value of 15,635 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	12,220,022	78.2%
Commercial	2,296,995	14.7%
Industrial	454,425	2.9%
Agricultural	26,557	0.2%
Religion	222,953	1.4%
Government	170,628	1.1%
Education	243,455	1.6%
Total	**15,635,035**	**100%**

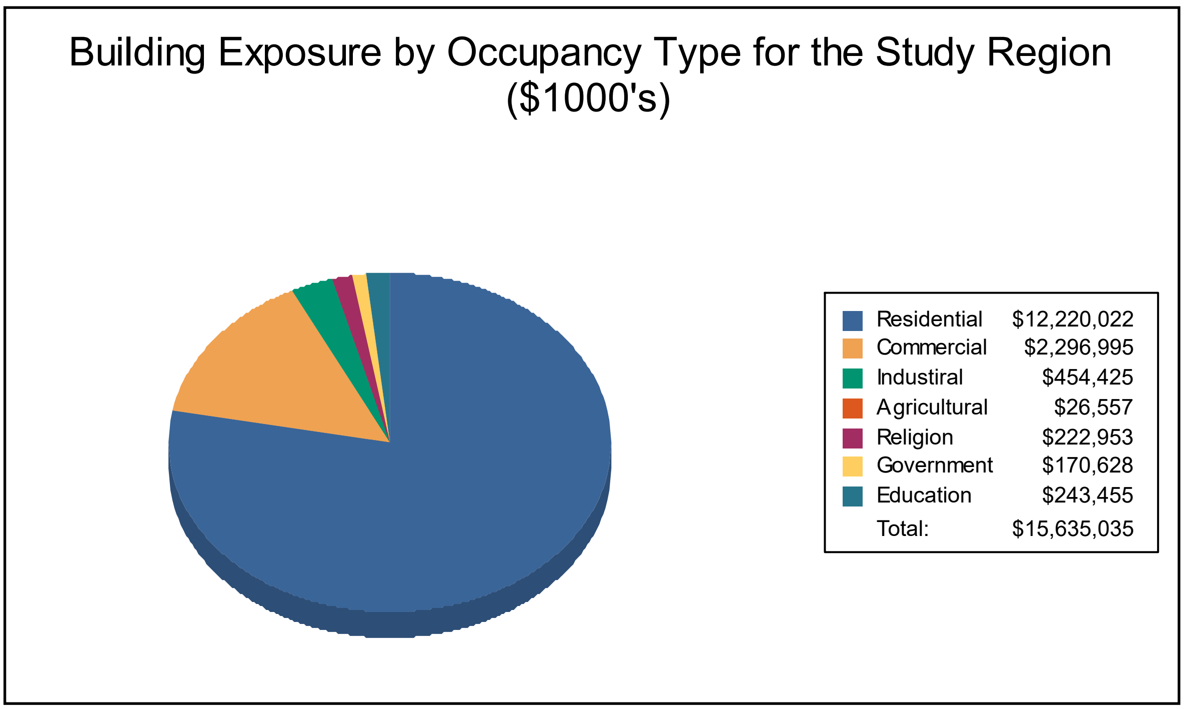
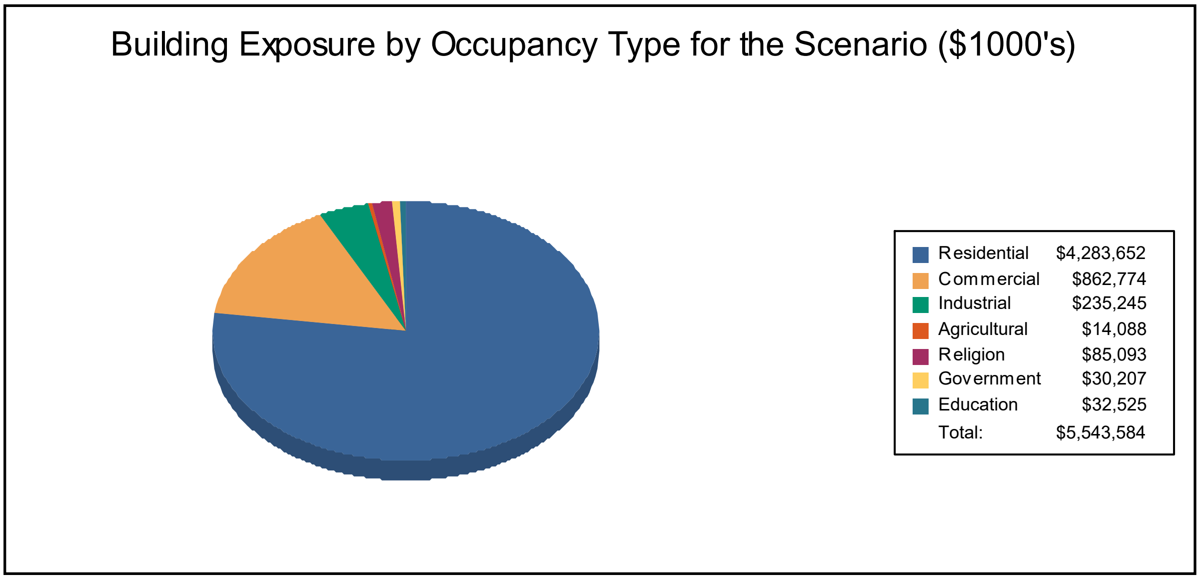


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,283,652	77.3%
Commercial	862,774	15.6%
Industrial	235,245	4.2%
Agricultural	14,088	0.3%
Religion	85,093	1.5%
Government	30,207	0.5%
Education	32,525	0.6%
Total	**5,543,584**	**100%**



Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 48 schools, 10 fire stations, 7 police stations and 2 emergency operation centers.

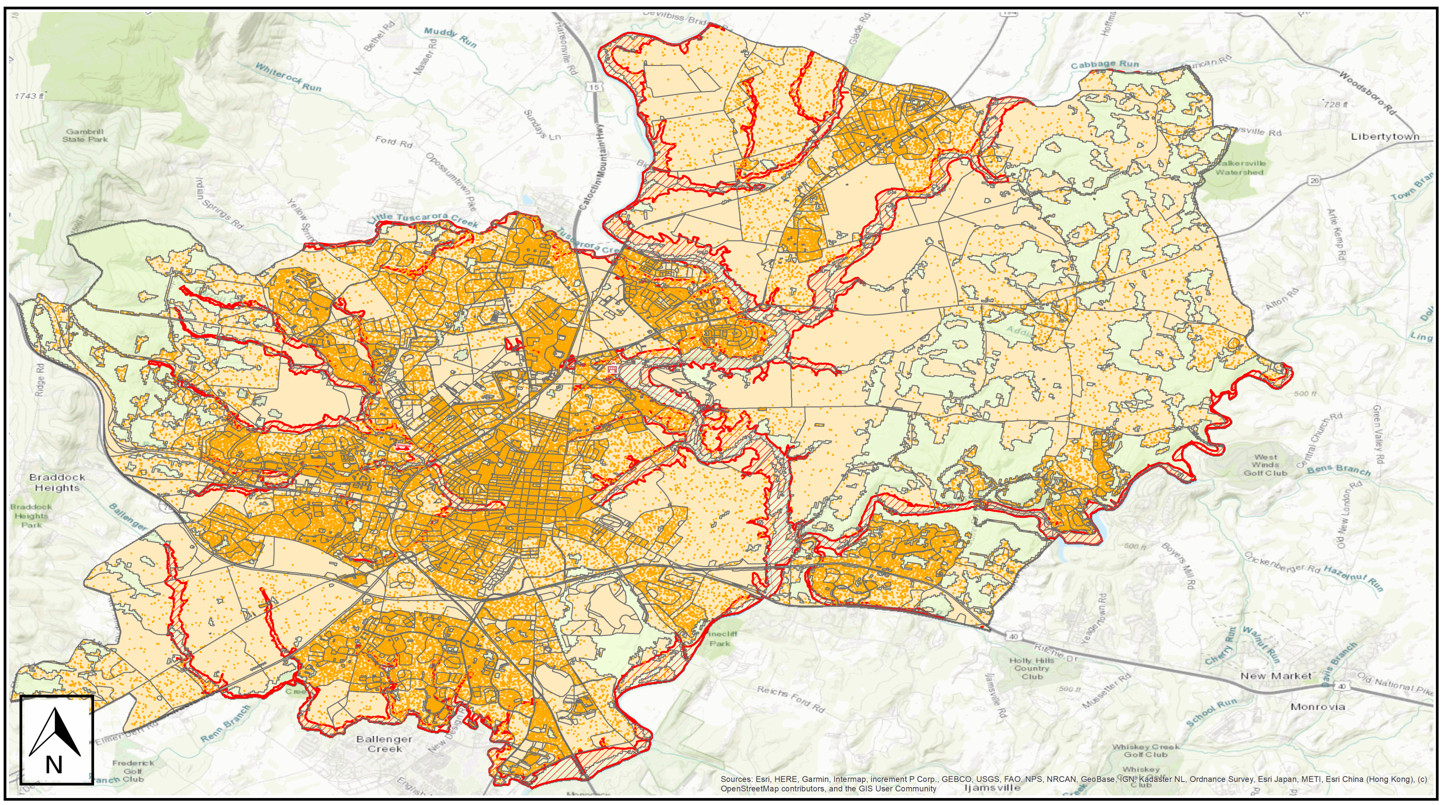
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_3
Scenario Name:	Multi
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



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Building Damage

General Building Stock Damage

Hazus estimates that about 498 buildings will be at least moderately damaged. This is over 53% of the total number of buildings in the scenario. There are an estimated 102 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

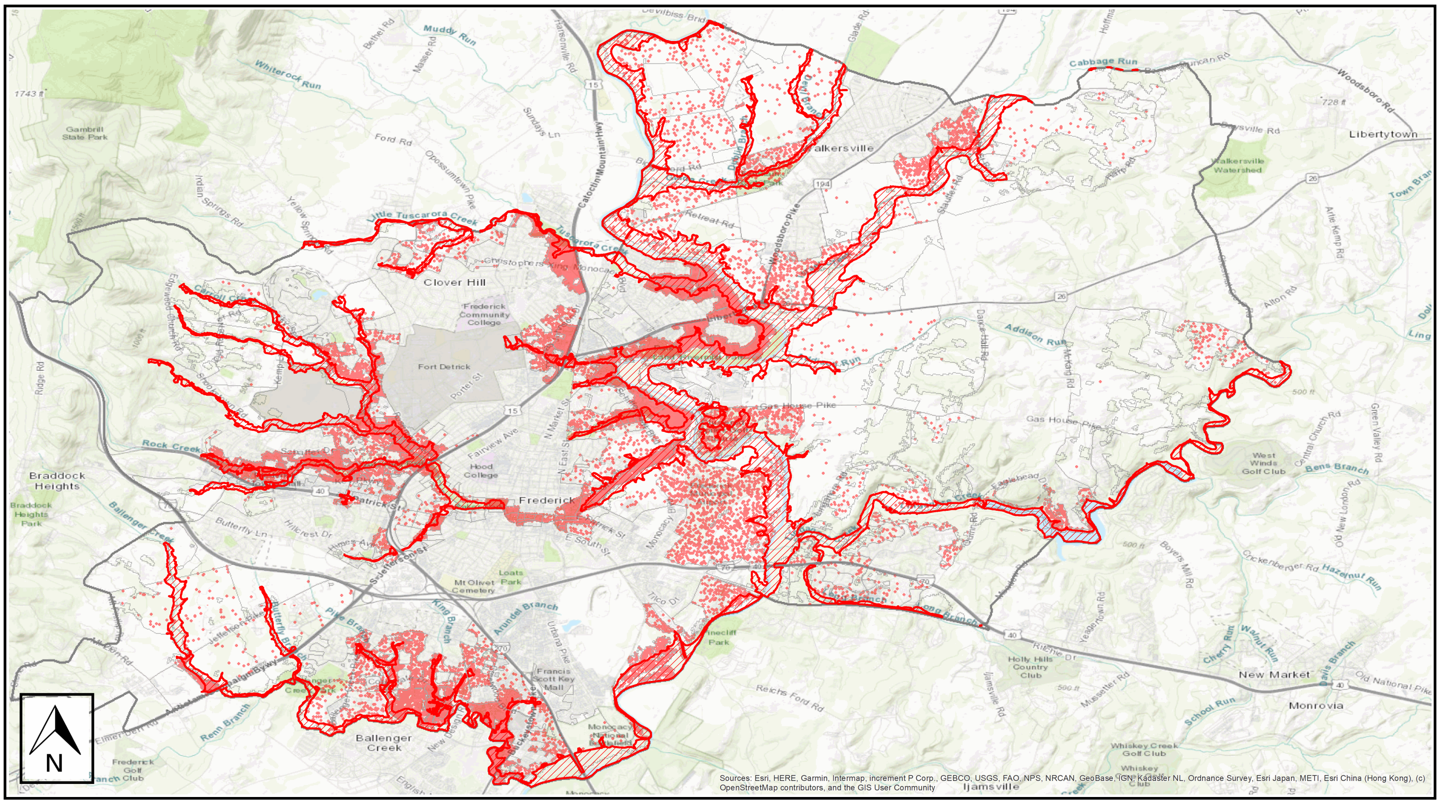


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	6	100	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	130	21	186	30	95	15	69	11	40	6	102	16
Total	**130**		**192**		**95**		**69**		**40**		**102**	

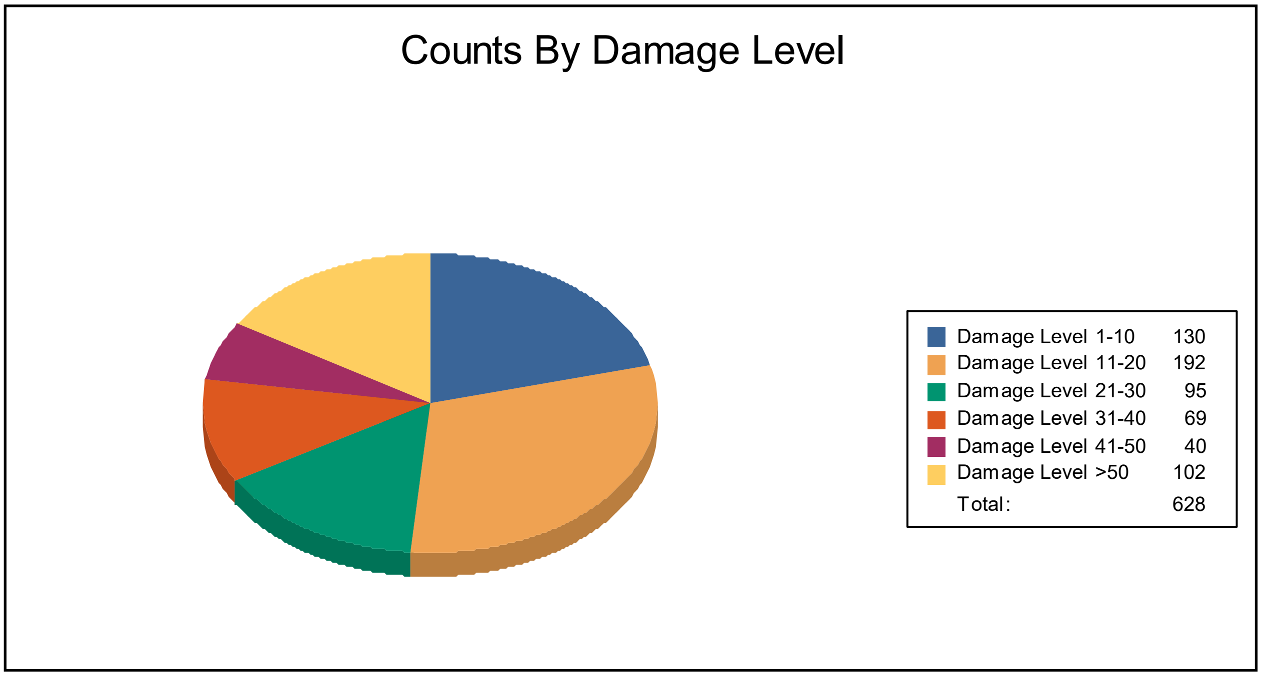


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	33	20	51	30	25	15	21	12	12	7	27	16
Steel	0	0	2	100	0	0	0	0	0	0	0	0
Wood	97	21	136	30	70	15	48	11	28	6	75	17

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 308 hospital beds available for use. On the day of the scenario flood event, the model estimates that 308 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	2	0	0	0
Fire Stations	10	1	0	1
Hospitals	1	0	0	0
Police Stations	7	0	0	0
Schools	48	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

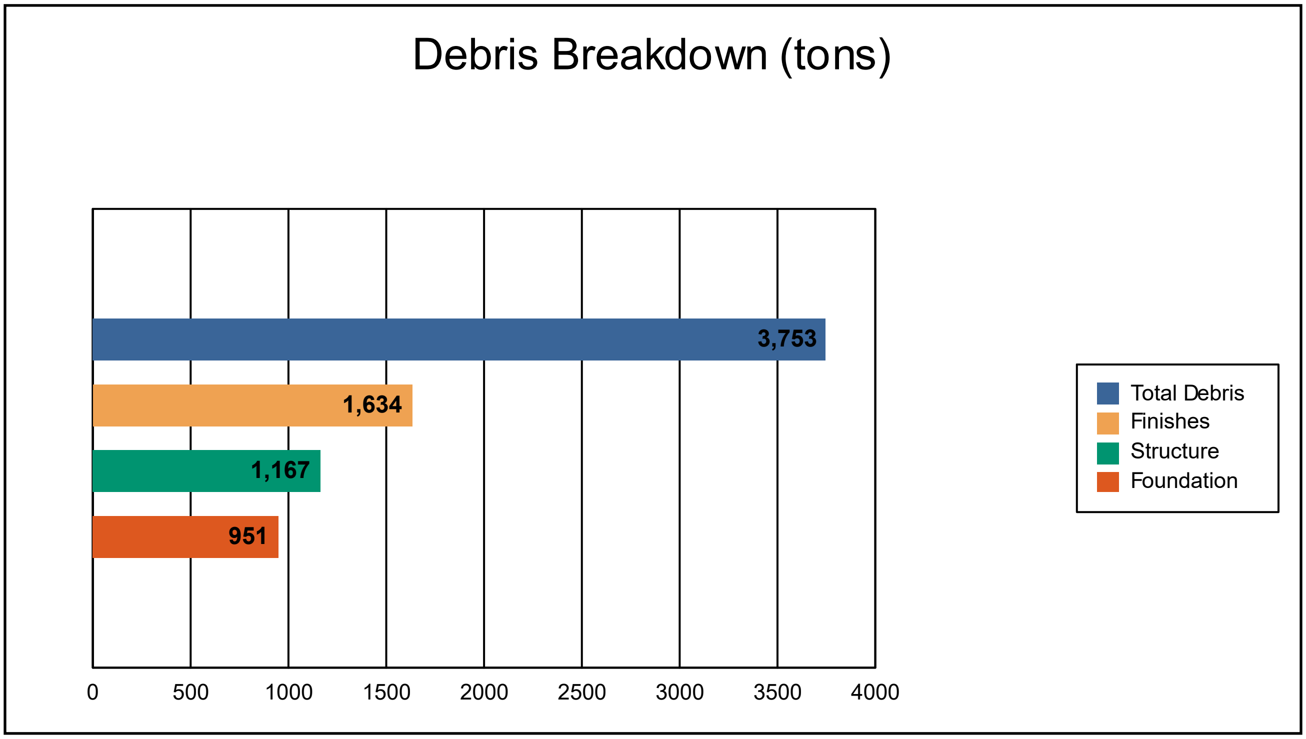
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

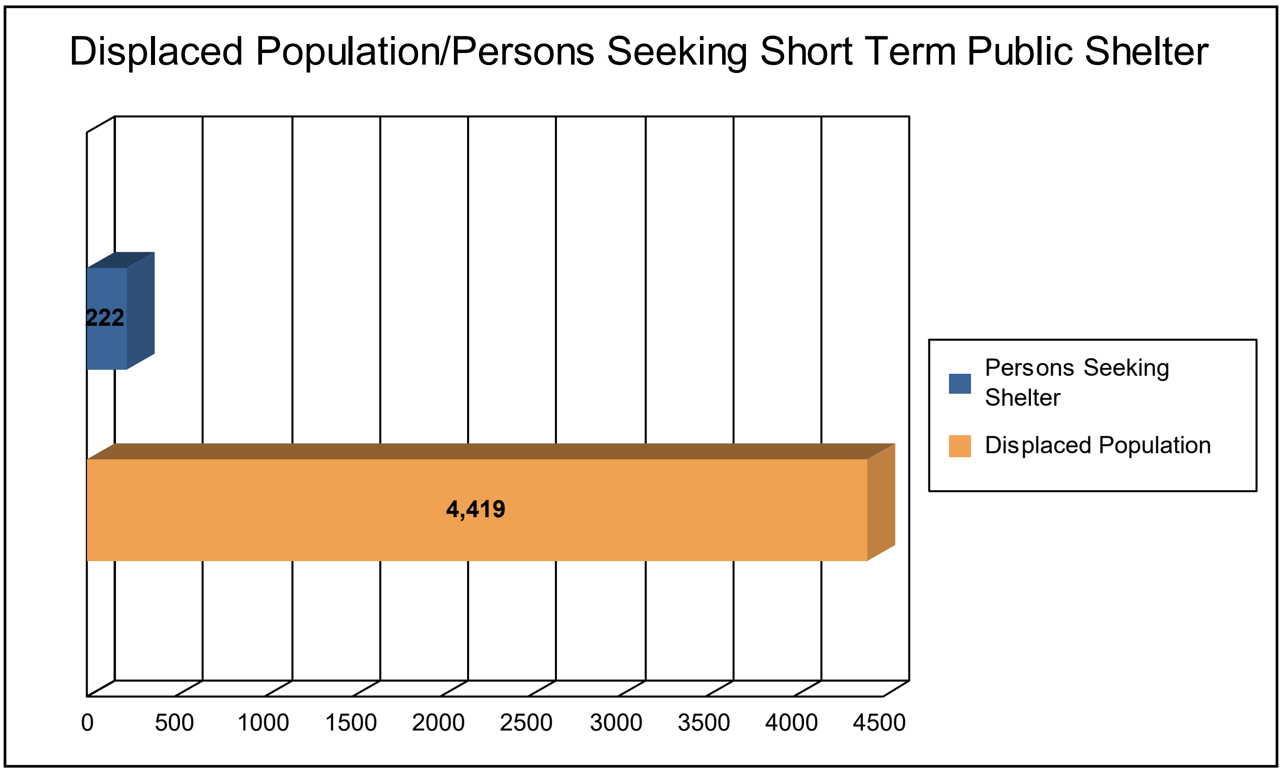


The model estimates that a total of 3,753 tons of debris will be generated. Of the total amount, Finishes comprises 44% of the total, Structure comprises 31% of the total, and Foundation comprises 25%. If the debris tonnage is converted into an estimated number of truckloads, it will require 151 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 1,473 households (or 4,419 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 222 people (out of a total population of 106,724) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 500.78 million dollars, which represents 9.03 % of the total replacement value of the scenario buildings.

Building-Related Losses

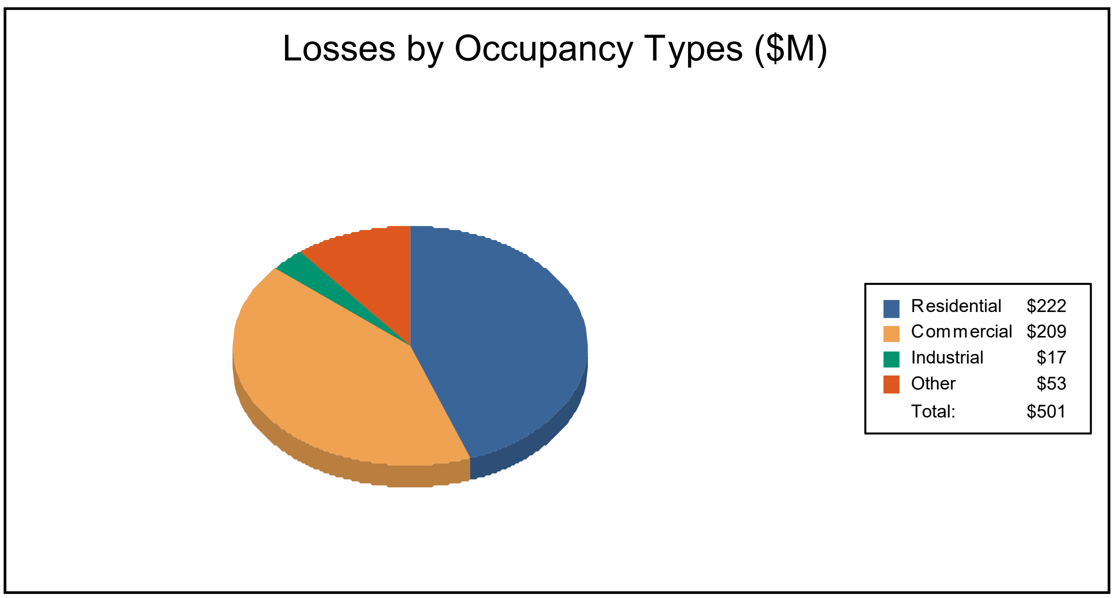
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 301.63 million dollars. 40% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 44.36% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	115.89	27.50	4.68	2.51	150.58
	Content	62.41	64.17	9.48	12.58	148.65
	Inventory	0.00	0.82	1.50	0.09	2.40
	Subtotal	**178.30**	**92.48**	**15.66**	**15.19**	**301.63**
Business Interruption						
	Income	1.53	49.39	0.25	3.90	55.06
	Relocation	27.31	11.76	0.23	1.70	40.99
	Rental Income	11.40	8.23	0.05	0.29	19.97
	Wage	3.62	47.55	0.45	31.51	83.14
	Subtotal	**43.86**	**116.92**	**0.97**	**37.40**	**199.15**
ALL	**Total**	**222.16**	**209.41**	**16.63**	**52.58**	**500.78**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Maryland				
Frederick	106,724	12,220,022	3,415,013	15,635,035
Total	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**
Total Study Region	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_4

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 138 square miles and contains 1,074 census blocks. The region contains over 9 thousand households and has a total population of 27,180 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 10,335 buildings in the region with a total building replacement value (excluding contents) of 3,945 million dollars. Approximately 91.67% of the buildings (and 88.71% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 10,335 buildings in the region which have an aggregate total replacement value of 3,945 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	3,499,625	88.7%
Commercial	238,367	6.0%
Industrial	89,655	2.3%
Agricultural	29,561	0.7%
Religion	45,679	1.2%
Government	5,013	0.1%
Education	37,265	0.9%
Total	**3,945,165**	**100%**

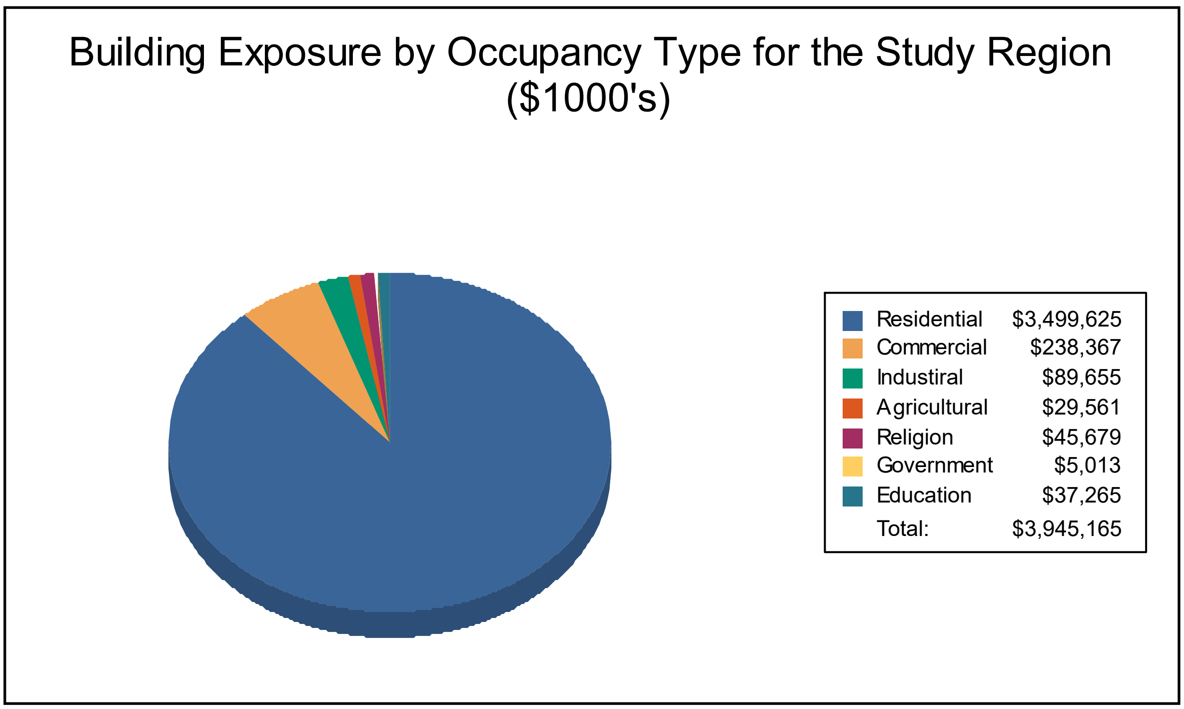
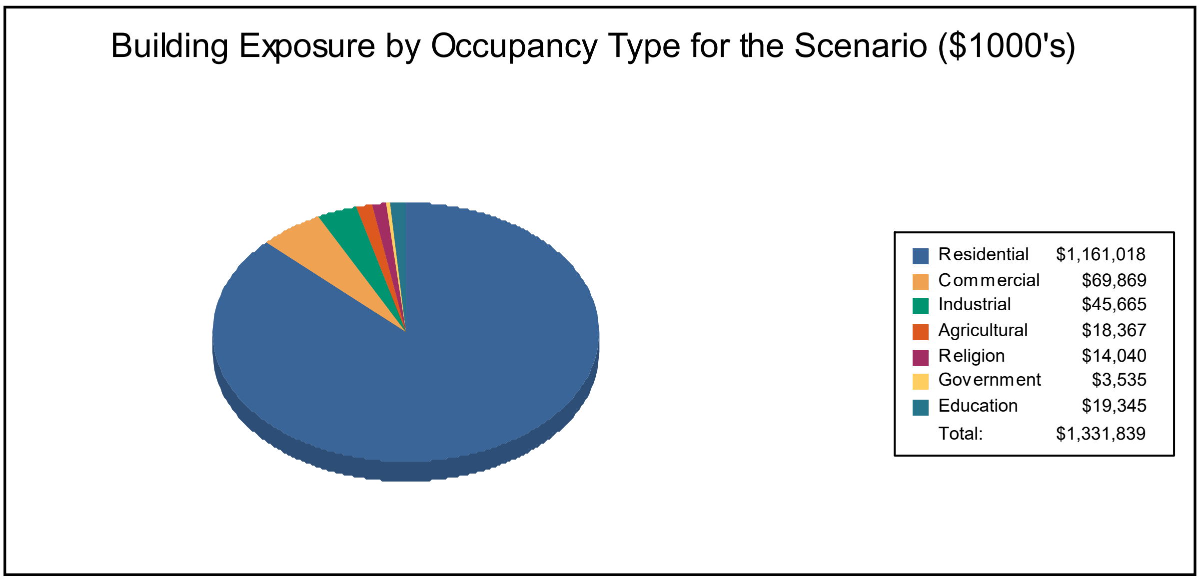


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	**Exposure ($1000)**	**Percent of Total**
Residential	1,161,018	87.2%
Commercial	69,869	5.2%
Industrial	45,665	3.4%
Agricultural	18,367	1.4%
Religion	14,040	1.1%
Government	3,535	0.3%
Education	19,345	1.5%
Total	**1,331,839**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

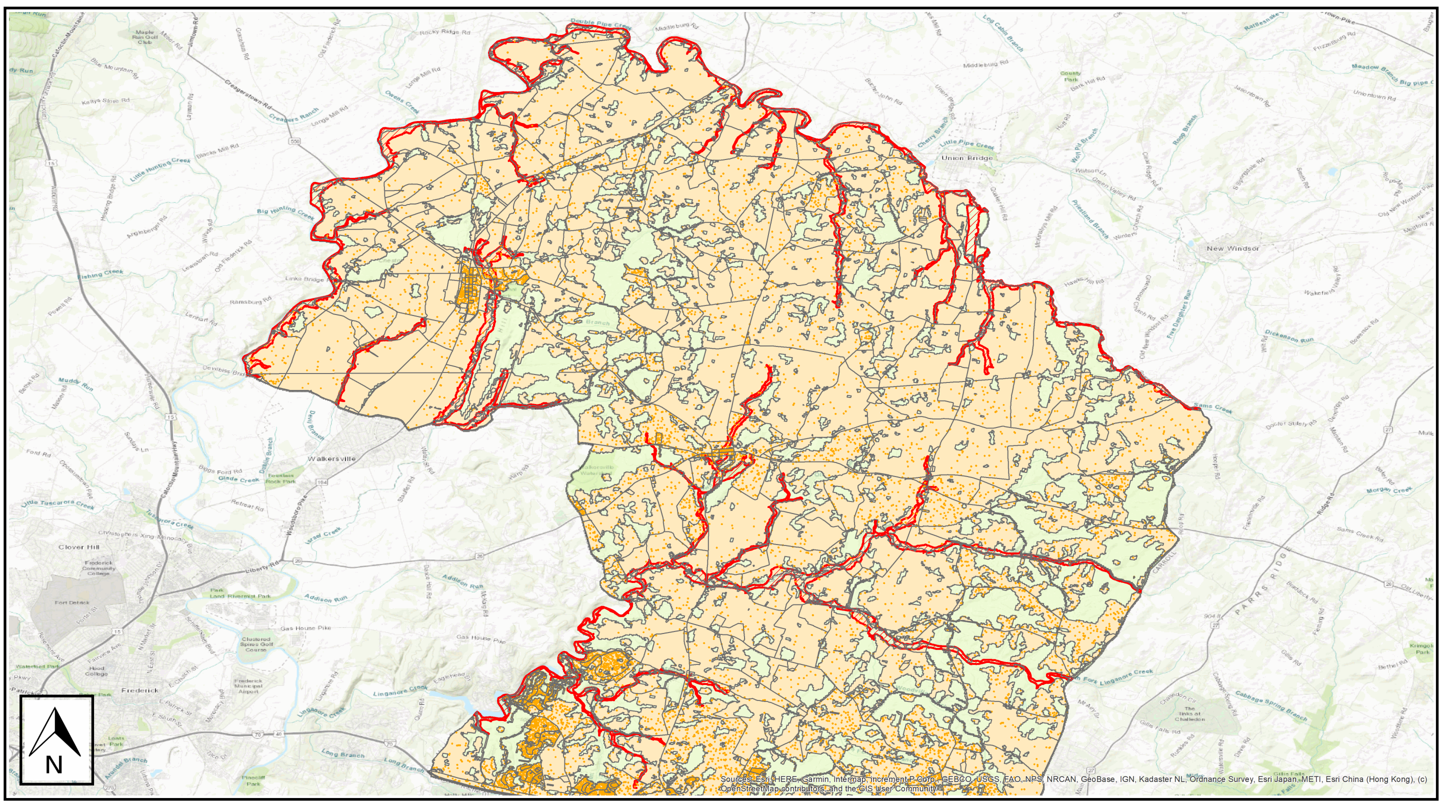
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_4
Scenario Name:	Multi
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 17 buildings will be at least moderately damaged. This is over 47% of the total number of buildings in the scenario. There are an estimated 5 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

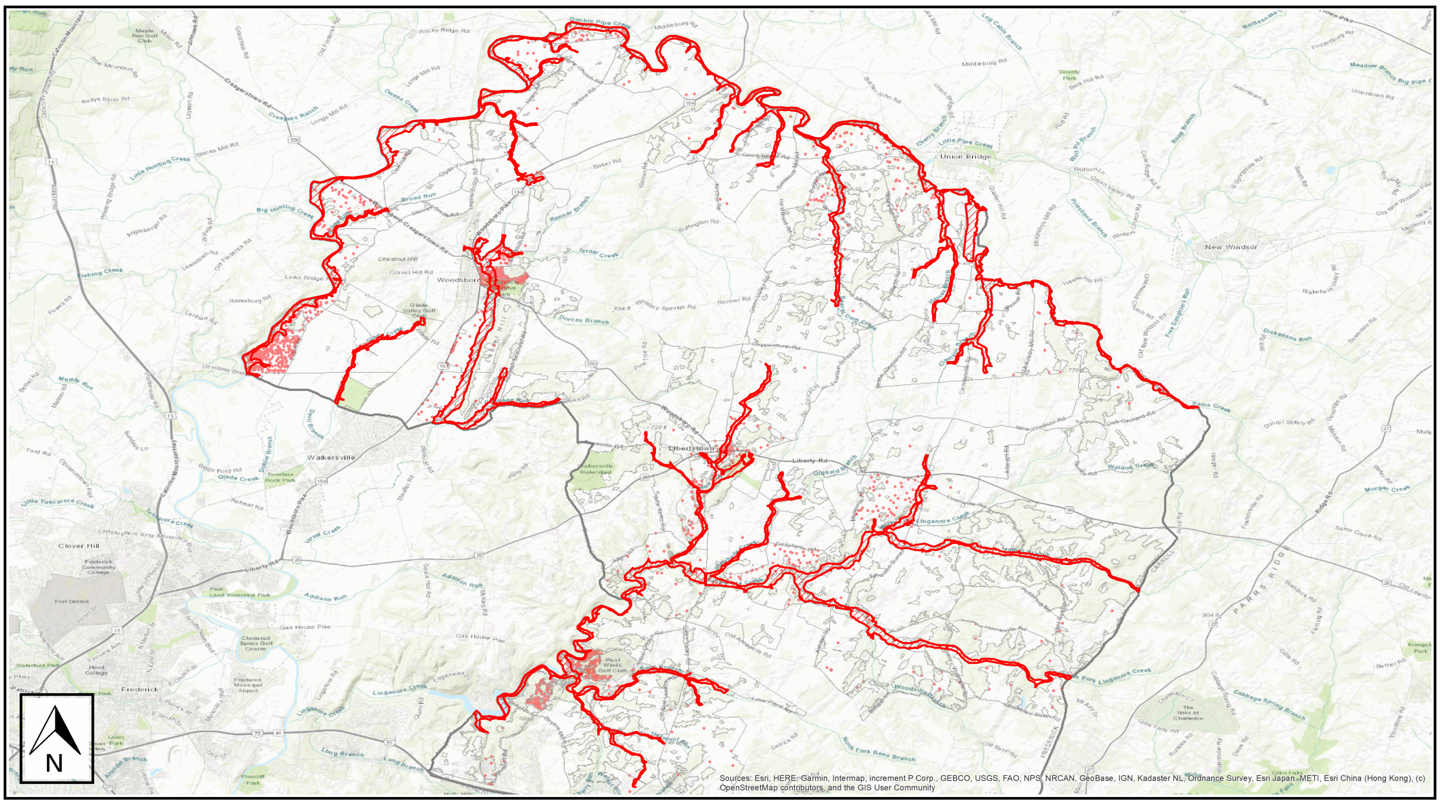


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	1	6	6	33	2	11	2	11	2	11	5	28
Total	**1**		**6**		**2**		**2**		**2**		**5**	

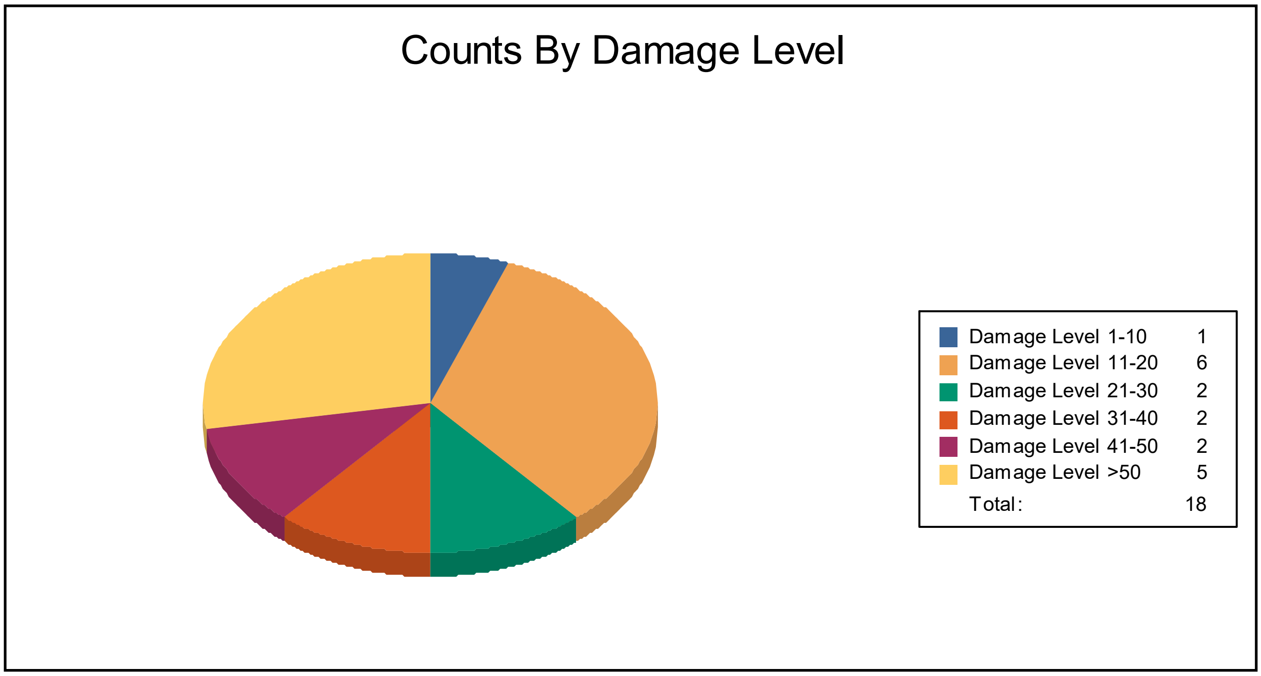


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	1	100
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	1	6	6	35	2	12	2	12	2	12	4	24

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

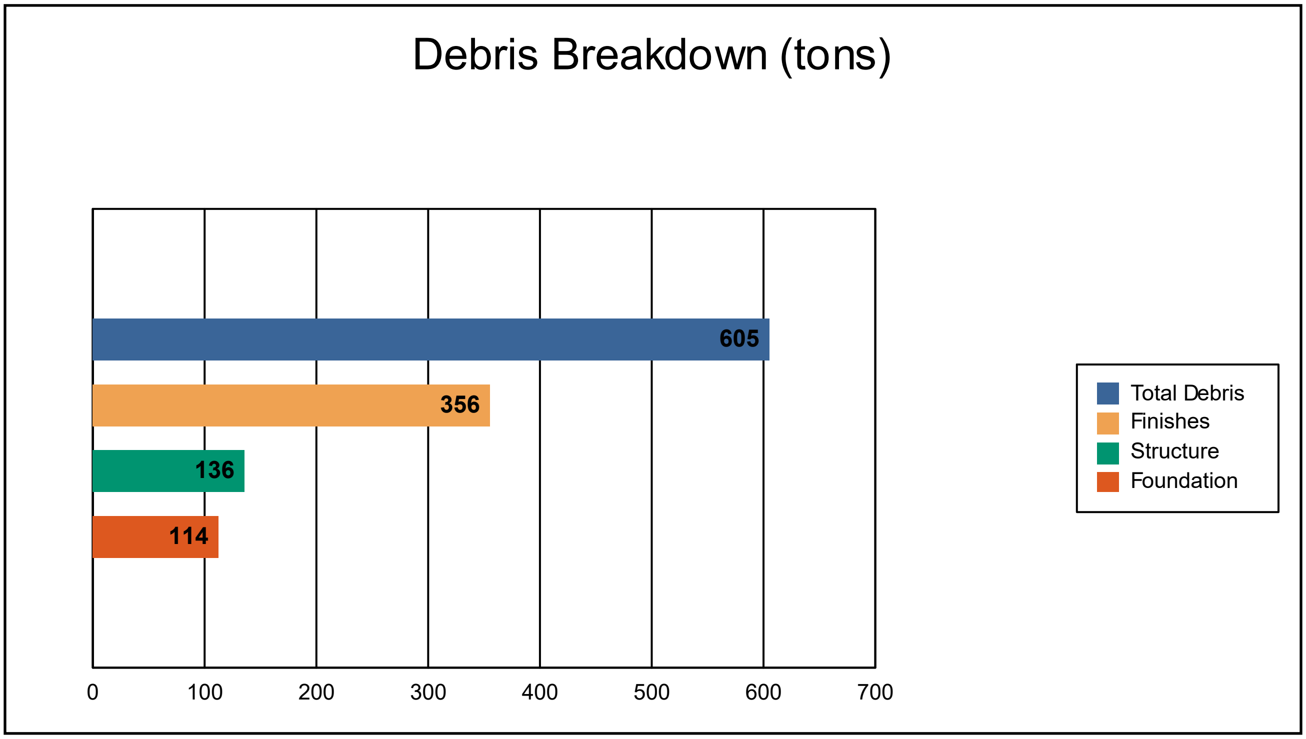
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

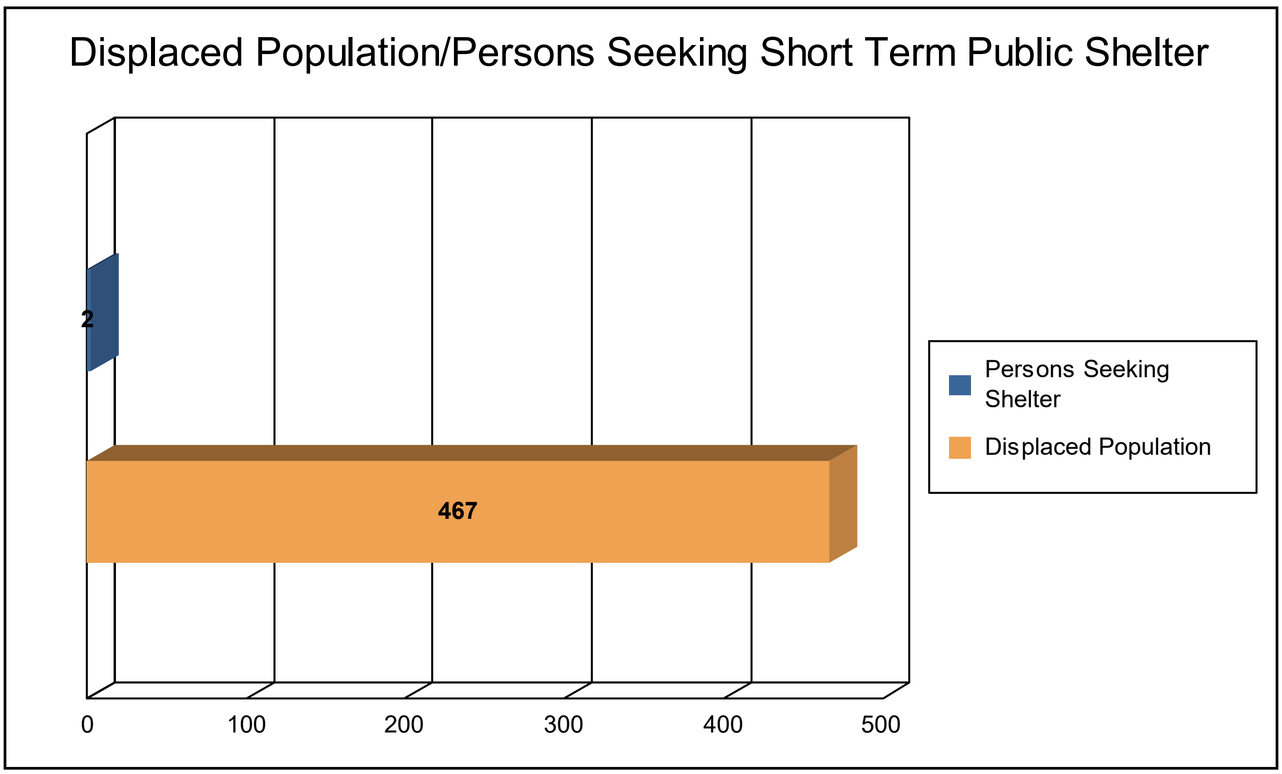


The model estimates that a total of 605 tons of debris will be generated. Of the total amount, Finishes comprises 59% of the total, Structure comprises 22% of the total, and Foundation comprises 19%. If the debris tonnage is converted into an estimated number of truckloads, it will require 25 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 156 households (or 467 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 2 people (out of a total population of 27,180) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 44.49 million dollars, which represents 3.34 % of the total replacement value of the scenario buildings.

Building-Related Losses

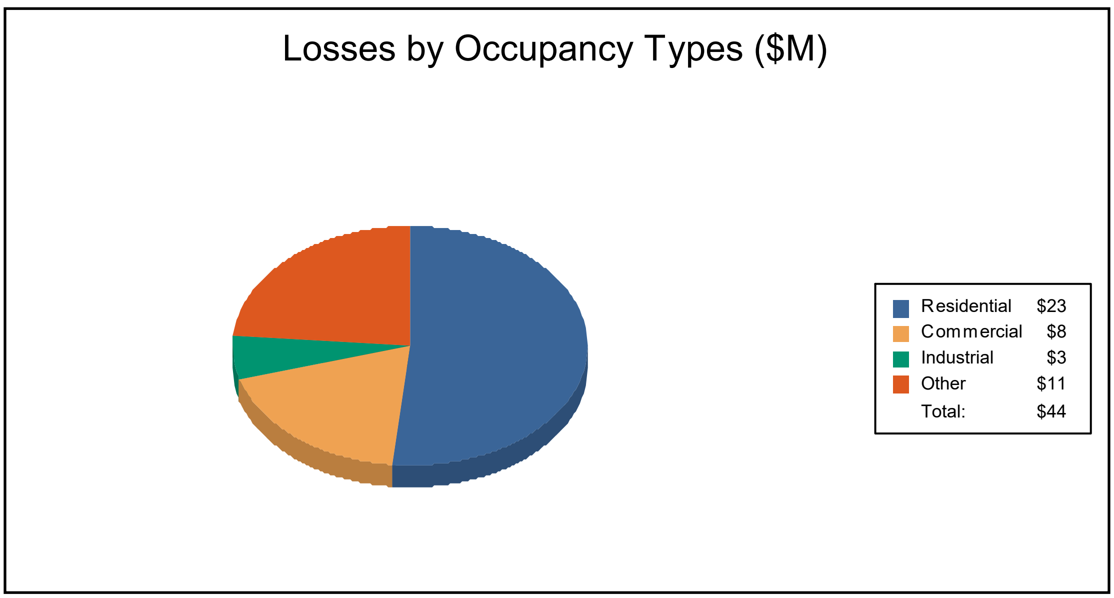
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 28.54 million dollars. 36% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 51.56% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	13.18	0.79	0.69	0.40	15.05
	Content	6.70	2.53	1.54	2.41	13.18
	Inventory	0.00	0.02	0.27	0.02	0.31
	Subtotal	**19.88**	**3.35**	**2.50**	**2.82**	**28.54**
Business Interruption						
	Income	0.00	2.36	0.03	0.90	3.29
	Relocation	2.38	0.23	0.03	0.35	2.99
	Rental Income	0.68	0.16	0.00	0.02	0.86
	Wage	0.00	2.29	0.06	6.45	8.80
	Subtotal	**3.06**	**5.04**	**0.12**	**7.72**	**15.94**
ALL	**Total**	**22.94**	**8.39**	**2.62**	**10.54**	**44.49**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	27,180	3,499,625	445,540	3,945,165
Total	**27,180**	**3,499,625**	**445,540**	**3,945,165**
Total Study Region	**27,180**	**3,499,625**	**445,540**	**3,945,165**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_5

Flood Scenario: Multi

Print Date: Thursday, August 5, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

HAZUS

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FEMA

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 173 square miles and contains 1,430 census blocks. The region contains over 9 thousand households and has a total population of 24,832 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 9,774 buildings in the region with a total building replacement value (excluding contents) of 3,437 million dollars. Approximately 90.65% of the buildings (and 84.66% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 9,774 buildings in the region which have an aggregate total replacement value of 3,437 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,909,982	84.7%
Commercial	227,400	6.6%
Industrial	98,717	2.9%
Agricultural	22,332	0.6%
Religion	118,912	3.5%
Government	39,615	1.2%
Education	20,149	0.6%
Total	**3,437,107**	**100%**

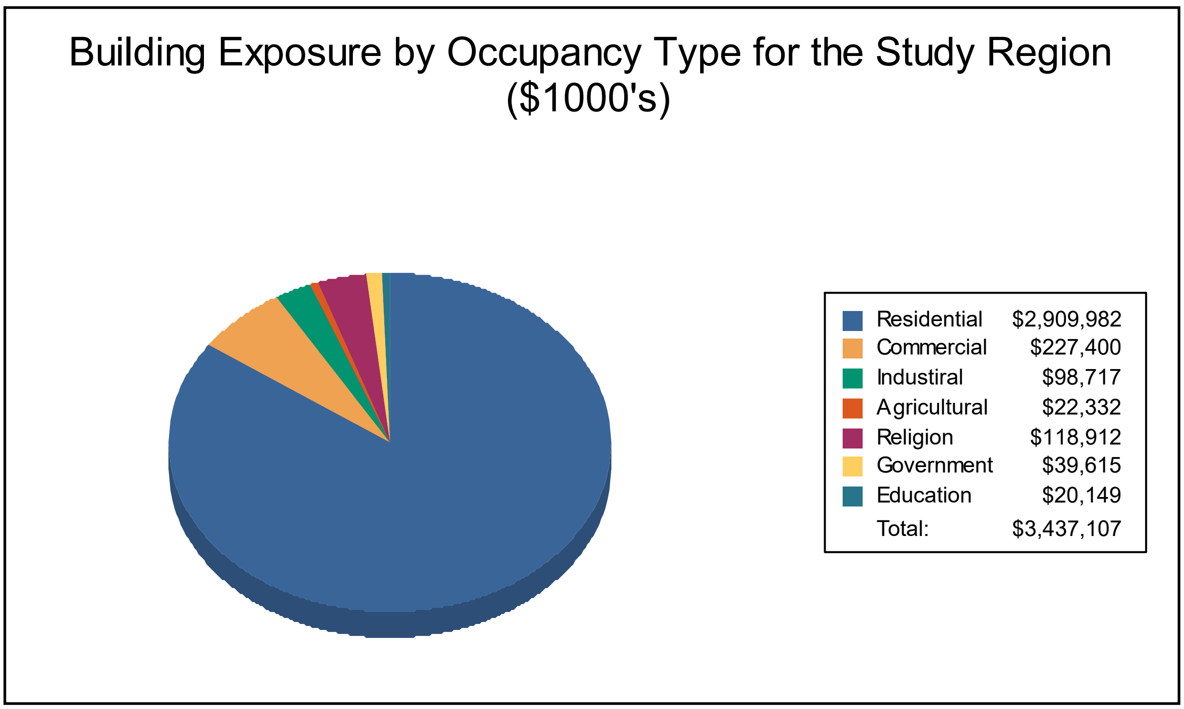
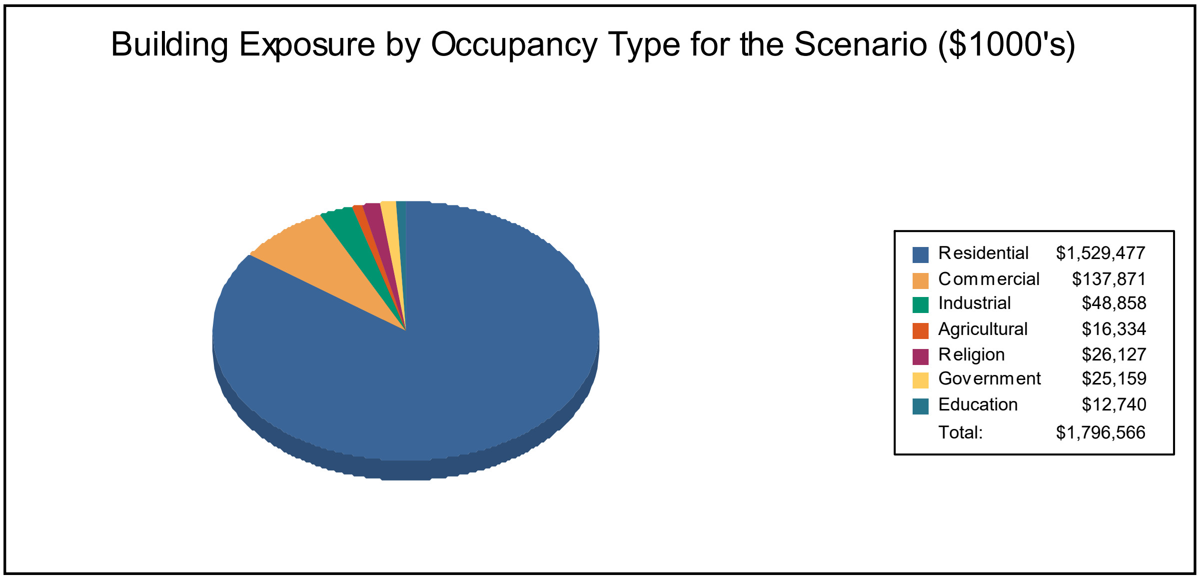


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,529,477	85.1%
Commercial	137,871	7.7%
Industrial	48,858	2.7%
Agricultural	16,334	0.9%
Religion	26,127	1.5%
Government	25,159	1.4%
Education	12,740	0.7%
Total	**1,796,566**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 11 schools, 7 fire stations, 2 police stations and no emergency operation centers.

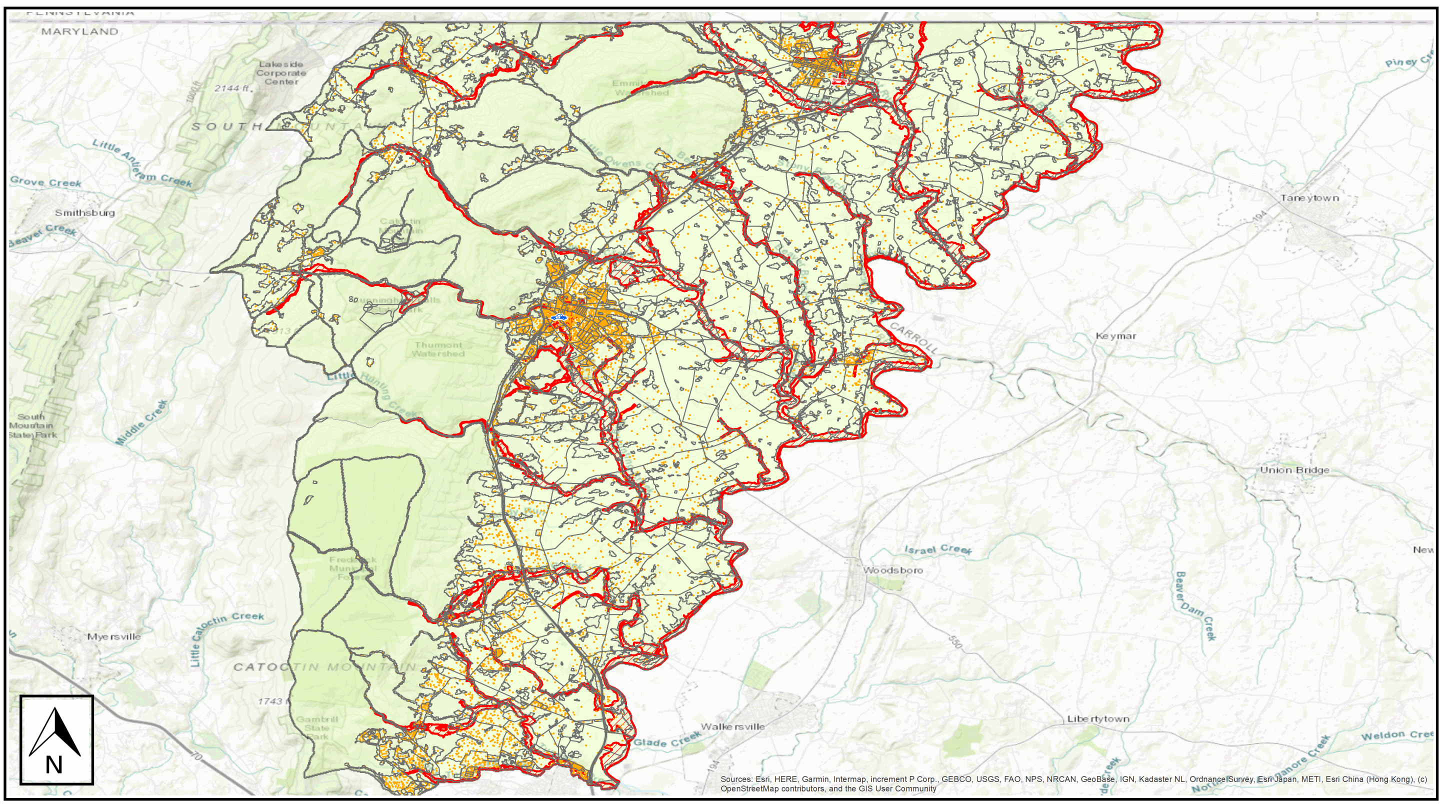
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_5
Scenario Name:	Multi
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 34 buildings will be at least moderately damaged. This is over 61% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

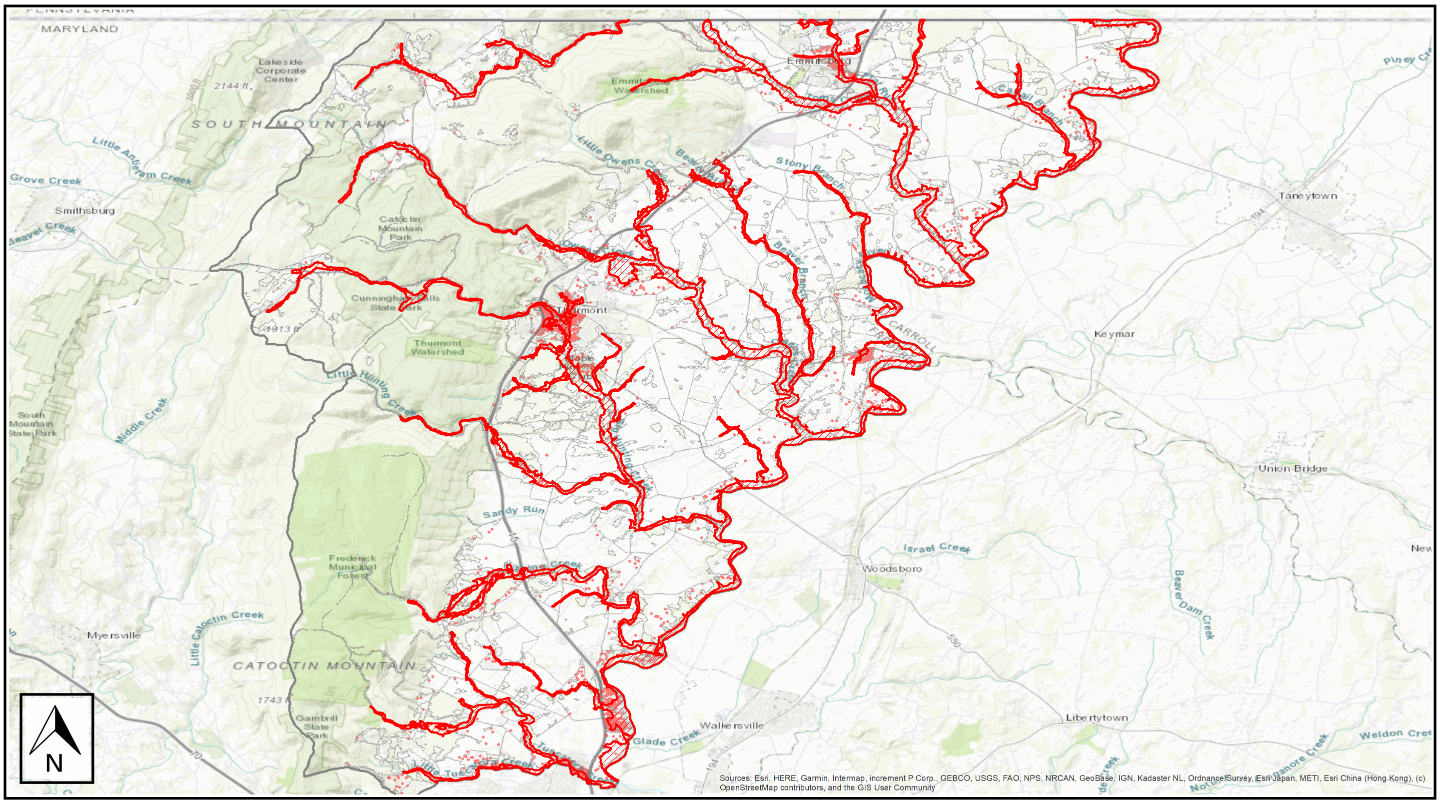


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	21	38	26	47	5	9	3	5	0	0	0	0
Total	**21**		**26**		**5**		**3**		**0**		**0**	

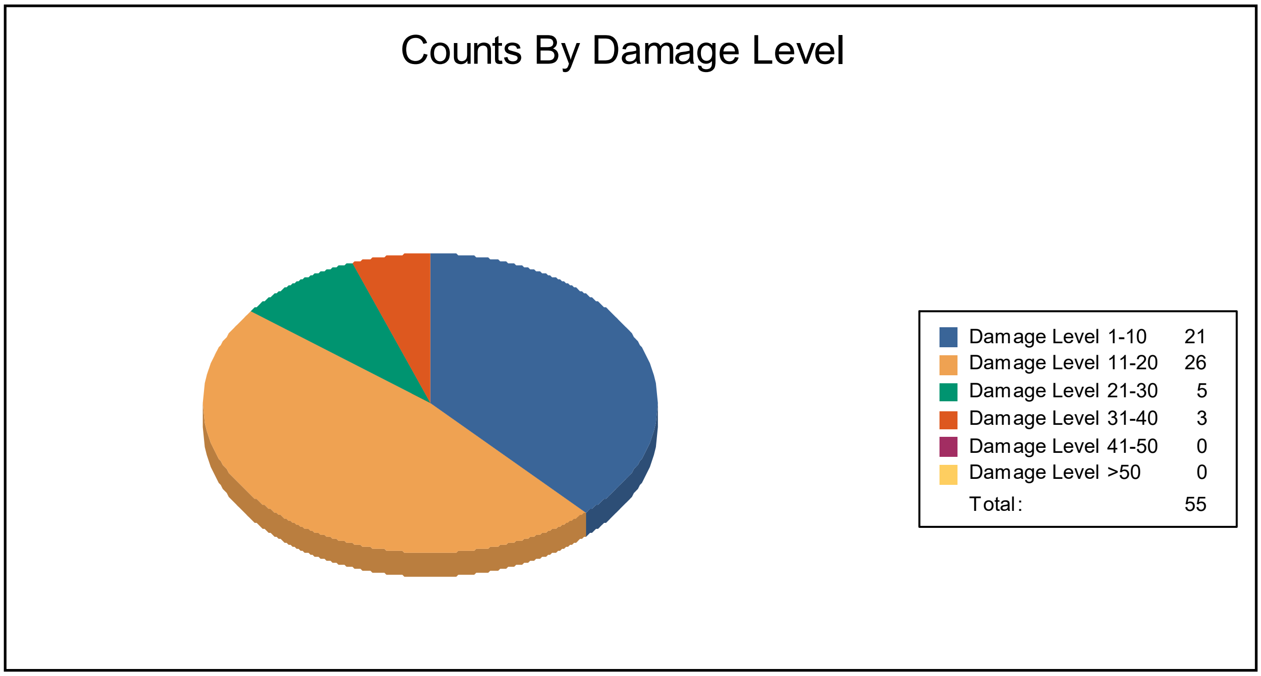


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	4	33	7	58	1	8	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	17	40	19	44	4	9	3	7	0	0	0	0

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	7	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	11	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

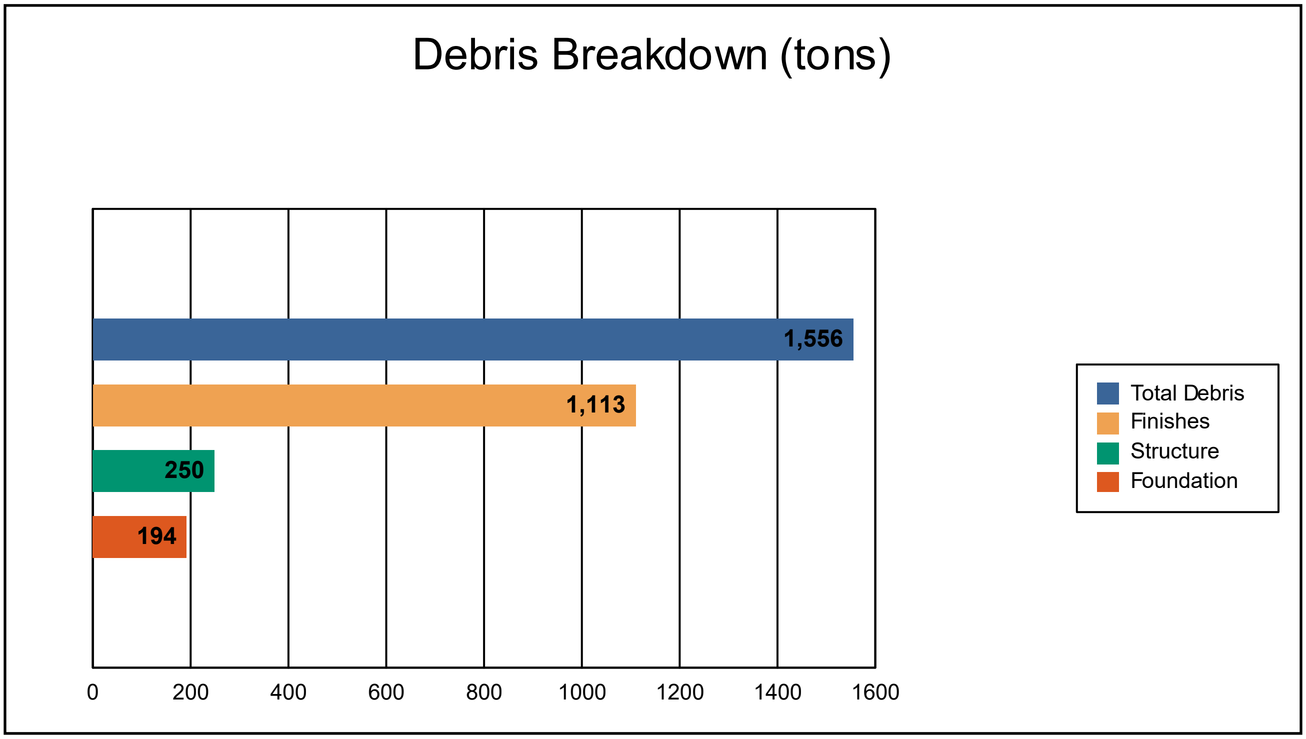
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

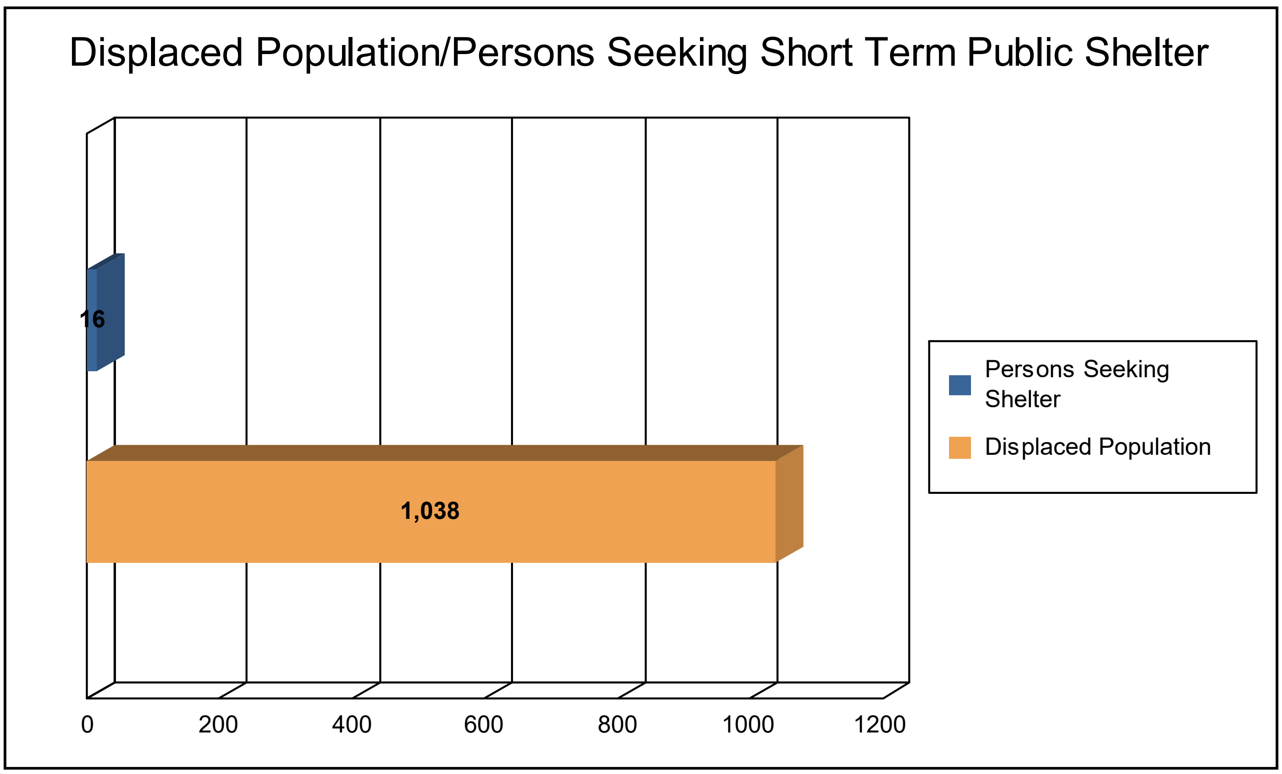


The model estimates that a total of 1,556 tons of debris will be generated. Of the total amount, Finishes comprises 71% of the total, Structure comprises 16% of the total, and Foundation comprises 12%. If the debris tonnage is converted into an estimated number of truckloads, it will require 63 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 346 households (or 1,038 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 16 people (out of a total population of 24,832) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 95.59 million dollars, which represents 5.32 % of the total replacement value of the scenario buildings.

Building-Related Losses

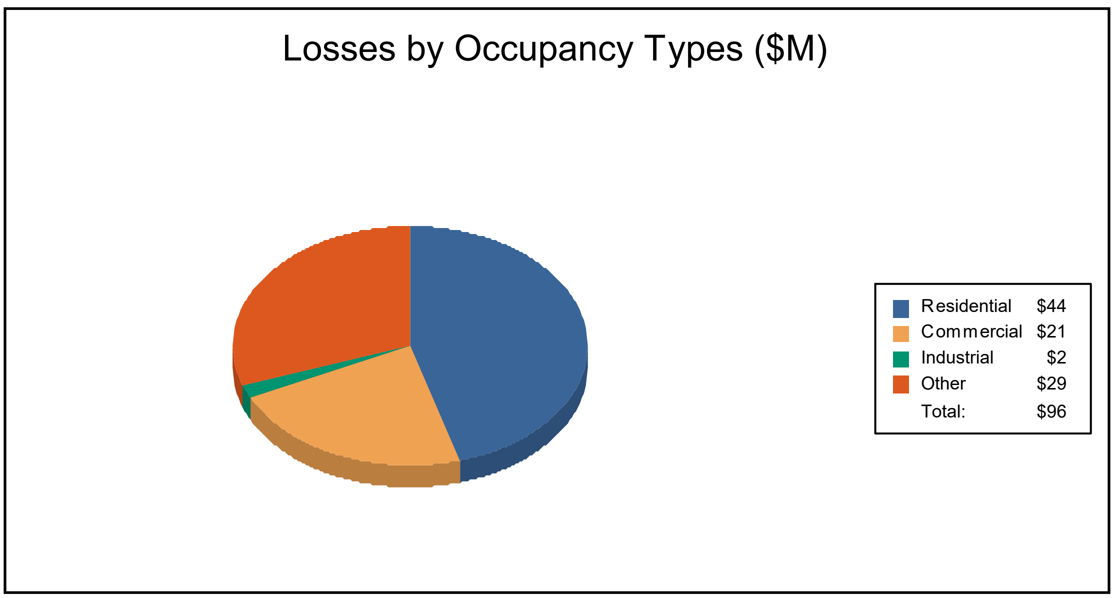
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 45.90 million dollars. 52% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 45.55% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	21.14	1.80	0.58	0.68	24.20
	Content	11.67	5.76	0.92	3.08	21.42
	Inventory	0.00	0.08	0.12	0.07	0.28
	Subtotal	**32.81**	**7.64**	**1.62**	**3.82**	**45.90**
Business Interruption						
	Income	0.81	6.10	0.02	1.12	8.05
	Relocation	5.79	0.76	0.01	0.56	7.11
	Rental Income	2.21	0.58	0.00	0.05	2.83
	Wage	1.93	6.23	0.05	23.51	31.71
	Subtotal	**10.73**	**13.66**	**0.07**	**25.24**	**49.70**
ALL	**Total**	**43.54**	**21.30**	**1.69**	**29.06**	**95.59**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Frederick	24,832	2,909,982	527,125	3,437,107
Total	**24,832**	**2,909,982**	**527,125**	**3,437,107**
Total Study Region	**24,832**	**2,909,982**	**527,125**	**3,437,107**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_1

Flood Scenario: Mulit

Print Date: Monday, August 2, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

Increasing Resilience Together

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 154 square miles and contains 1,492 census blocks. The region contains over 13 thousand households and has a total population of 34,951 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 13,924 buildings in the region with a total building replacement value (excluding contents) of 4,884 million dollars. Approximately 92.06% of the buildings (and 89.46% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 13,924 buildings in the region which have an aggregate total replacement value of 4,884 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,369,448	89.5%
Commercial	298,832	6.1%
Industrial	83,521	1.7%
Agricultural	23,904	0.5%
Religion	65,399	1.3%
Government	17,551	0.4%
Education	25,330	0.5%
Total	**4,883,985**	**100%**

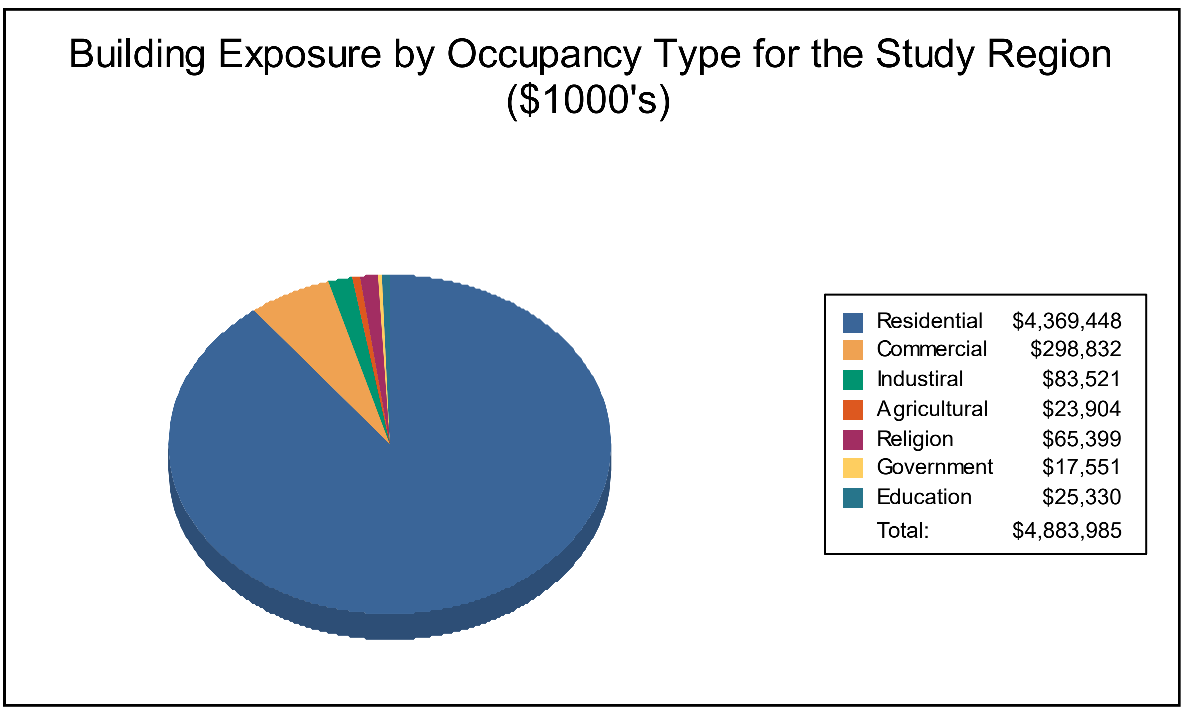
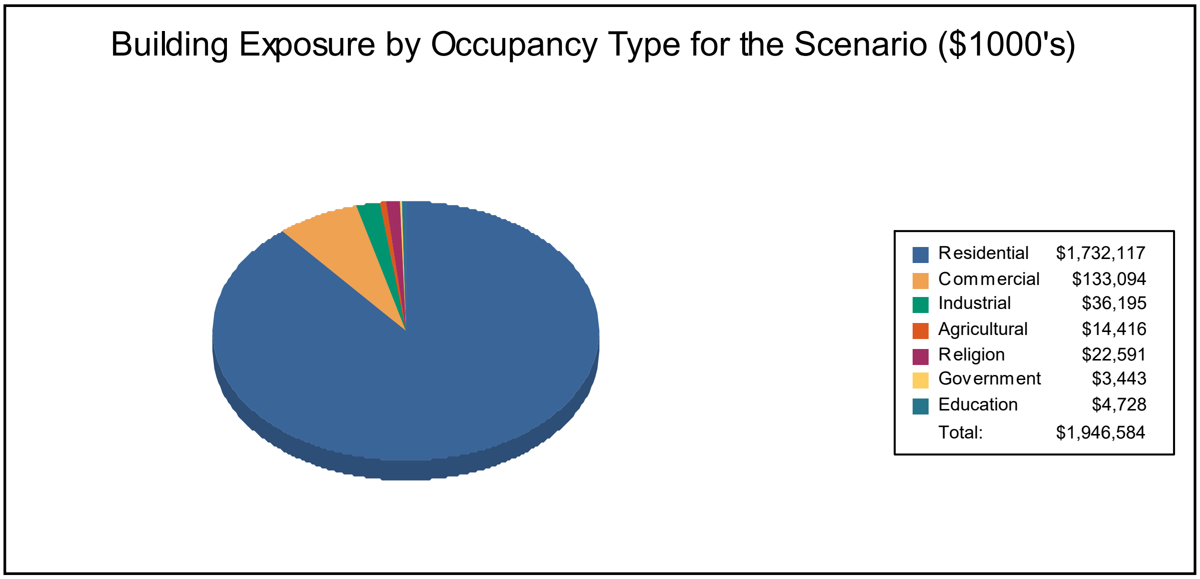


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,732,117	89.0%
Commercial	133,094	6.8%
Industrial	36,195	1.9%
Agricultural	14,416	0.7%
Religion	22,591	1.2%
Government	3,443	0.2%
Education	4,728	0.2%
Total	**1,946,584**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 14 schools, 6 fire stations, 2 police stations and no emergency operation centers.

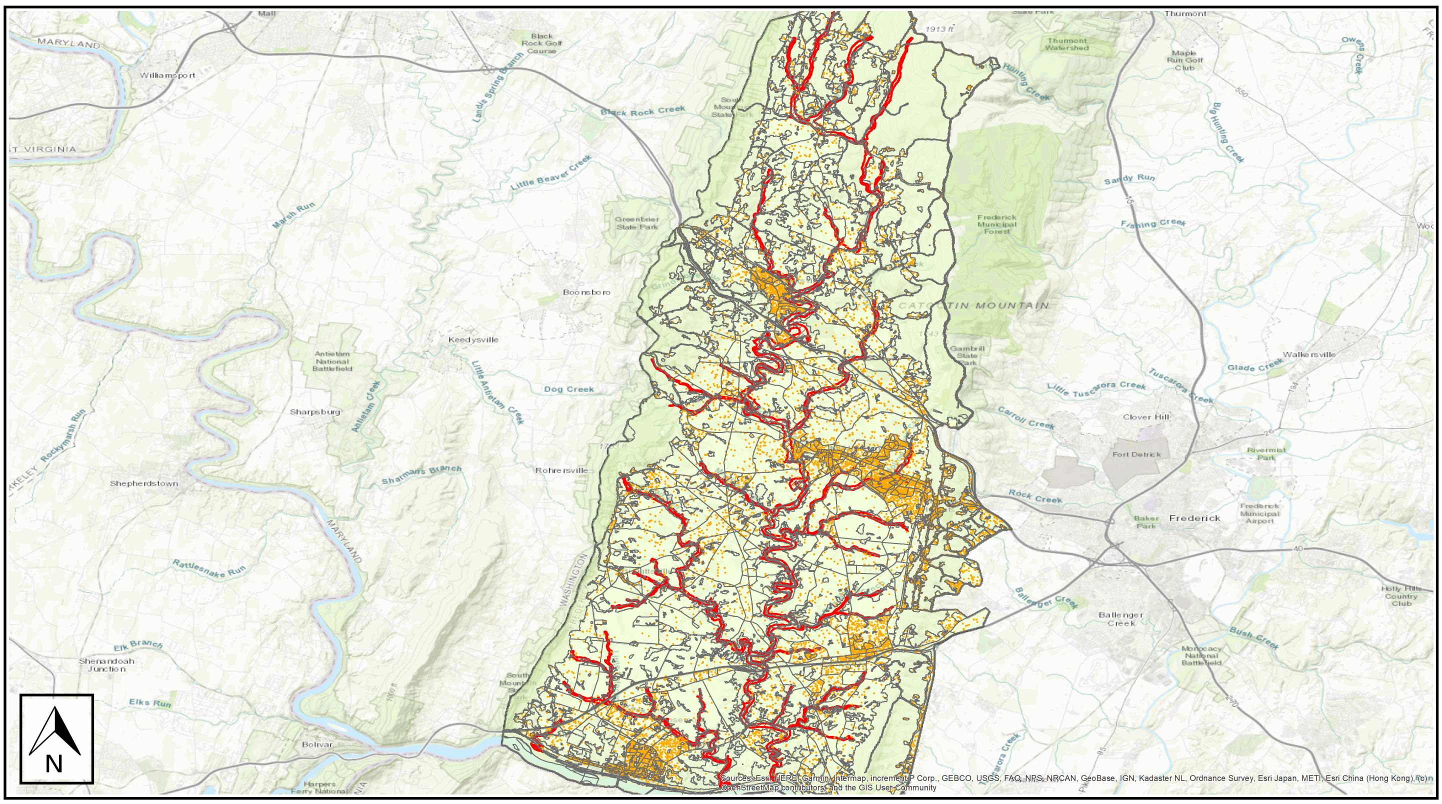
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_1
Scenario Name:	Mulit
Return Period Analyzed:	500
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 12 buildings will be at least moderately damaged. This is over 74% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

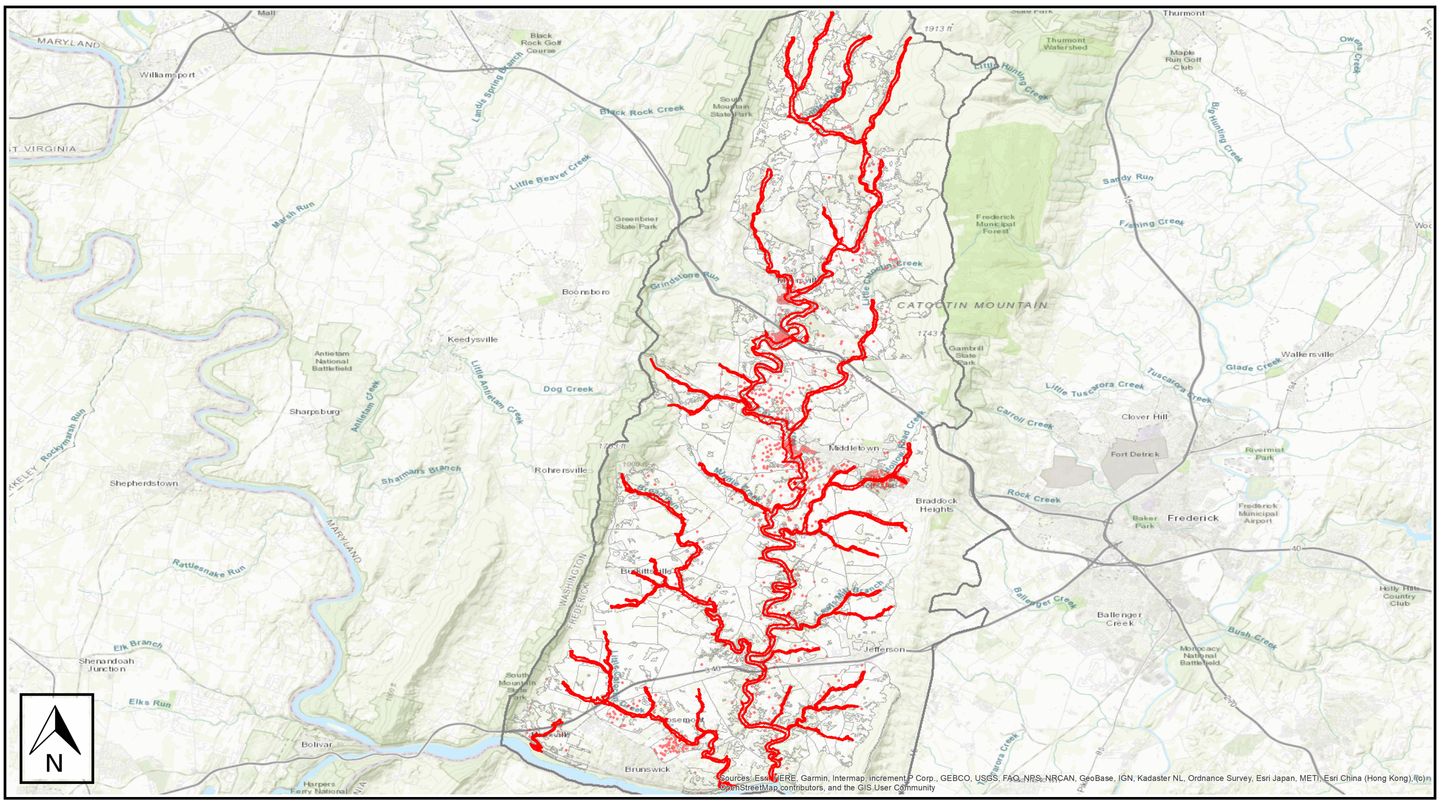


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	4	25	7	44	3	19	1	6	1	6	0	0
Total	**4**		**7**		**3**		**1**		**1**		**0**	

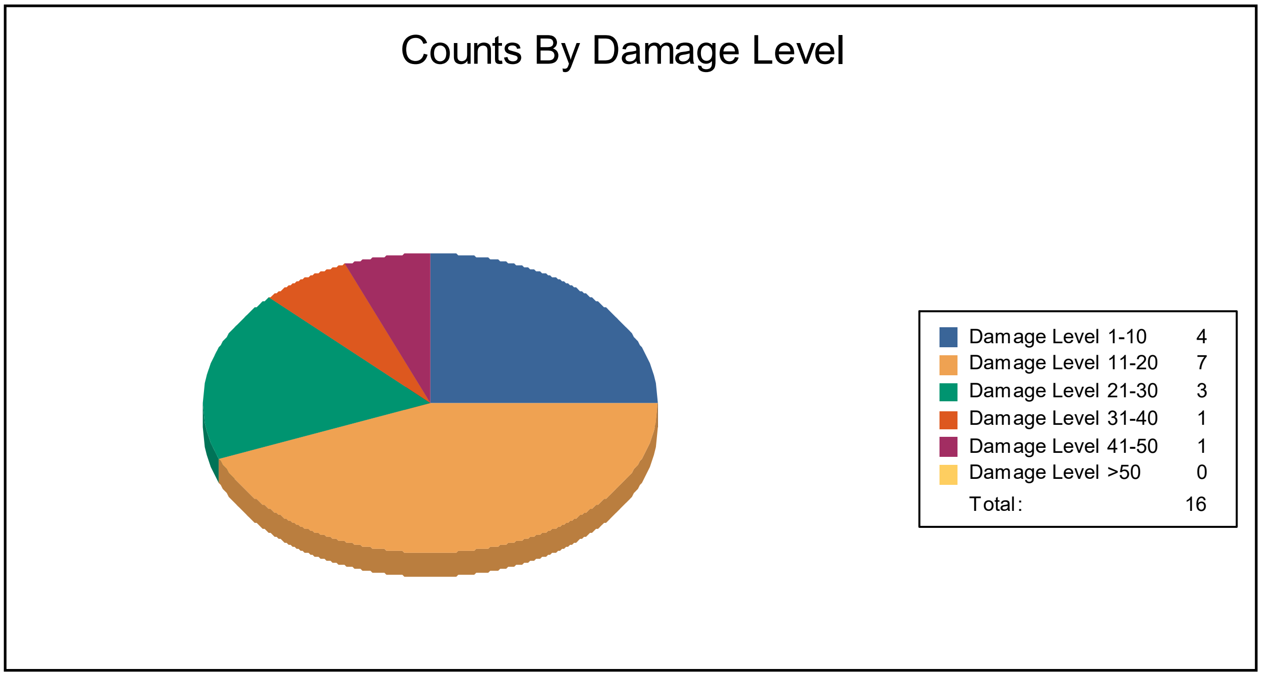


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	2	100	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	4	29	5	36	3	21	1	7	1	7	0	0

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	6	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	14	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

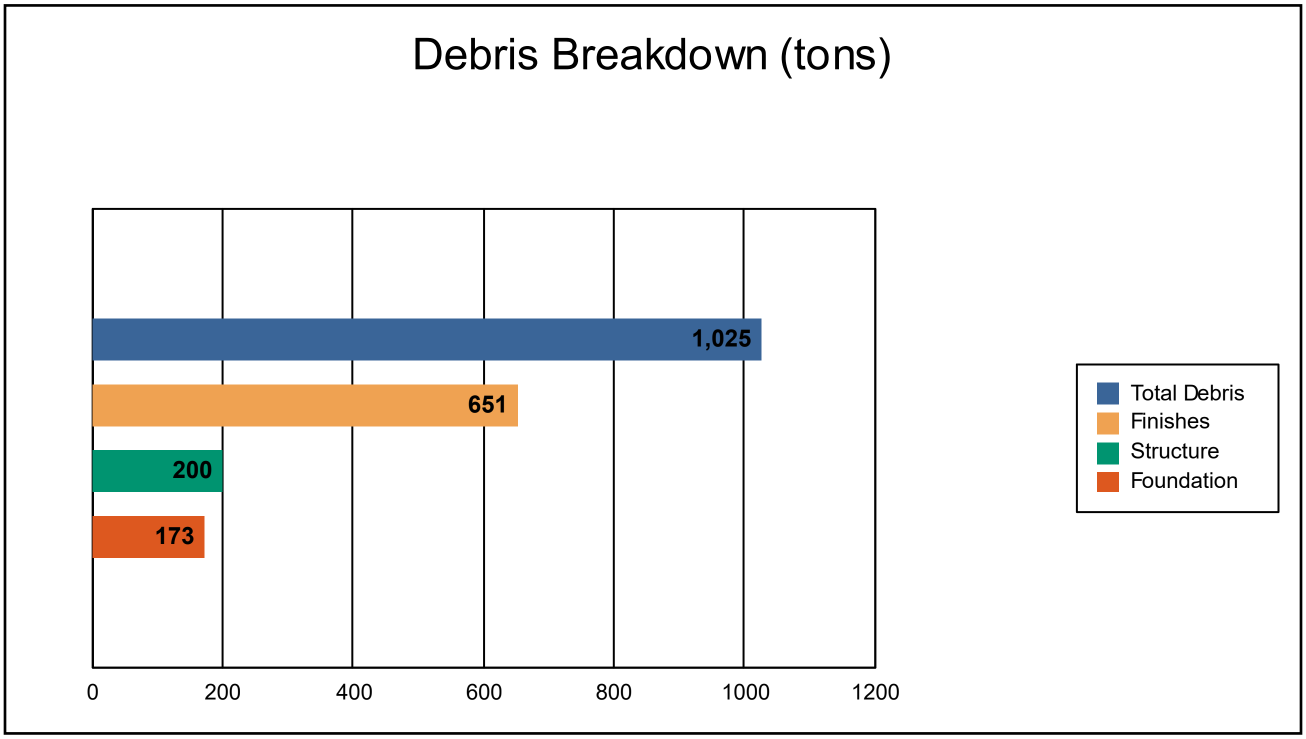
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

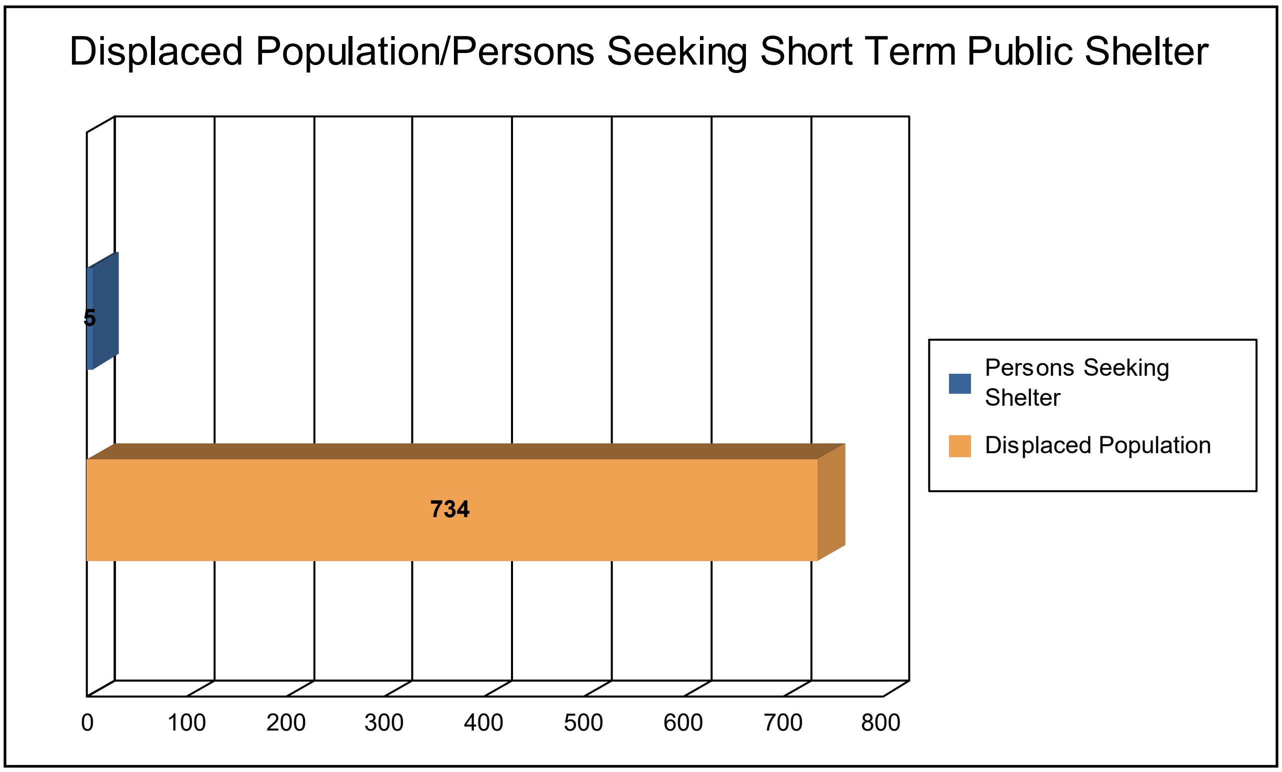


The model estimates that a total of 1,025 tons of debris will be generated. Of the total amount, Finishes comprises 64% of the total, Structure comprises 20% of the total, and Foundation comprises 17%. If the debris tonnage is converted into an estimated number of truckloads, it will require 42 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 245 households (or 734 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 5 people (out of a total population of 34,951) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 73.53 million dollars, which represents 3.78 % of the total replacement value of the scenario buildings.

Building-Related Losses

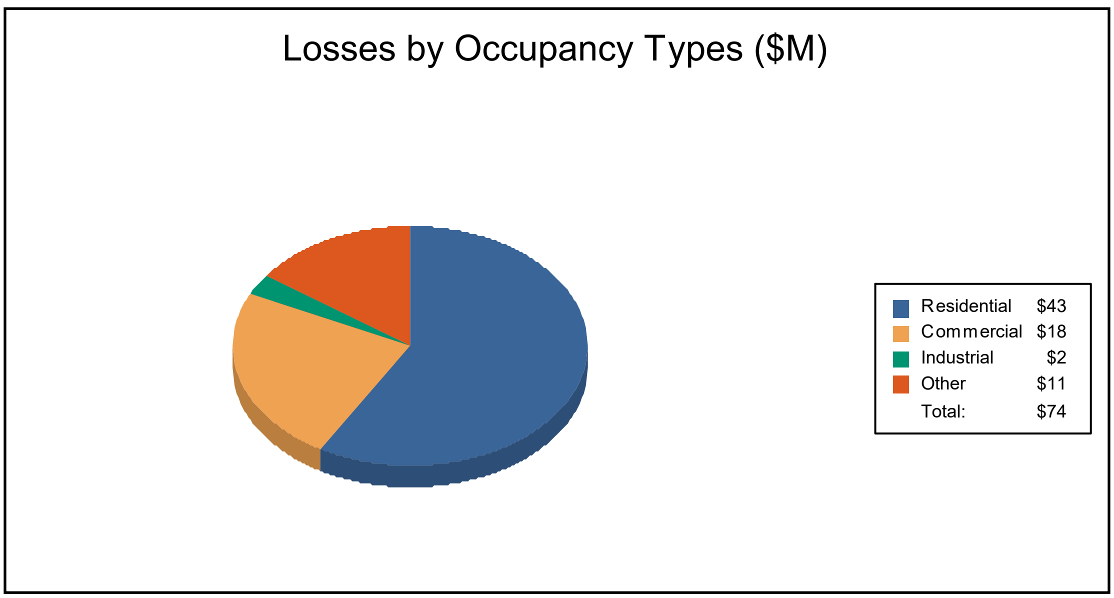
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 50.34 million dollars. 32% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 58.36% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	25.14	2.07	0.68	0.37	28.25
	Content	12.84	5.65	1.19	2.17	21.84
	Inventory	0.00	0.05	0.17	0.03	0.25
	Subtotal	**37.97**	**7.76**	**2.03**	**2.58**	**50.34**
Business Interruption						
	Income	0.07	4.62	0.01	0.46	5.16
	Relocation	3.66	0.45	0.01	0.13	4.24
	Rental Income	1.06	0.22	0.00	0.01	1.29
	Wage	0.16	4.49	0.03	7.84	12.50
	Subtotal	**4.94**	**9.77**	**0.05**	**8.44**	**23.19**
ALL	**Total**	**42.91**	**17.53**	**2.08**	**11.01**	**73.53**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	34,951	4,369,448	514,537	4,883,985
Total	**34,951**	**4,369,448**	**514,537**	**4,883,985**
Total Study Region	**34,951**	**4,369,448**	**514,537**	**4,883,985**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_2

Flood Scenario: Multi

Print Date: Tuesday, August 3, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 128 square miles and contains 1,470 census blocks. The region contains over 13 thousand households and has a total population of 39,698 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 14,322 buildings in the region with a total building replacement value (excluding contents) of 6,331 million dollars. Approximately 92.32% of the buildings (and 82.33% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 14,322 buildings in the region which have an aggregate total replacement value of 6,331 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	5,212,418	82.3%
Commercial	386,876	6.1%
Industrial	595,666	9.4%
Agricultural	33,020	0.5%
Religion	58,625	0.9%
Government	25,544	0.4%
Education	18,866	0.3%
Total	**6,331,015**	**100%**

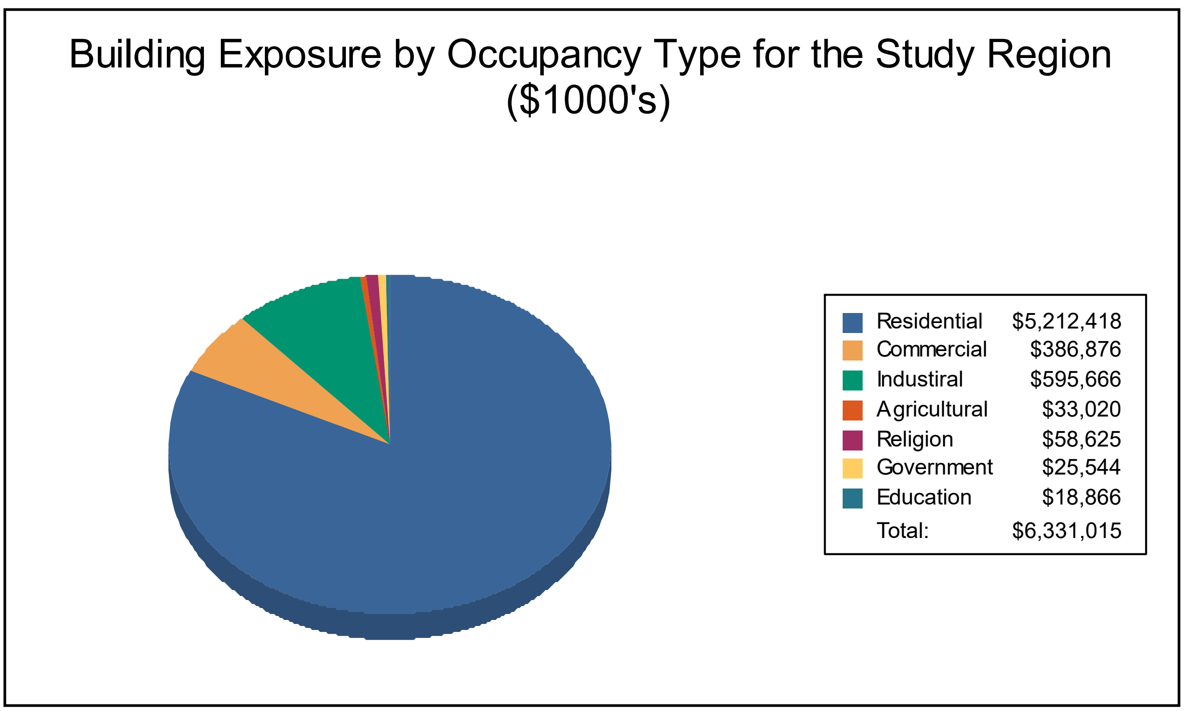
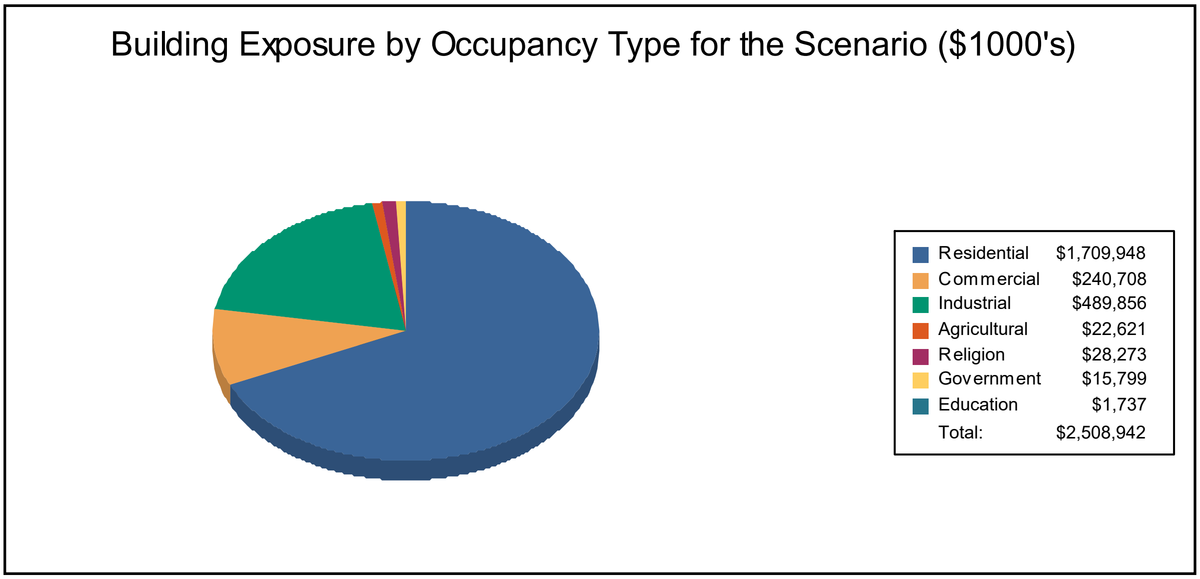


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,709,948	68.2%
Commercial	240,708	9.6%
Industrial	489,856	19.5%
Agricultural	22,621	0.9%
Religion	28,273	1.1%
Government	15,799	0.6%
Education	1,737	0.1%
Total	**2,508,942**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

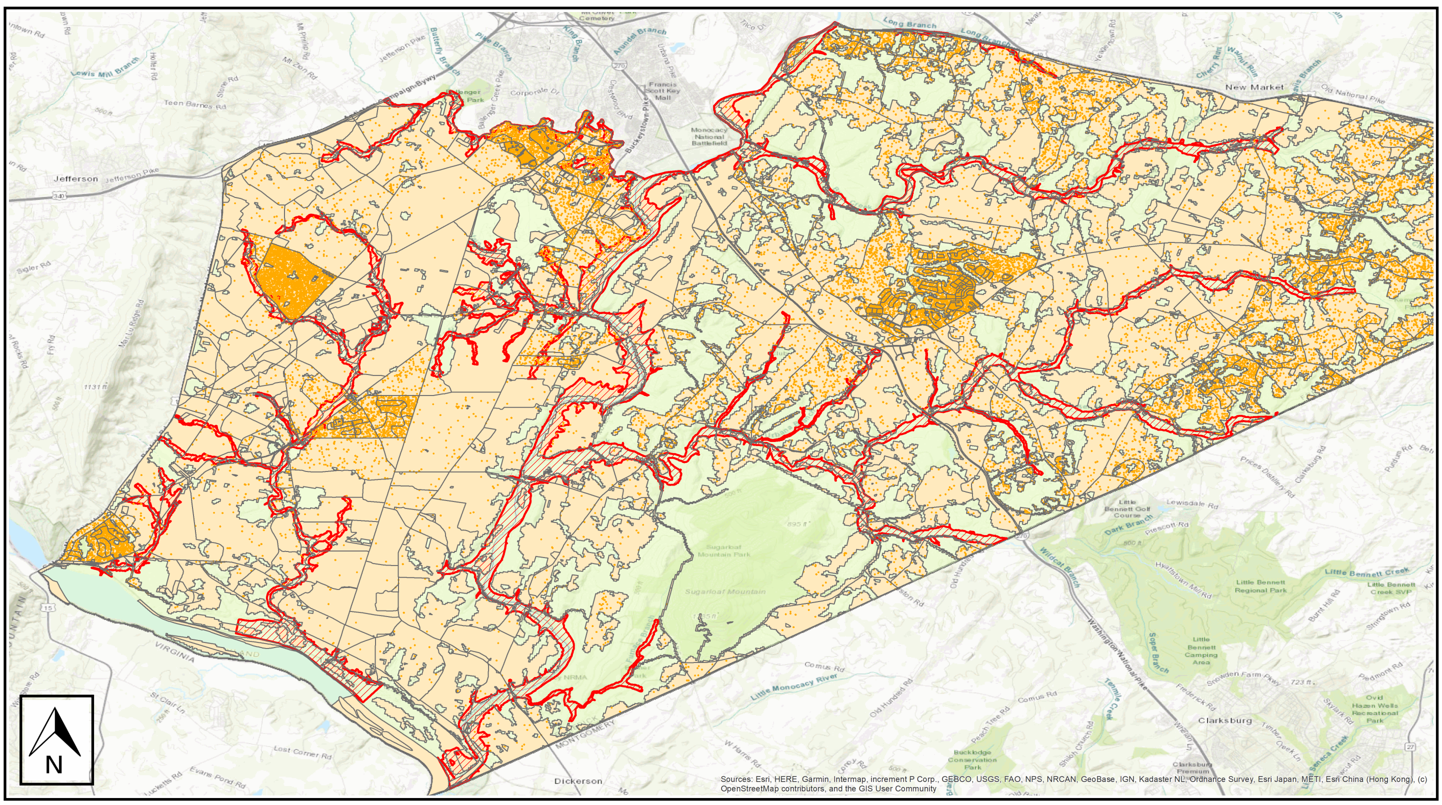
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_2
Scenario Name:	Multi
Return Period Analyzed:	500
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 150 buildings will be at least moderately damaged. This is over 26% of the total number of buildings in the scenario. There are an estimated 74 buildings that will be completely destroyed. The definition of the ‘damage states’ is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

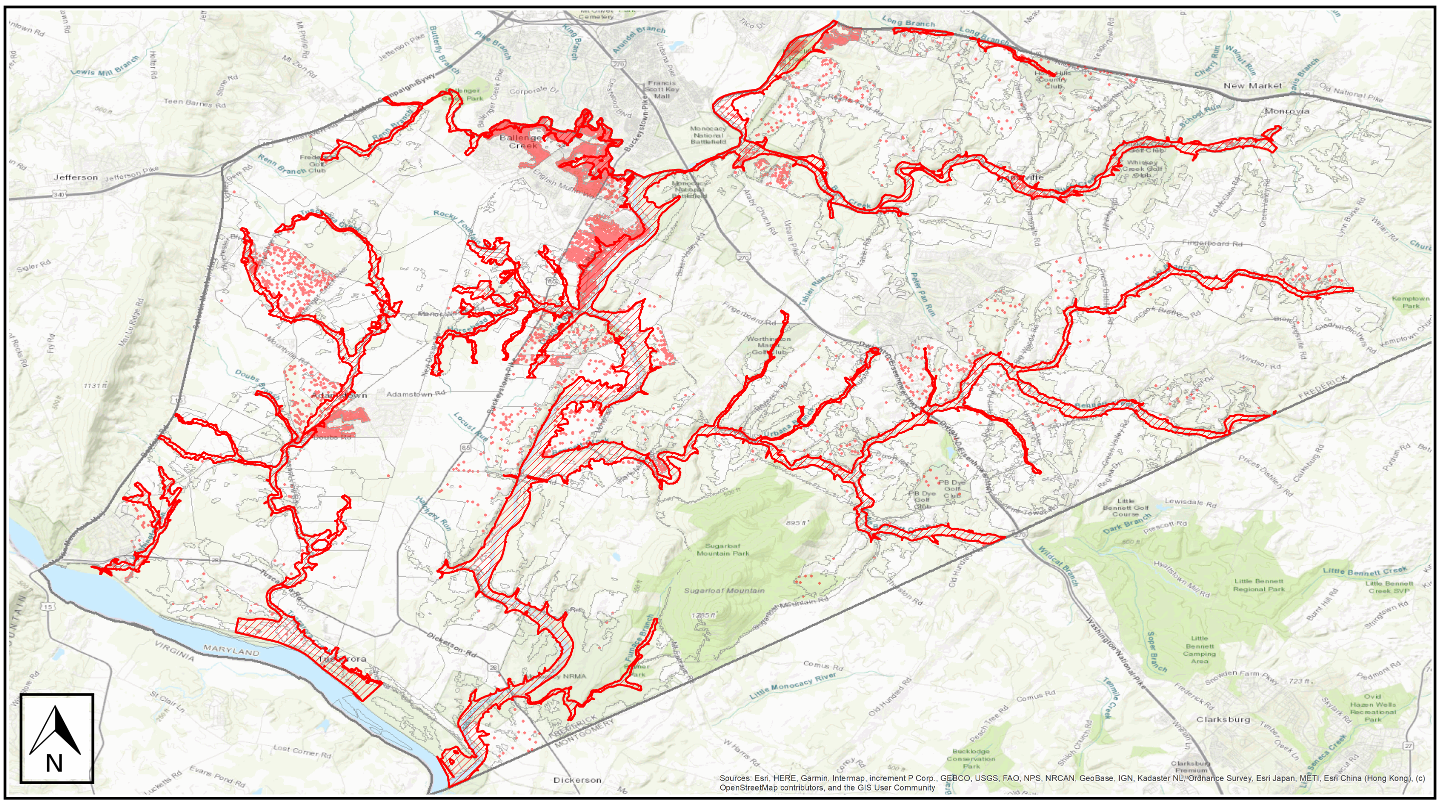


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	8	5	19	12	17	11	19	12	21	13	74	47
Total	**8**		**19**		**17**		**19**		**21**		**74**	

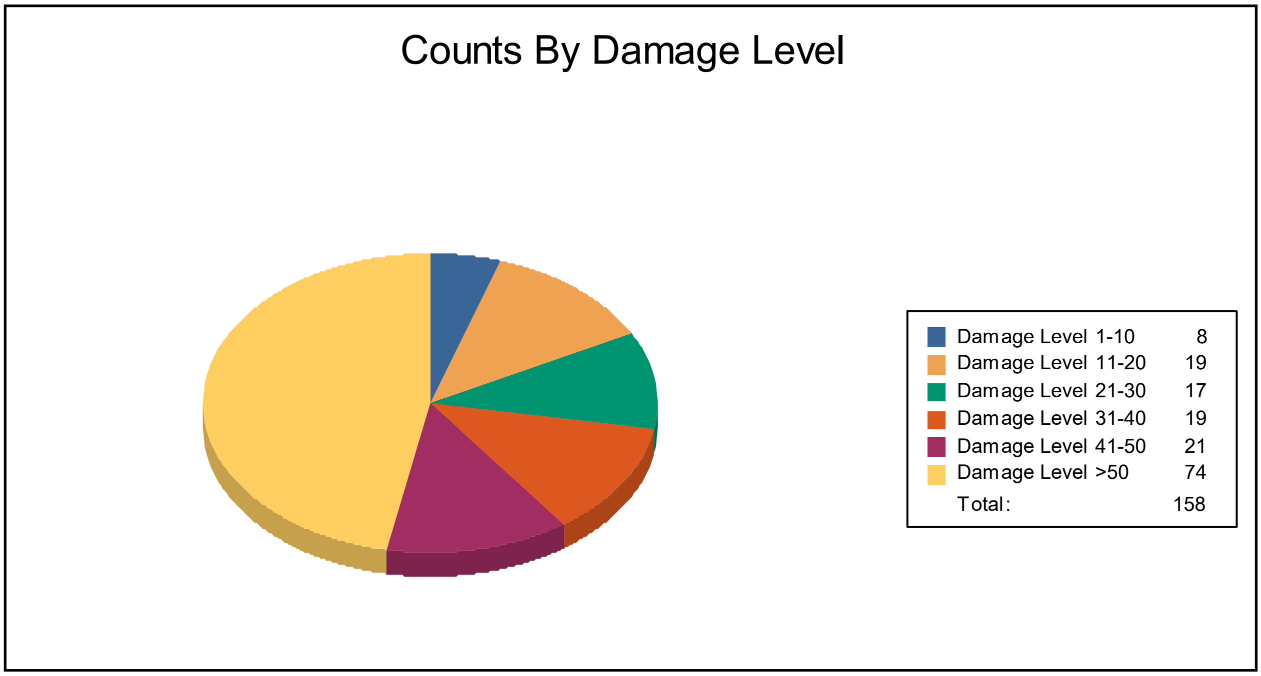


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	2	5	4	10	4	10	5	12	6	15	20	49
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	6	5	15	13	13	11	14	12	15	13	54	46

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

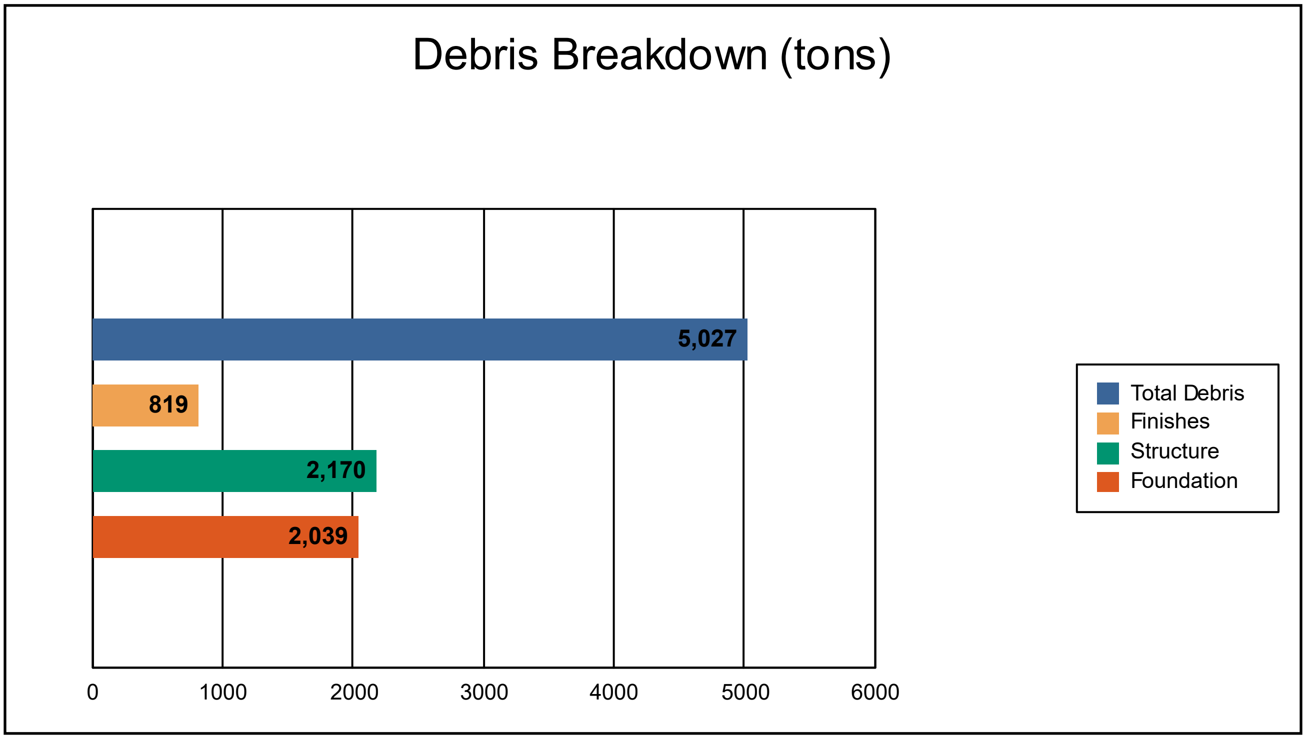
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

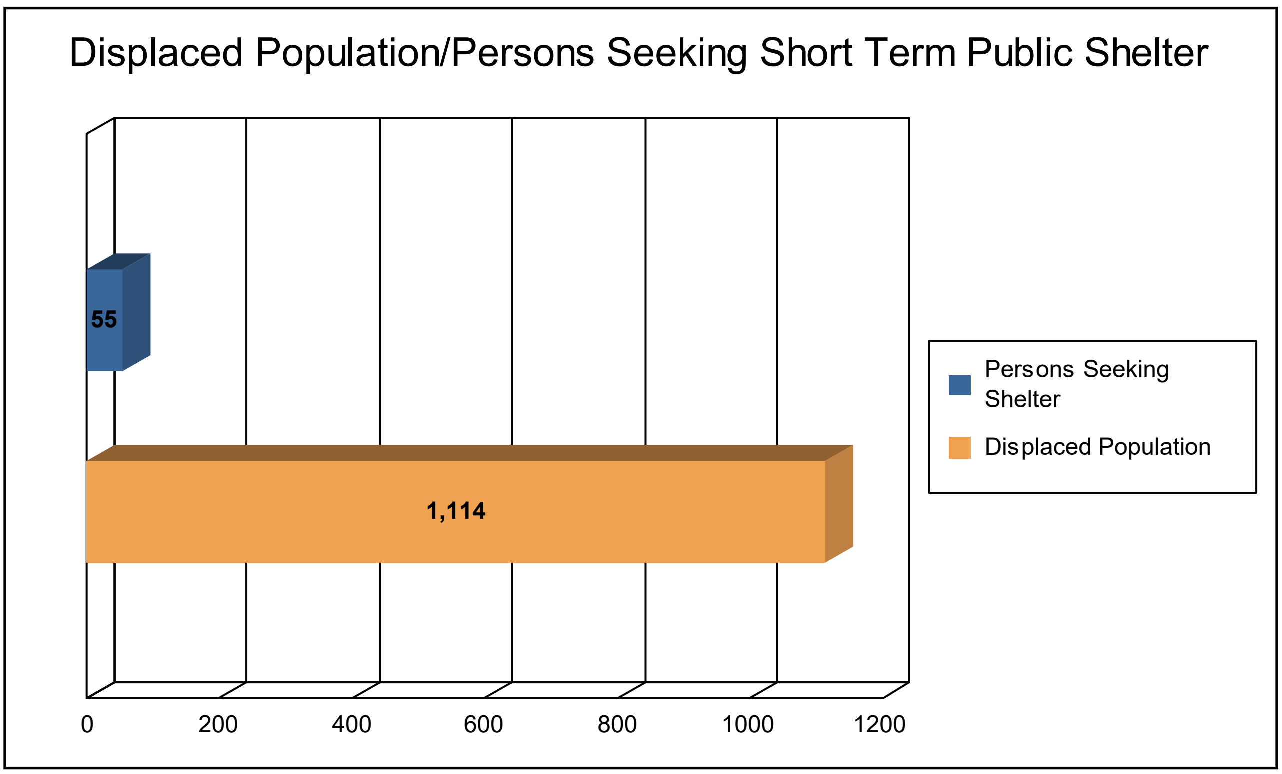


The model estimates that a total of 5,027 tons of debris will be generated. Of the total amount, Finishes comprises 16% of the total, Structure comprises 43% of the total, and Foundation comprises 41%. If the debris tonnage is converted into an estimated number of truckloads, it will require 202 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 371 households (or 1,114 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 55 people (out of a total population of 39,698) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 182.96 million dollars, which represents 7.29 % of the total replacement value of the scenario buildings.

Building-Related Losses

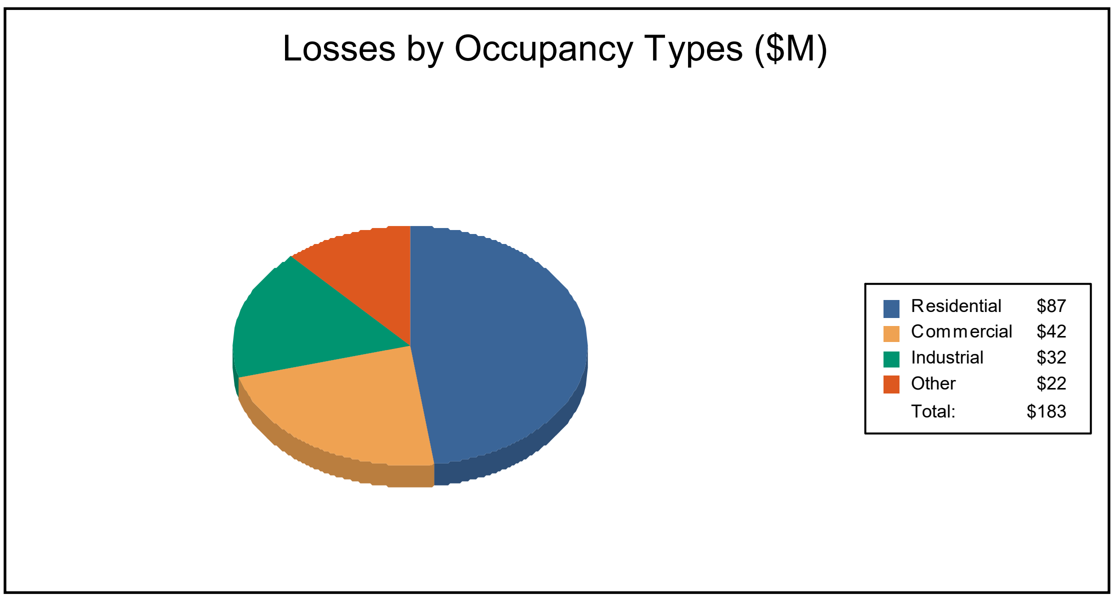
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 136.30 million dollars. 26% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 47.78% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	50.94	7.86	7.98	2.41	69.20
	Content	25.72	14.52	18.57	4.79	63.59
	Inventory	0.00	0.45	2.79	0.28	3.52
	Subtotal	**76.66**	**22.83**	**29.35**	**7.47**	**136.30**
Business Interruption						
	Income	0.33	8.68	0.81	1.07	10.90
	Relocation	7.07	1.48	0.49	0.20	9.24
	Rental Income	2.58	1.13	0.12	0.01	3.83
	Wage	0.78	8.30	0.84	12.76	22.69
	Subtotal	**10.77**	**19.59**	**2.26**	**14.04**	**46.66**
ALL	**Total**	**87.43**	**42.42**	**31.60**	**21.52**	**182.96**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	39,698	5,212,418	1,118,597	6,331,015
Total	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**
Total Study Region	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_3

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 73 square miles and contains 2,890 census blocks. The region contains over 41 thousand households and has a total population of 106,724 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 36,786 buildings in the region with a total building replacement value (excluding contents) of 15,635 million dollars. Approximately 90.42% of the buildings (and 78.16% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 36,786 buildings in the region which have an aggregate total replacement value of 15,635 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	12,220,022	78.2%
Commercial	2,296,995	14.7%
Industrial	454,425	2.9%
Agricultural	26,557	0.2%
Religion	222,953	1.4%
Government	170,628	1.1%
Education	243,455	1.6%
Total	**15,635,035**	**100%**

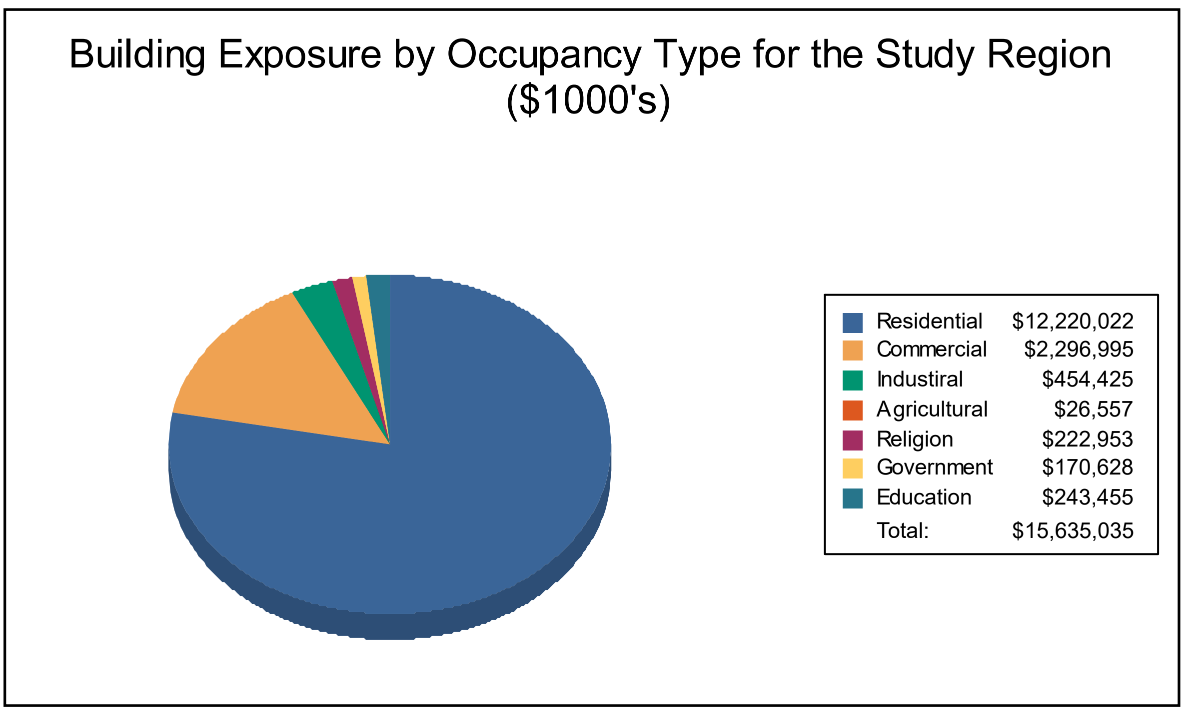
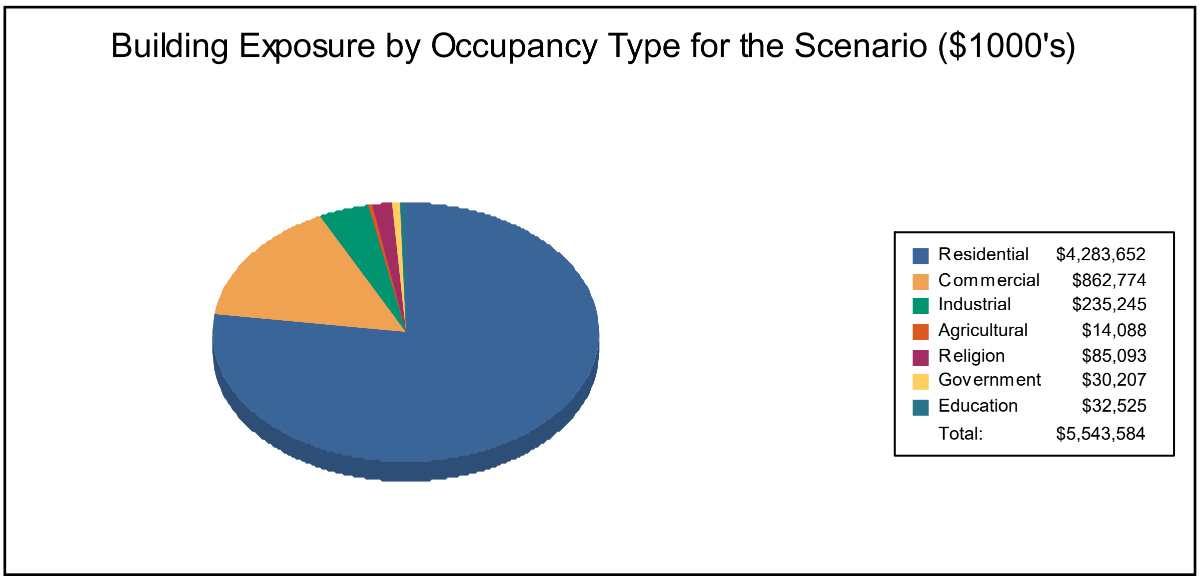


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,283,652	77.3%
Commercial	862,774	15.6%
Industrial	235,245	4.2%
Agricultural	14,088	0.3%
Religion	85,093	1.5%
Government	30,207	0.5%
Education	32,525	0.6%
Total	**5,543,584**	**100%**



Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 48 schools, 10 fire stations, 7 police stations and 2 emergency operation centers.

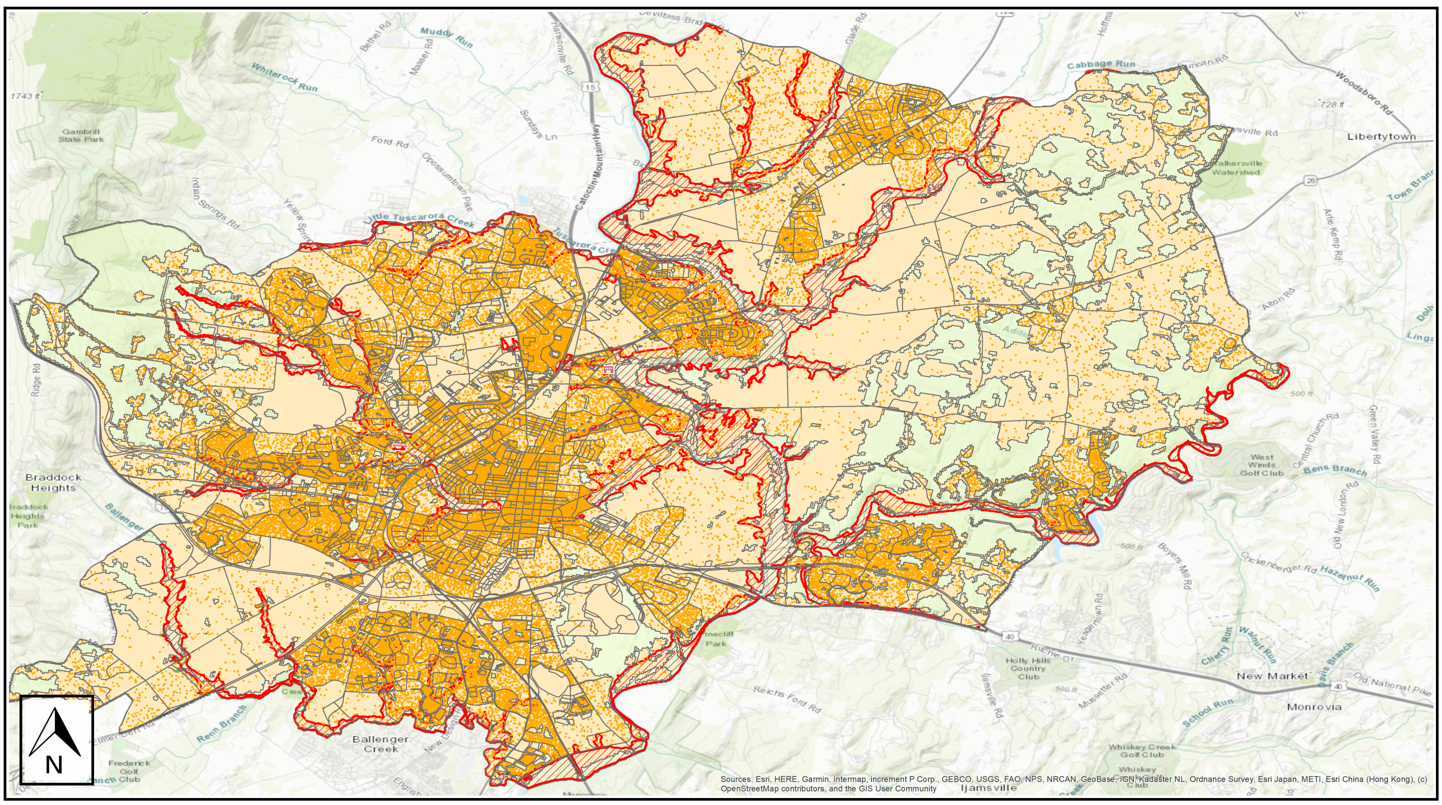
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_3
Scenario Name:	Multi
Return Period Analyzed:	500
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 847 buildings will be at least moderately damaged. This is over 46% of the total number of buildings in the scenario. There are an estimated 230 buildings that will be completely destroyed. The definition of the ‘damage states’ is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

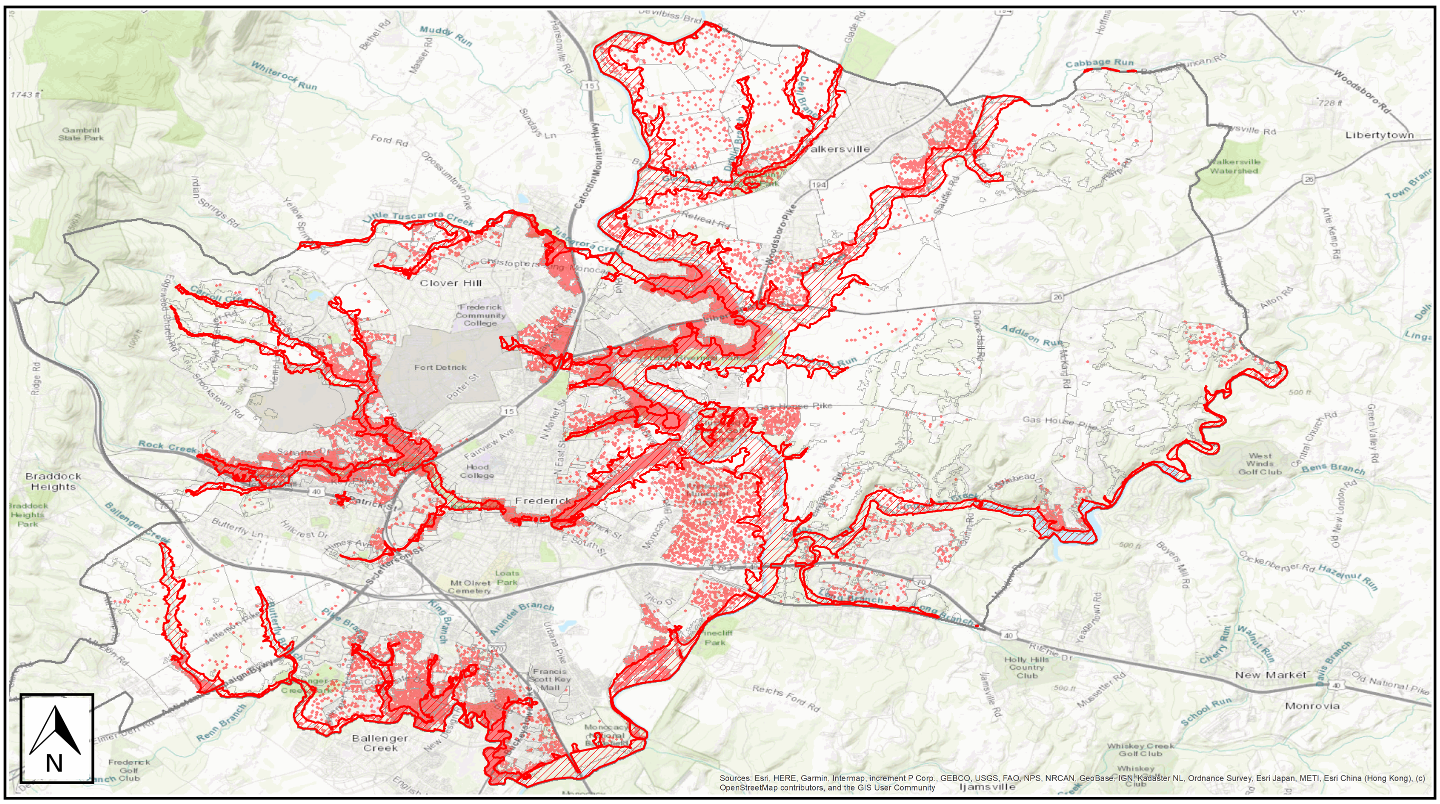


Table 3: Expected Building Damage by Occupancy

Occupancy	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	>50 Count	>50 (%)
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	9	82	2	18	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	164	16	242	24	145	15	126	13	93	9	230	23
Total	**164**		**251**		**147**		**126**		**93**		**230**	

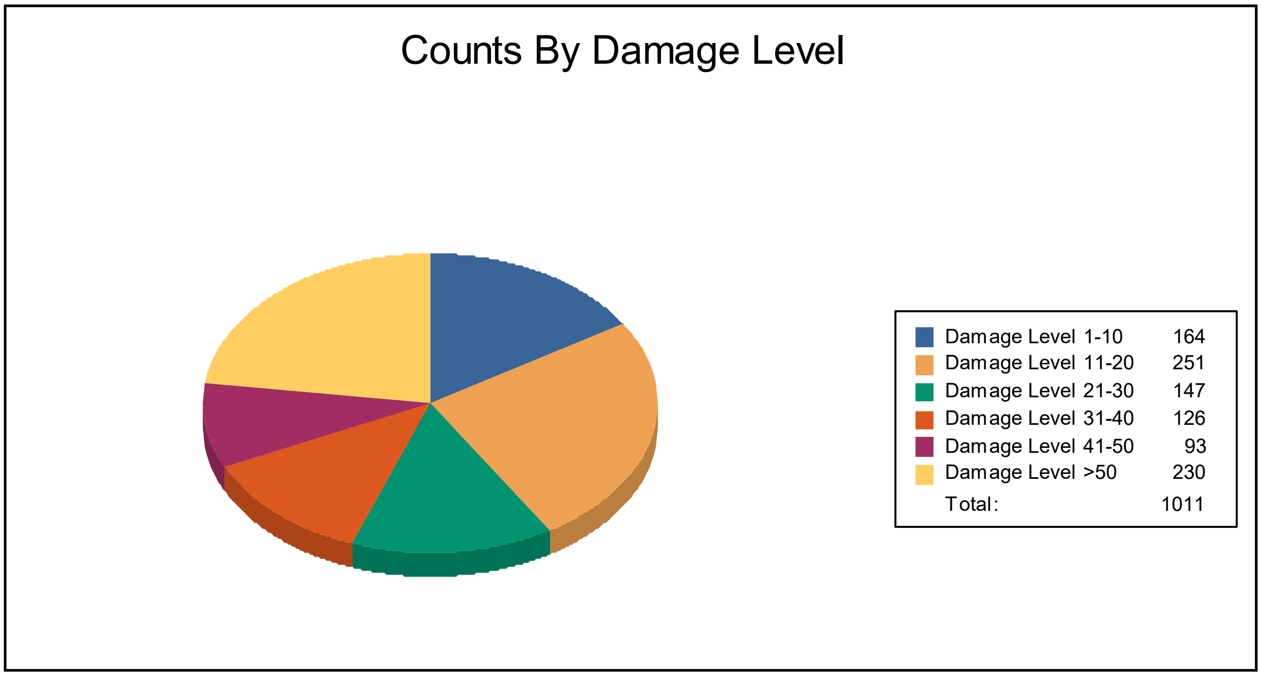


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	40	15	66	25	39	15	31	12	25	10	60	23
Steel	0	0	3	75	1	25	0	0	0	0	0	0
Wood	123	17	178	24	106	14	95	13	68	9	168	23

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 308 hospital beds available for use. On the day of the scenario flood event, the model estimates that 308 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	2	0	0	0
Fire Stations	10	1	0	1
Hospitals	1	0	0	0
Police Stations	7	0	0	0
Schools	48	1	0	1

If this report displays all zeros or is blank, two possibilities can explain this.

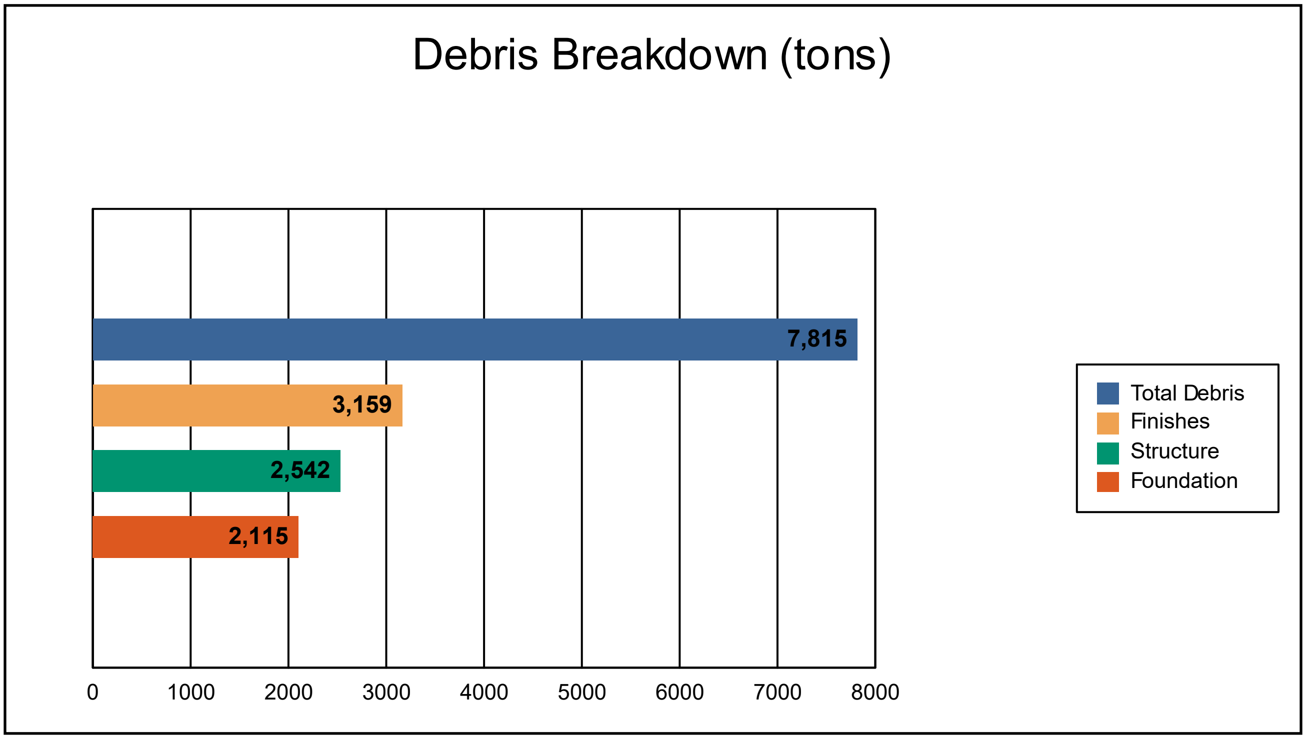
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

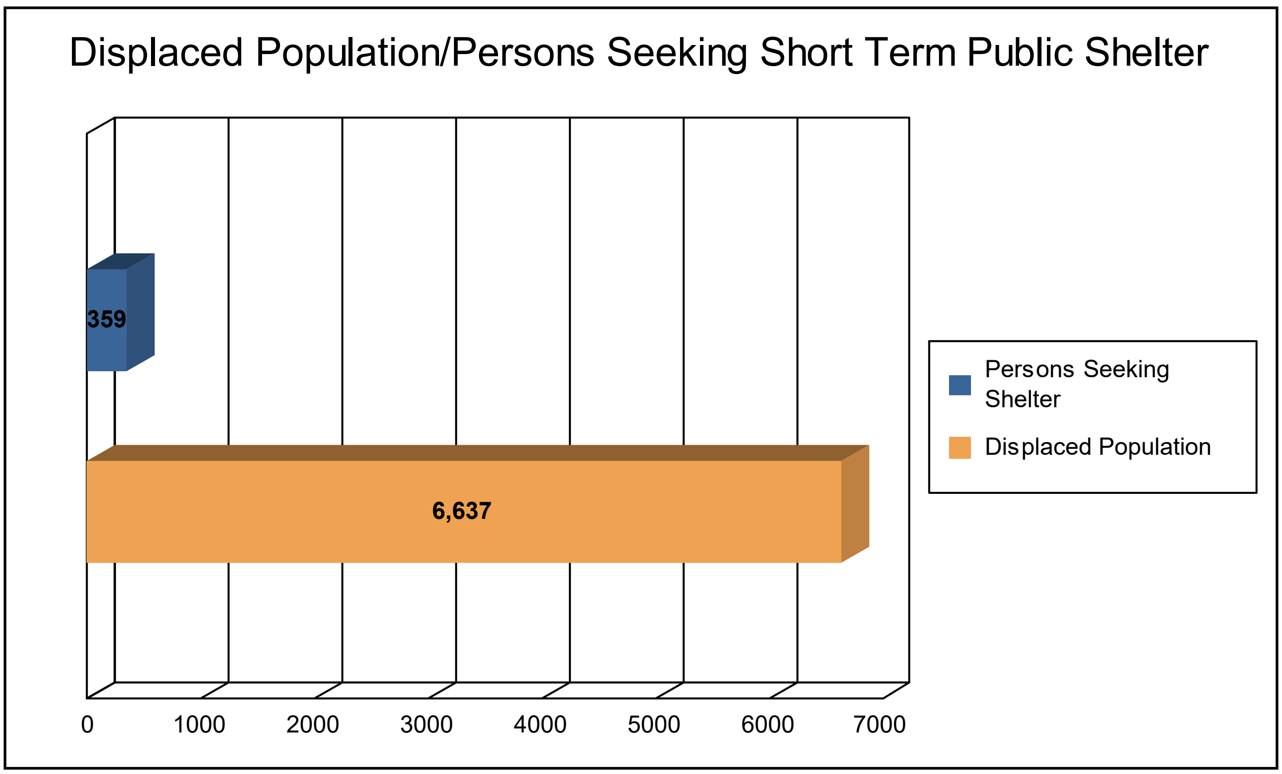


The model estimates that a total of 7,815 tons of debris will be generated. Of the total amount, Finishes comprises 40% of the total, Structure comprises 33% of the total, and Foundation comprises 27%. If the debris tonnage is converted into an estimated number of truckloads, it will require 313 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 2,212 households (or 6,637 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 359 people (out of a total population of 106,724) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 847.88 million dollars, which represents 15.29 % of the total replacement value of the scenario buildings.

Building-Related Losses

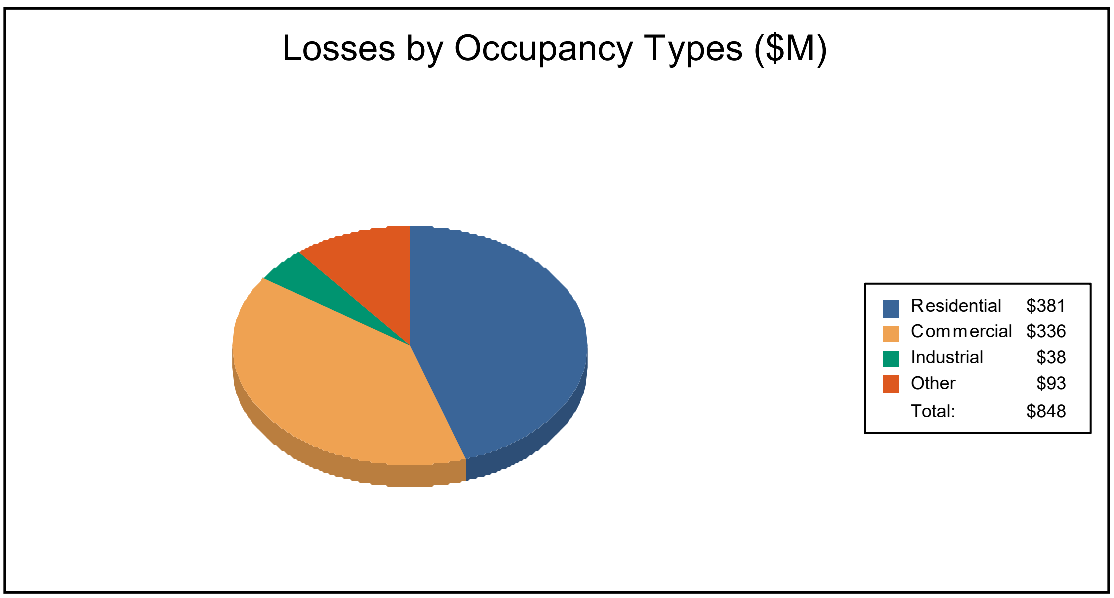
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 526.60 million dollars. 38% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 44.89% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	203.07	47.39	9.78	5.09	265.33
	Content	108.35	101.08	22.21	24.46	256.10
	Inventory	0.00	1.46	3.57	0.13	5.17
	Subtotal	**311.42**	**149.93**	**35.56**	**29.68**	**526.60**
Business Interruption						
	Income	2.21	77.61	0.58	7.30	87.69
	Relocation	43.12	19.60	0.63	3.44	66.78
	Rental Income	18.63	13.93	0.14	0.50	33.20
	Wage	5.23	75.32	1.02	52.05	133.62
	Subtotal	**69.18**	**186.45**	**2.37**	**63.28**	**321.28**
ALL	**Total**	**380.61**	**336.38**	**37.93**	**92.96**	**847.88**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Frederick	106,724	12,220,022	3,415,013	15,635,035
Total	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**
Total Study Region	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_4

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

Increasing Resilience Together

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 138 square miles and contains 1,074 census blocks. The region contains over 9 thousand households and has a total population of 27,180 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 10,335 buildings in the region with a total building replacement value (excluding contents) of 3,945 million dollars. Approximately 91.67% of the buildings (and 88.71% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 10,335 buildings in the region which have an aggregate total replacement value of 3,945 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	3,499,625	88.7%
Commercial	238,367	6.0%
Industrial	89,655	2.3%
Agricultural	29,561	0.7%
Religion	45,679	1.2%
Government	5,013	0.1%
Education	37,265	0.9%
Total	**3,945,165**	**100%**

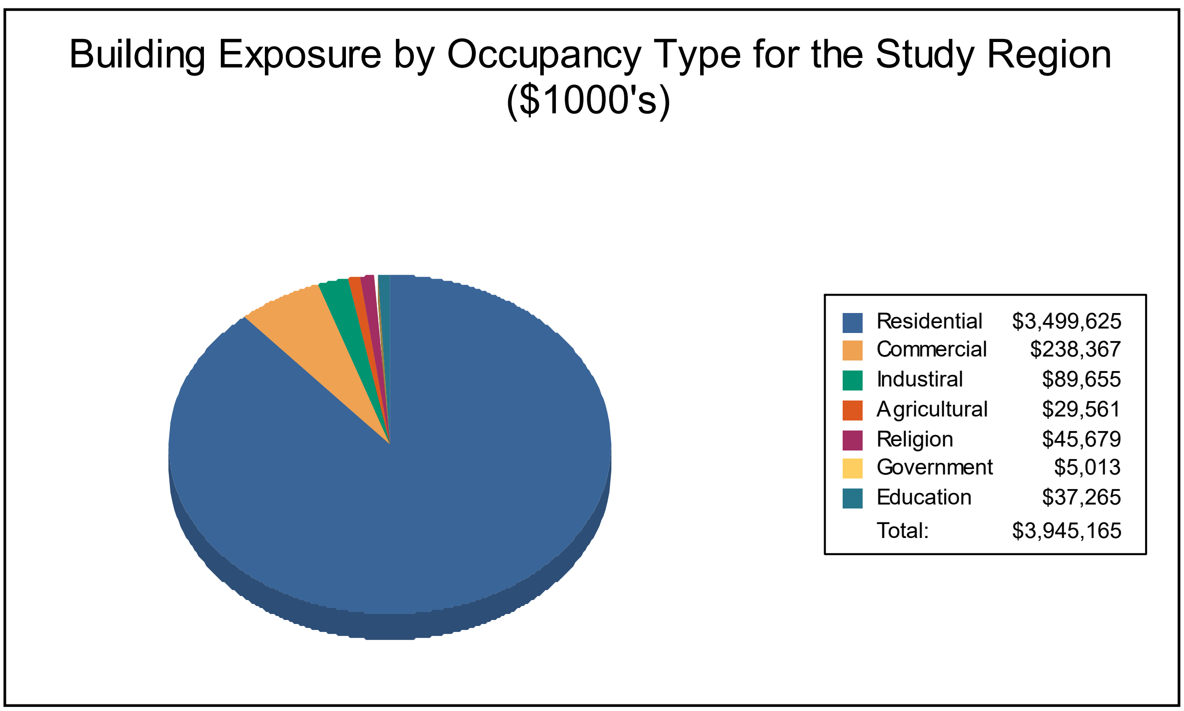
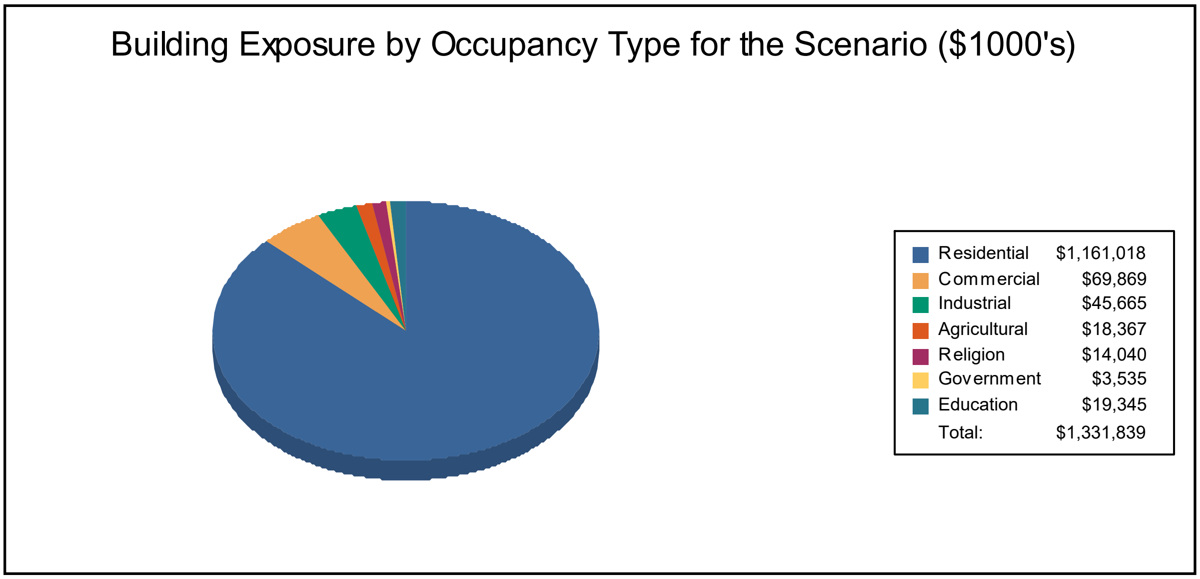


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,161,018	87.2%
Commercial	69,869	5.2%
Industrial	45,665	3.4%
Agricultural	18,367	1.4%
Religion	14,040	1.1%
Government	3,535	0.3%
Education	19,345	1.5%
Total	**1,331,839**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

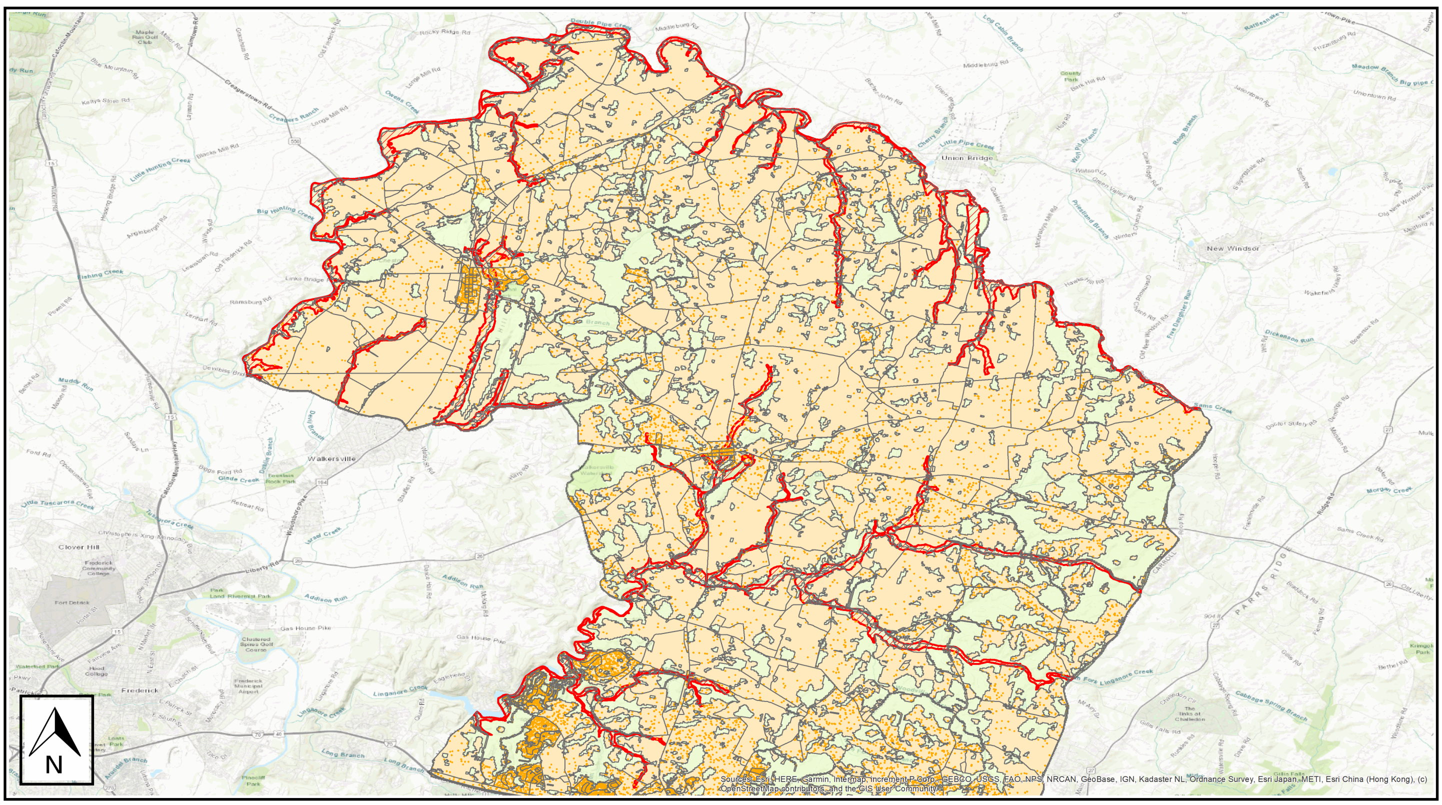
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_4
Scenario Name:	Multi
Return Period Analyzed:	500
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 23 buildings will be at least moderately damaged. This is over 38% of the total number of buildings in the scenario. There are an estimated 11 buildings that will be completely destroyed. The definition of the ‘damage states’ is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

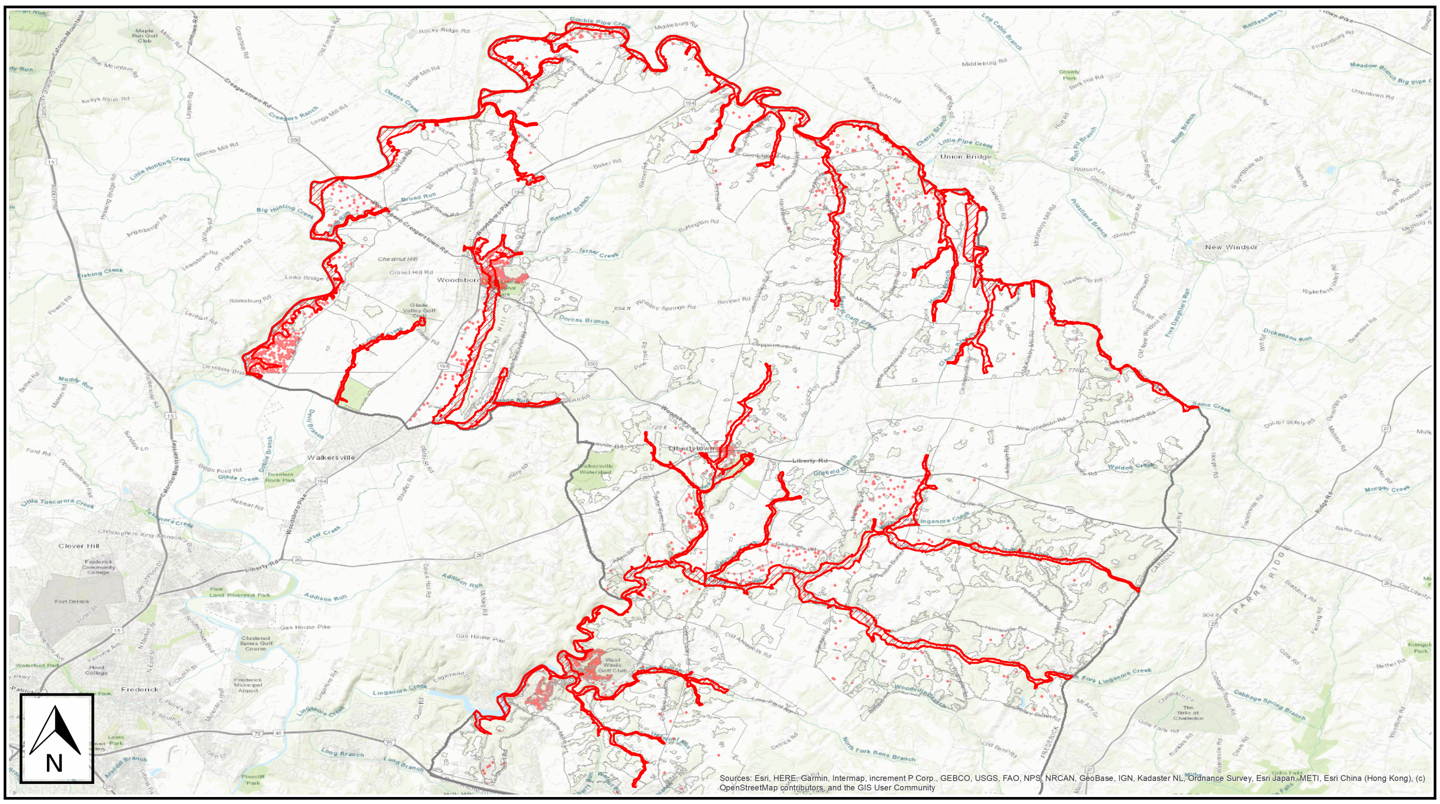


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Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	1	4	7	29	1	4	2	8	2	8	11	46
Total	**1**		**7**		**1**		**2**		**2**		**11**	

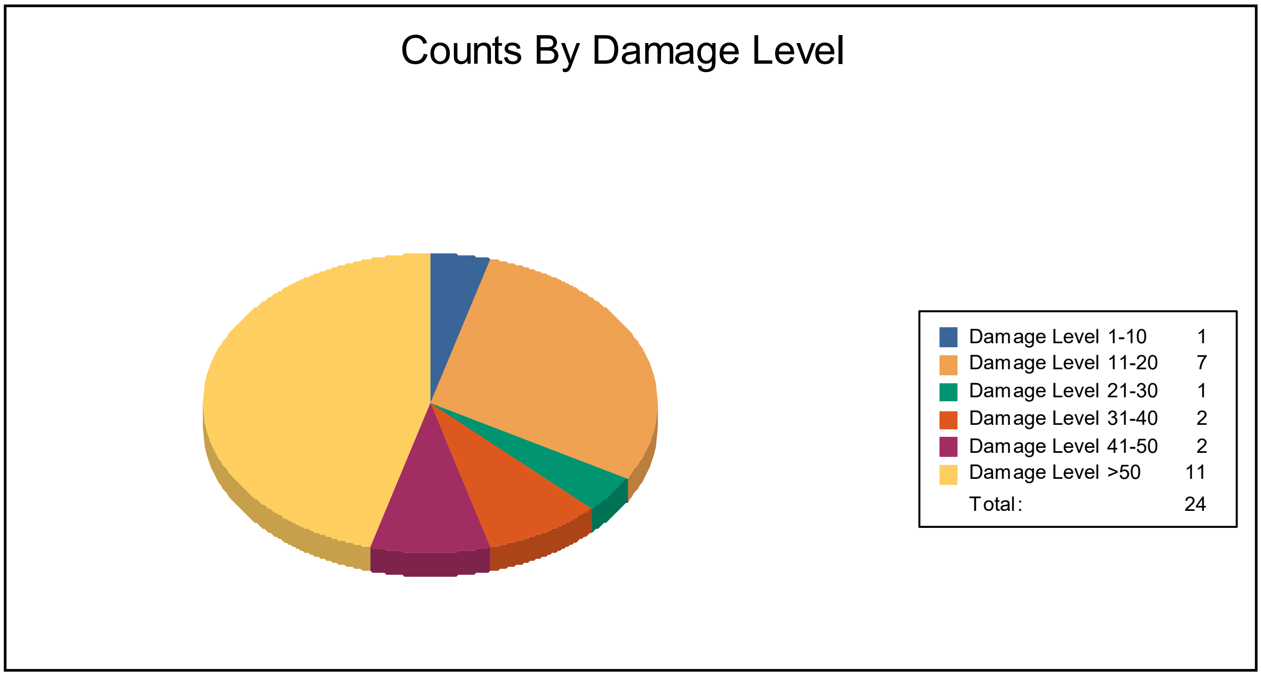


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	1	33	0	0	0	0	0	0	2	67
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	1	5	6	29	1	5	2	10	2	10	9	43

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

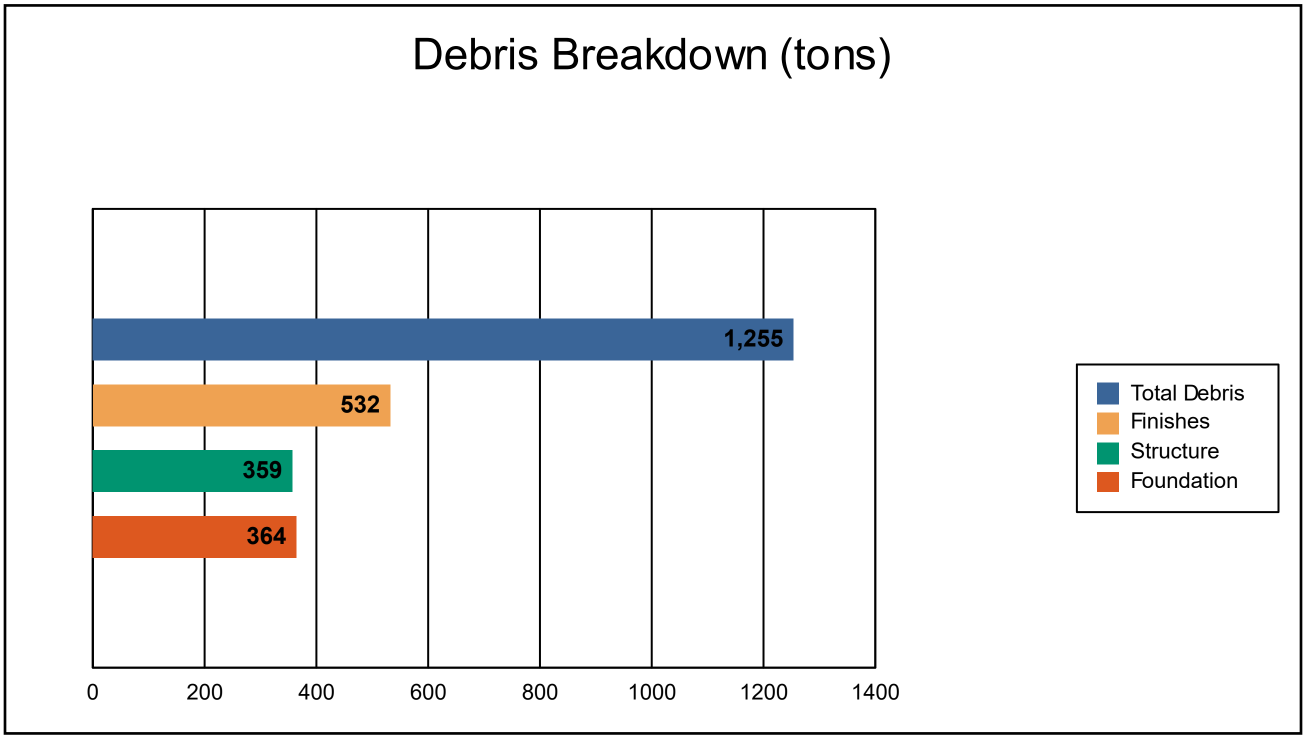
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

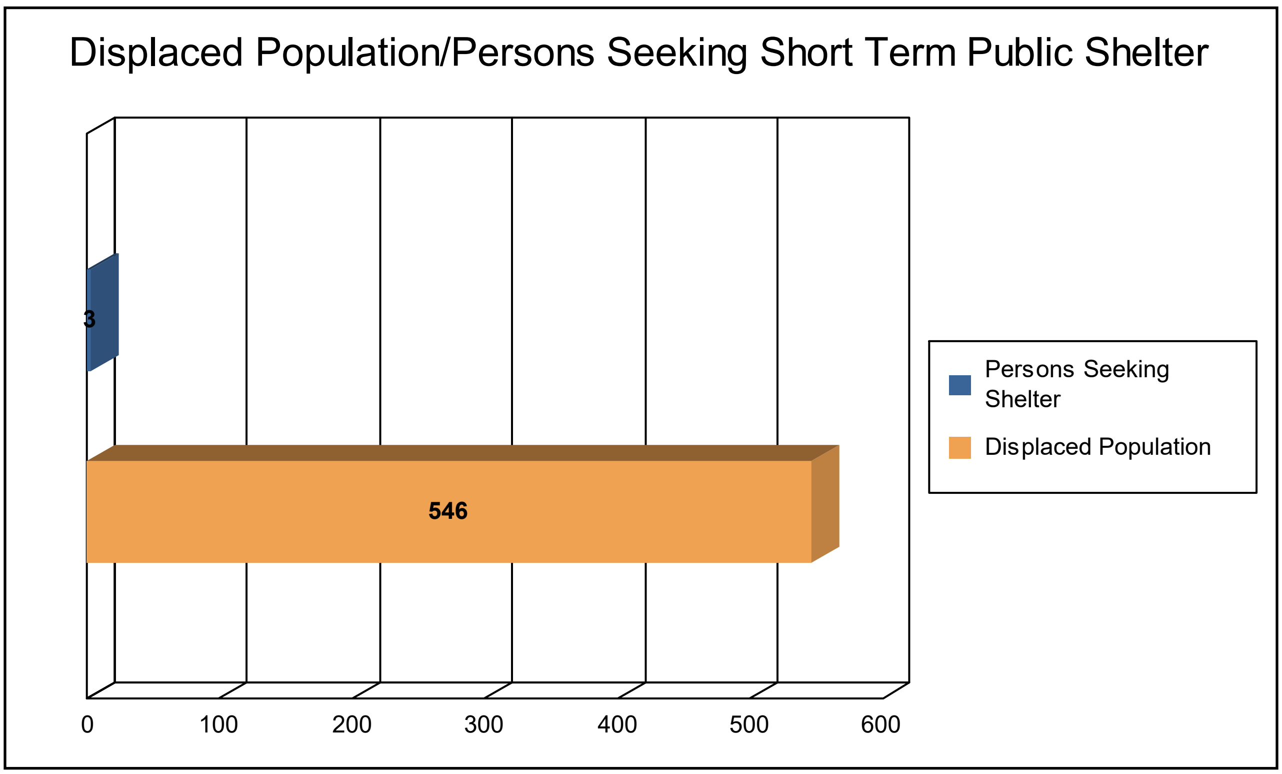


The model estimates that a total of 1,255 tons of debris will be generated. Of the total amount, Finishes comprises 42% of the total, Structure comprises 29% of the total, and Foundation comprises 29%. If the debris tonnage is converted into an estimated number of truckloads, it will require 51 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 182 households (or 546 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 3 people (out of a total population of 27,180) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 63.18 million dollars, which represents 4.74 % of the total replacement value of the scenario buildings.

Building-Related Losses

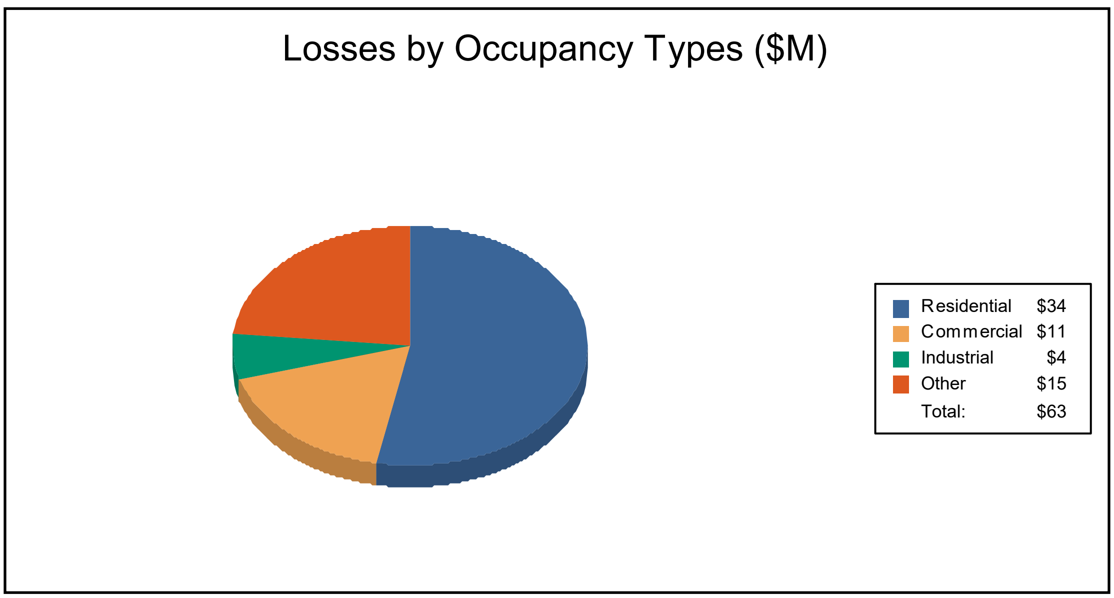
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 42.43 million dollars. 33% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 53.19% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	19.92	1.19	1.05	0.61	22.76
	Content	10.00	3.58	2.33	3.27	19.19
	Inventory	0.00	0.05	0.40	0.03	0.48
	Subtotal	**29.92**	**4.81**	**3.79**	**3.91**	**42.43**
Business Interruption						
	Income	0.00	2.88	0.04	1.09	4.02
	Relocation	2.85	0.25	0.03	0.42	3.55
	Rental Income	0.83	0.18	0.01	0.03	1.04
	Wage	0.00	2.81	0.07	9.26	12.13
	Subtotal	**3.68**	**6.12**	**0.15**	**10.80**	**20.74**
ALL	**Total**	**33.60**	**10.94**	**3.93**	**14.71**	**63.18**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	27,180	3,499,625	445,540	3,945,165
Total	**27,180**	**3,499,625**	**445,540**	**3,945,165**
Total Study Region	**27,180**	**3,499,625**	**445,540**	**3,945,165**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_5

Flood Scenario: Multi

Print Date: Thursday, August 5, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is approximately 173 square miles and contains 1,430 census blocks. The region contains over 9 thousand households and has a total population of 24,832 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 9,774 buildings in the region with a total building replacement value (excluding contents) of 3,437 million dollars. Approximately 90.65% of the buildings (and 84.66% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 9,774 buildings in the region which have an aggregate total replacement value of 3,437 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,909,982	84.7%
Commercial	227,400	6.6%
Industrial	98,717	2.9%
Agricultural	22,332	0.6%
Religion	118,912	3.5%
Government	39,615	1.2%
Education	20,149	0.6%
Total	**3,437,107**	**100%**

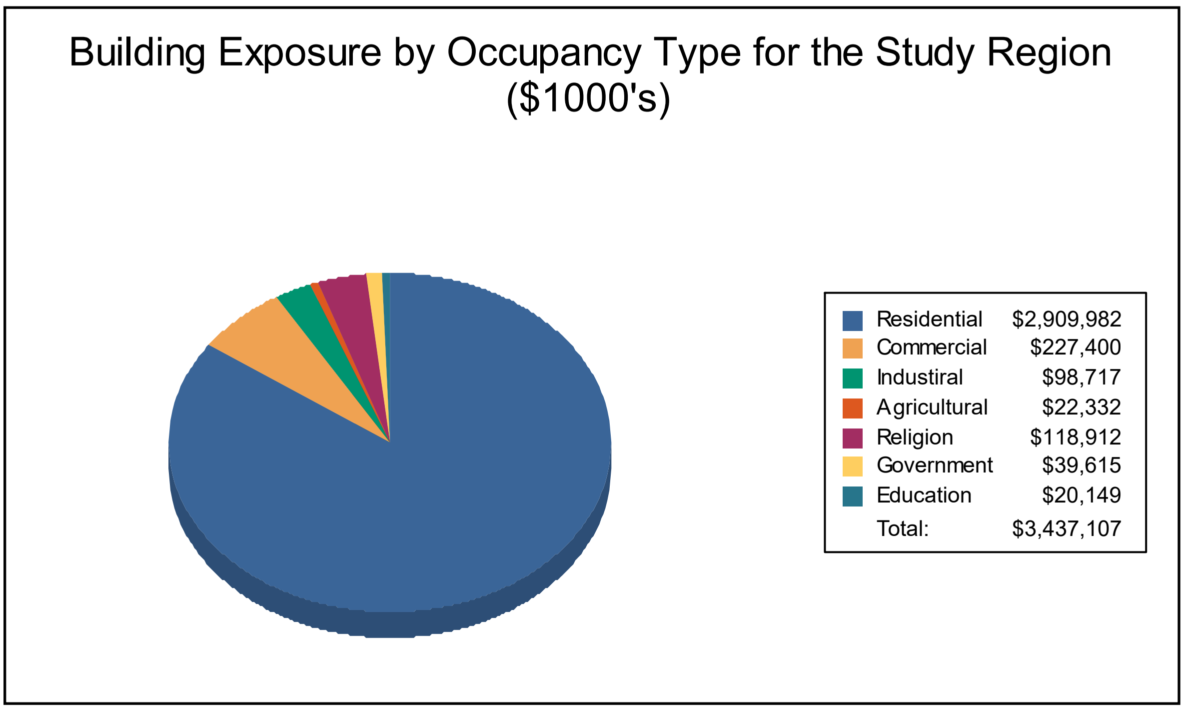
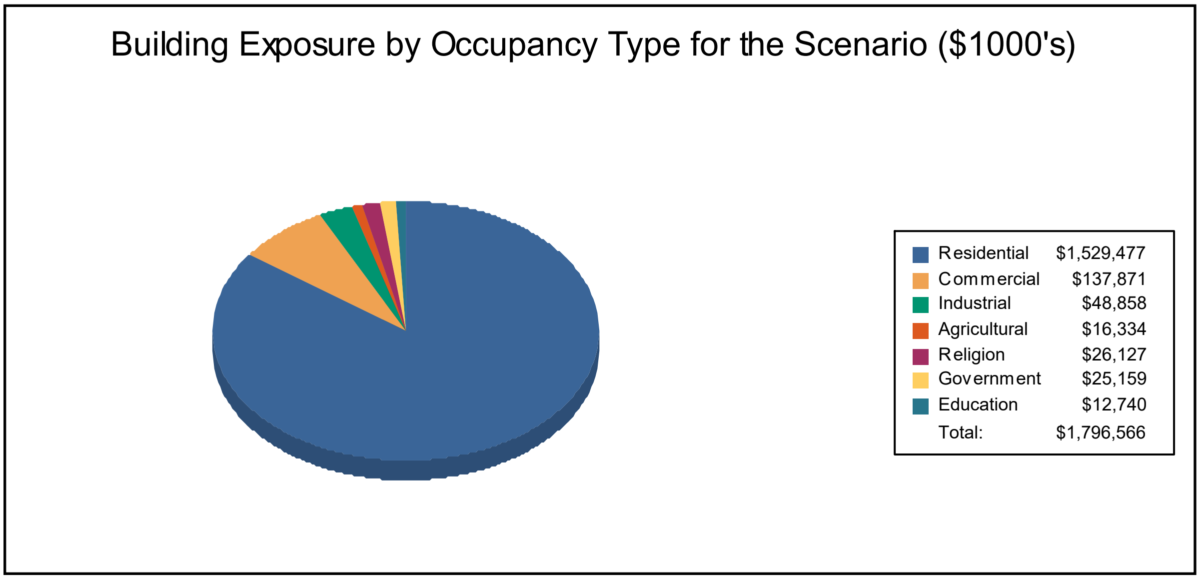


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,529,477	85.1%
Commercial	137,871	7.7%
Industrial	48,858	2.7%
Agricultural	16,334	0.9%
Religion	26,127	1.5%
Government	25,159	1.4%
Education	12,740	0.7%
Total	**1,796,566**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 11 schools, 7 fire stations, 2 police stations and no emergency operation centers.

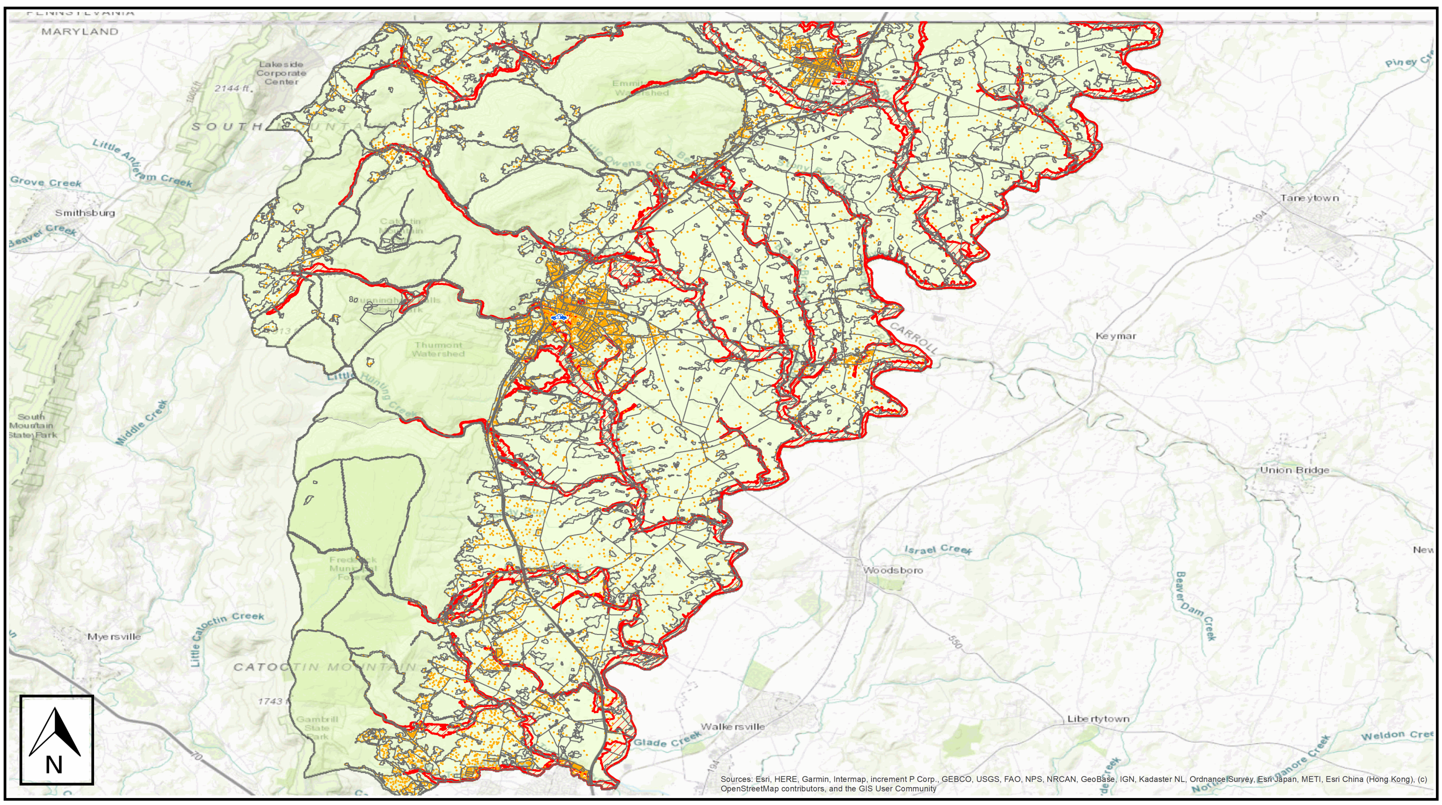
Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_5
Scenario Name:	Multi
Return Period Analyzed:	500
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure



Building Damage

General Building Stock Damage

Hazus estimates that about 66 buildings will be at least moderately damaged. This is over 69% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

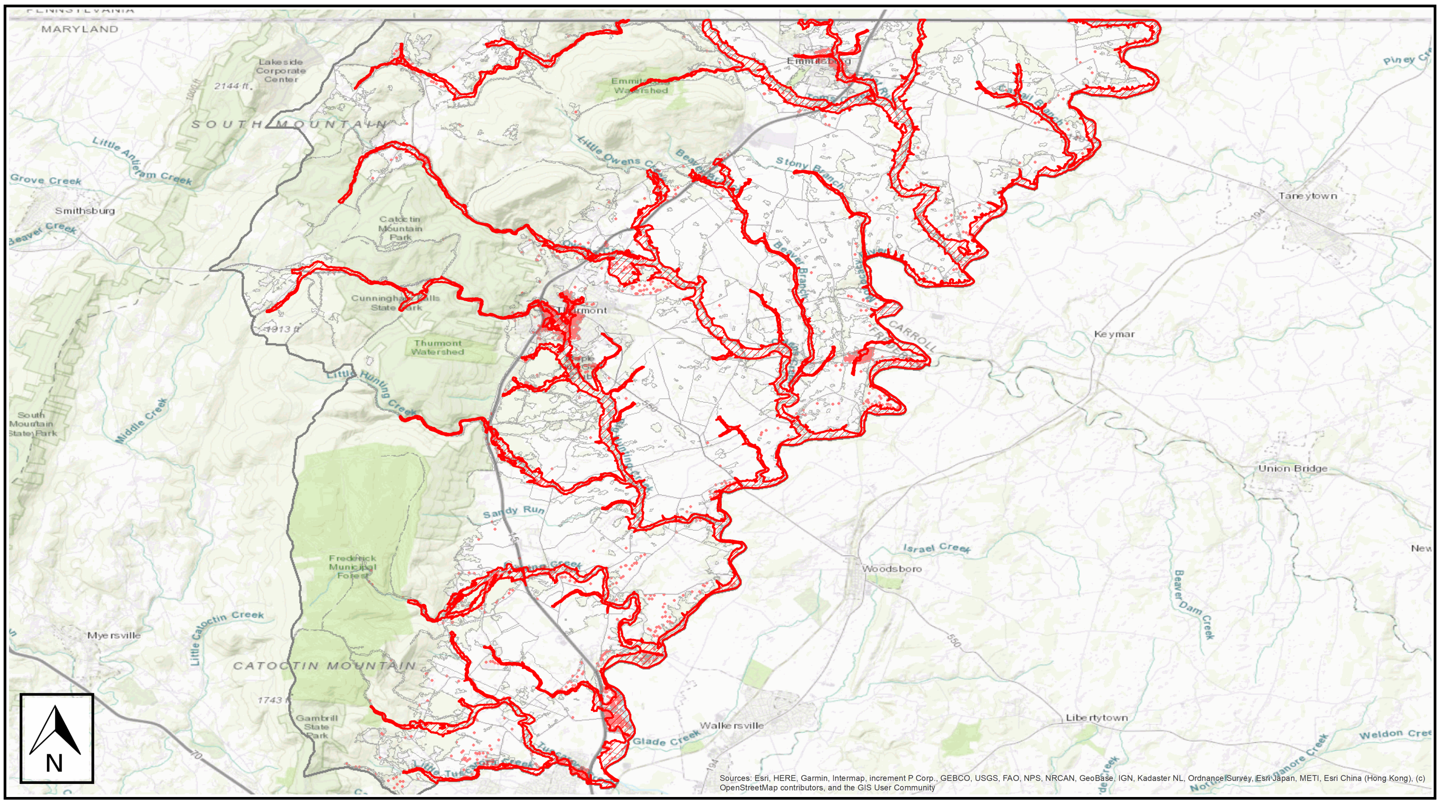


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	25	27	43	47	13	14	7	8	3	3	0	0
Total	**25**		**43**		**13**		**7**		**3**		**0**	

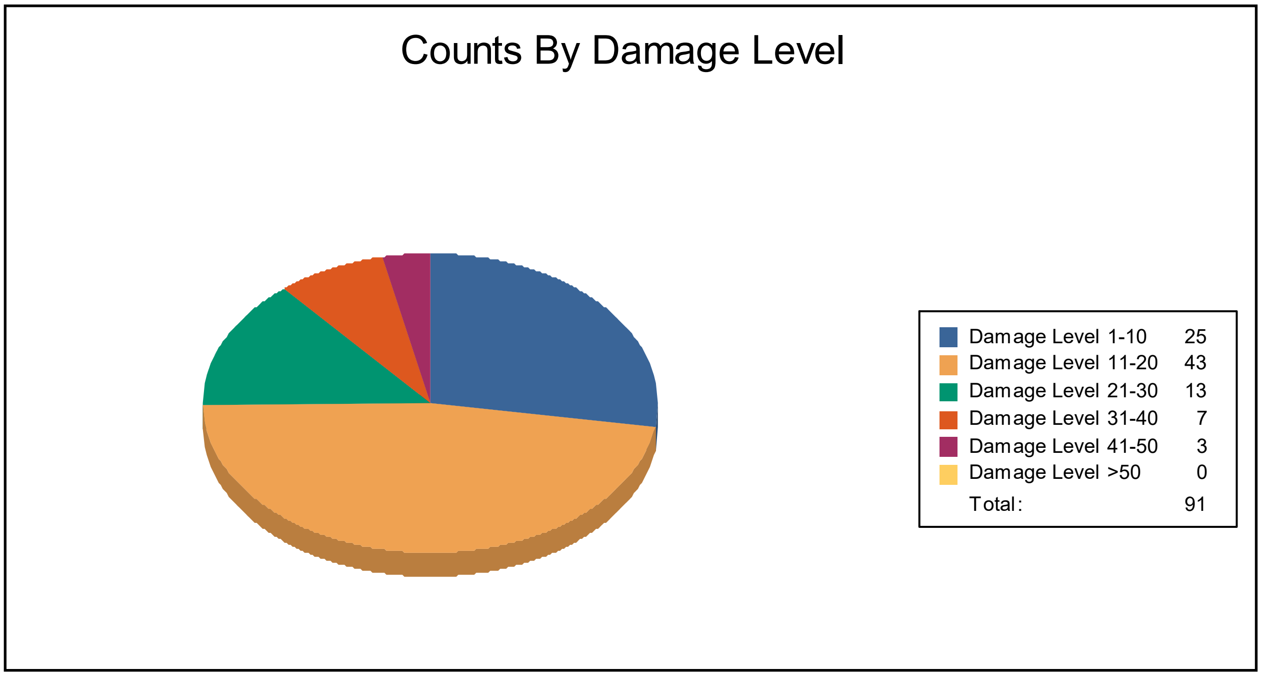


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	4	24	10	59	2	12	1	6	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	21	28	33	45	11	15	6	8	3	4	0	0

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	7	1	0	1
Hospitals	0	0	0	0
Police Stations	2	1	0	1
Schools	11	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

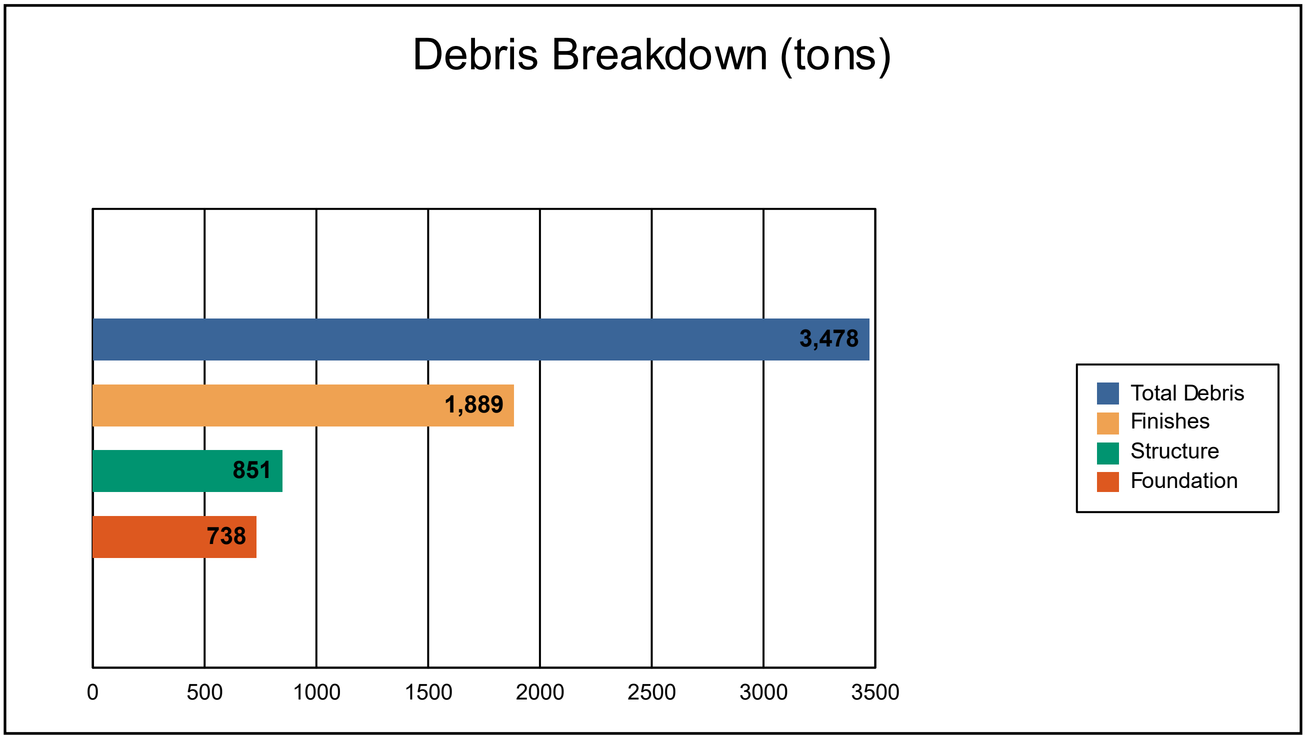
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

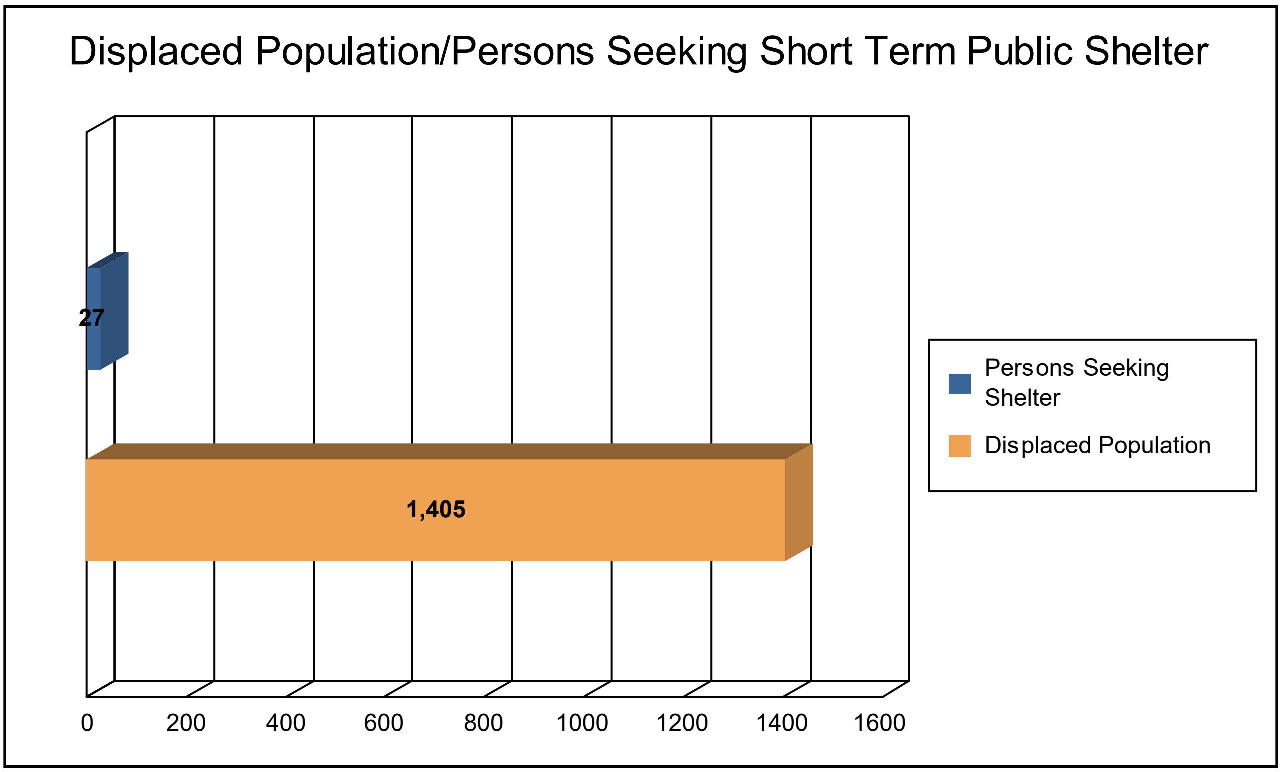


The model estimates that a total of 3,478 tons of debris will be generated. Of the total amount, Finishes comprises 54% of the total, Structure comprises 24% of the total, and Foundation comprises 21%. If the debris tonnage is converted into an estimated number of truckloads, it will require 140 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 468 households (or 1,405 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 27 people (out of a total population of 24,832) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 142.65 million dollars, which represents 7.94 % of the total replacement value of the scenario buildings.

Building-Related Losses

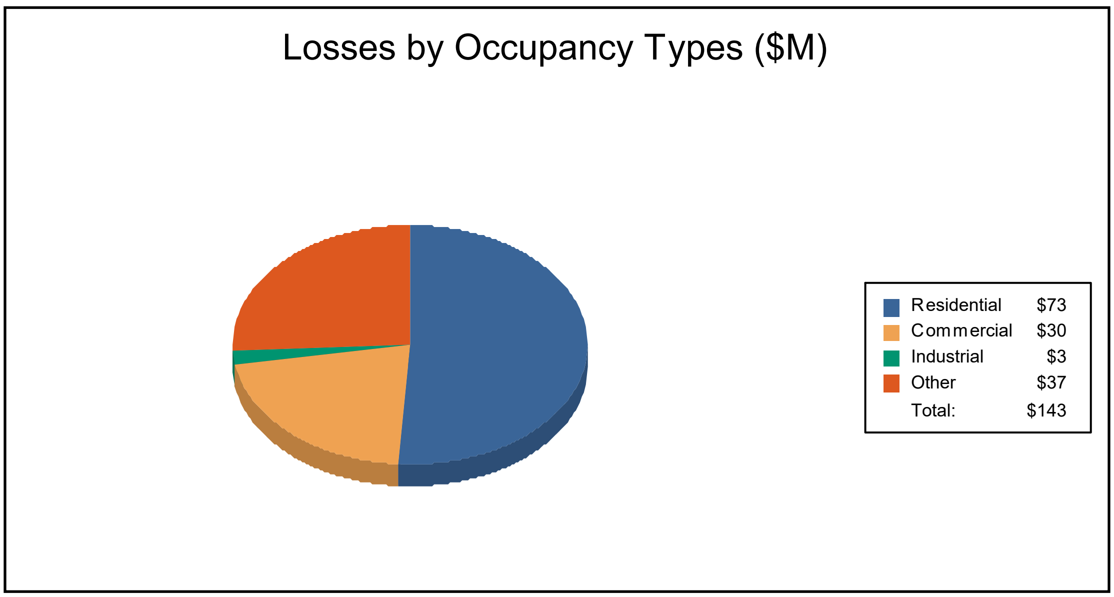
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 79.33 million dollars. 44% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 51.16% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	37.71	3.14	1.03	1.14	43.02
	Content	20.60	8.92	1.61	4.70	35.83
	Inventory	0.00	0.14	0.22	0.12	0.48
	Subtotal	**58.30**	**12.20**	**2.86**	**5.96**	**79.33**
Business Interruption						
	Income	1.07	7.96	0.03	1.49	10.55
	Relocation	8.00	0.99	0.01	0.69	9.69
	Rental Income	3.07	0.76	0.00	0.07	3.90
	Wage	2.53	8.12	0.06	28.46	39.18
	Subtotal	**14.67**	**17.83**	**0.11**	**30.71**	**63.32**
ALL	**Total**	**72.97**	**30.03**	**2.97**	**36.67**	**142.65**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Frederick	24,832	2,909,982	527,125	3,437,107
Total	**24,832**	**2,909,982**	**527,125**	**3,437,107**
Total Study Region	**24,832**	**2,909,982**	**527,125**	**3,437,107**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_1

Flood Scenario: Mulit

Print Date: Monday, August 2, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 154 square miles and contains 1,492 census blocks. The region contains over 13 thousand households and has a total population of 34,951 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 13,924 buildings in the region with a total building replacement value (excluding contents) of 4,884 million dollars. Approximately 92.06% of the buildings (and 89.46% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 13,924 buildings in the region which have an aggregate total replacement value of 4,884 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,369,448	89.5%
Commercial	298,832	6.1%
Industrial	83,521	1.7%
Agricultural	23,904	0.5%
Religion	65,399	1.3%
Government	17,551	0.4%
Education	25,330	0.5%
Total	**4,883,985**	**100%**

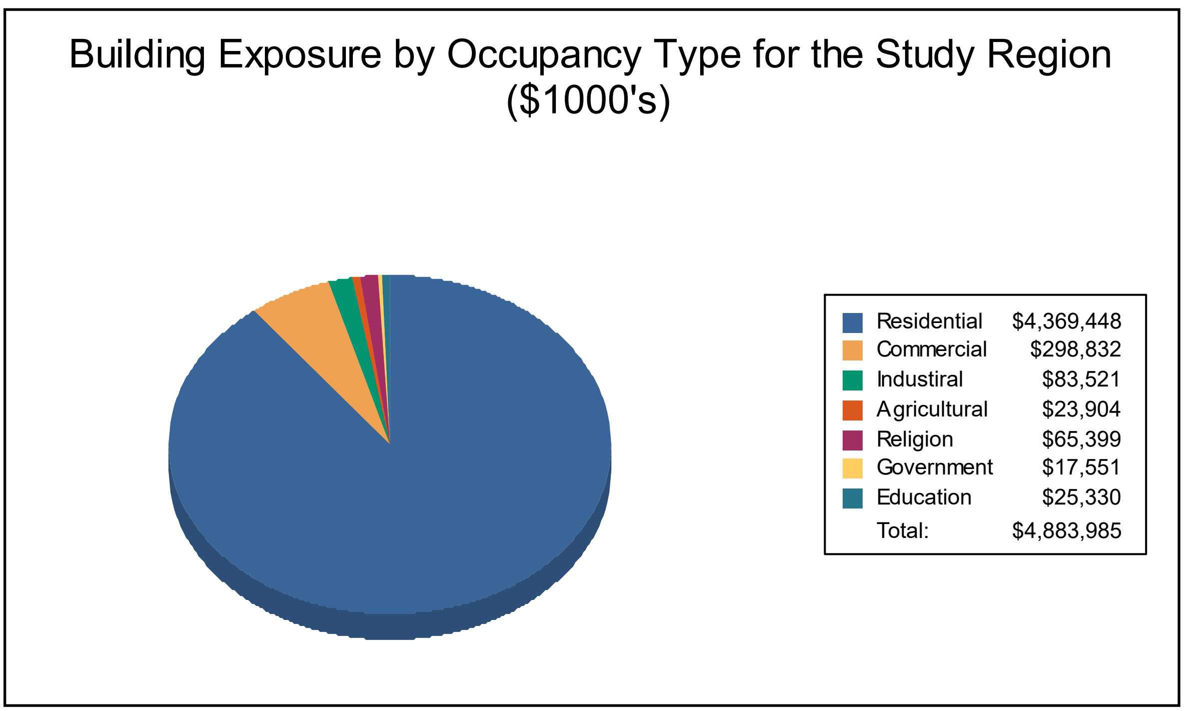
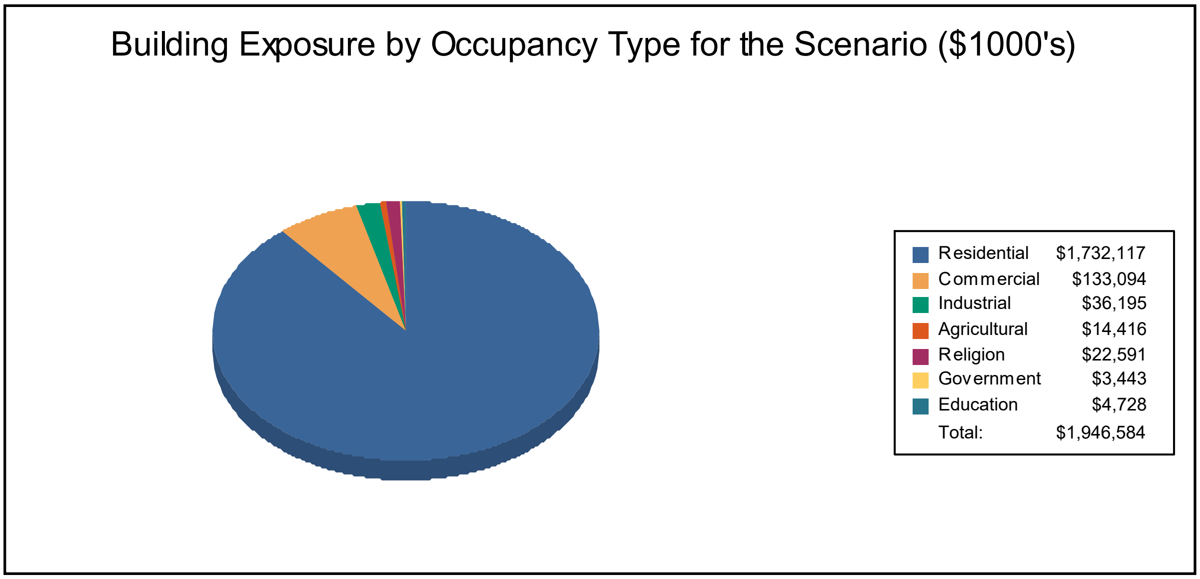


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,732,117	89.0%
Commercial	133,094	6.8%
Industrial	36,195	1.9%
Agricultural	14,416	0.7%
Religion	22,591	1.2%
Government	3,443	0.2%
Education	4,728	0.2%
Total	**1,946,584**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 14 schools, 6 fire stations, 2 police stations and no emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_1
Scenario Name:	Mulit
Return Period Analyzed:	Annual
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure

Analysis has not been performed for this Scenario.
AAL results are not available for Essential Facilities. Please select a return period to view Essential Facilities results.

Building Damage

General Building Stock Damage

Analysis has not been performed for this Scenario.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)

Analysis has not been performed for this Scenario.

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)

Analysis has not been performed for this Scenario.

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	6	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	14	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

Analysis has not been performed for this Scenario.

Social Impact

Shelter Requirements

Analysis has not been performed for this Scenario.

Economic Loss

The total economic loss estimated for the flood is 2.98 million dollars, which represents 0.15 % of the total replacement value of the scenario buildings.

Building-Related Losses

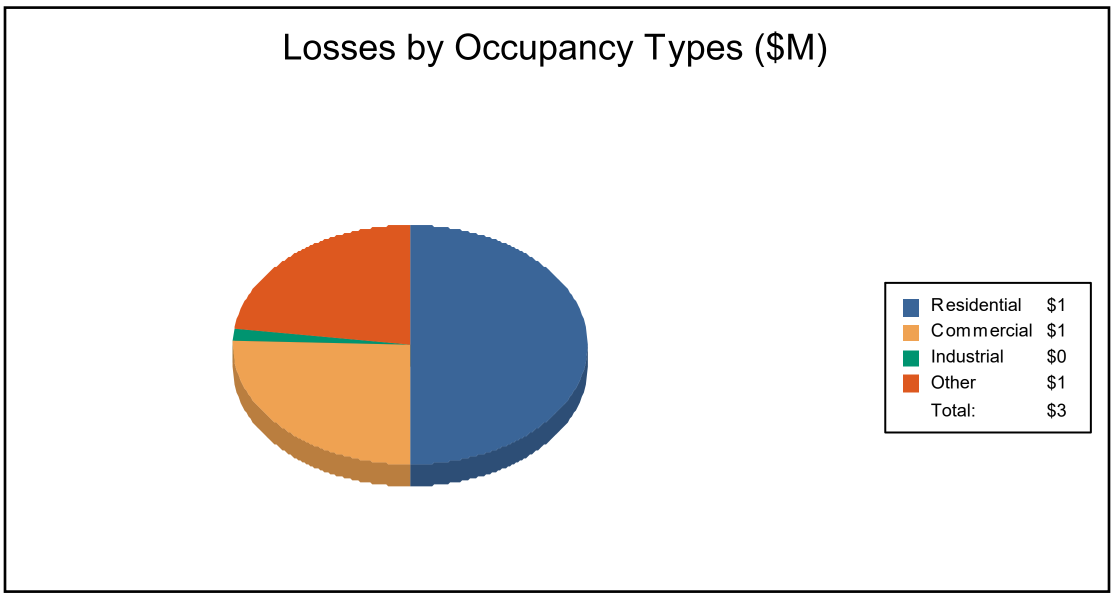
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 1.61 million dollars. 46% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 49.87% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	0.83	0.05	0.02	0.01	0.91
	Content	0.42	0.18	0.03	0.07	0.70
	Inventory	0.00	0.00	0.00	0.00	0.01
	Subtotal	**1.25**	**0.23**	**0.05**	**0.08**	**1.61**
Business Interruption						
	Income	0.00	0.25	0.00	0.02	0.28
	Relocation	0.18	0.03	0.00	0.01	0.23
	Rental Income	0.04	0.01	0.00	0.00	0.05
	Wage	0.01	0.25	0.00	0.56	0.81
	Subtotal	**0.24**	**0.54**	**0.00**	**0.59**	**1.37**
ALL	**Total**	**1.49**	**0.77**	**0.05**	**0.68**	**2.98**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Maryland				
Frederick	34,951	4,369,448	514,537	4,883,985
Total	**34,951**	**4,369,448**	**514,537**	**4,883,985**
Total Study Region	**34,951**	**4,369,448**	**514,537**	**4,883,985**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_2

Flood Scenario: Multi

Print Date: Tuesday, August 3, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 128 square miles and contains 1,470 census blocks. The region contains over 13 thousand households and has a total population of 39,698 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 14,322 buildings in the region with a total building replacement value (excluding contents) of 6,331 million dollars. Approximately 92.32% of the buildings (and 82.33% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 14,322 buildings in the region which have an aggregate total replacement value of 6,331 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	5,212,418	82.3%
Commercial	386,876	6.1%
Industrial	595,666	9.4%
Agricultural	33,020	0.5%
Religion	58,625	0.9%
Government	25,544	0.4%
Education	18,866	0.3%
Total	**6,331,015**	**100%**

Building Exposure by Occupancy Type for the Study Region ($1000's)

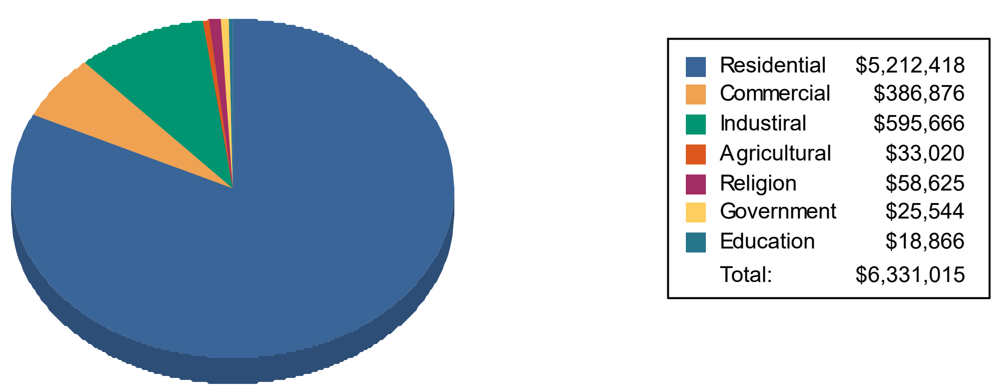
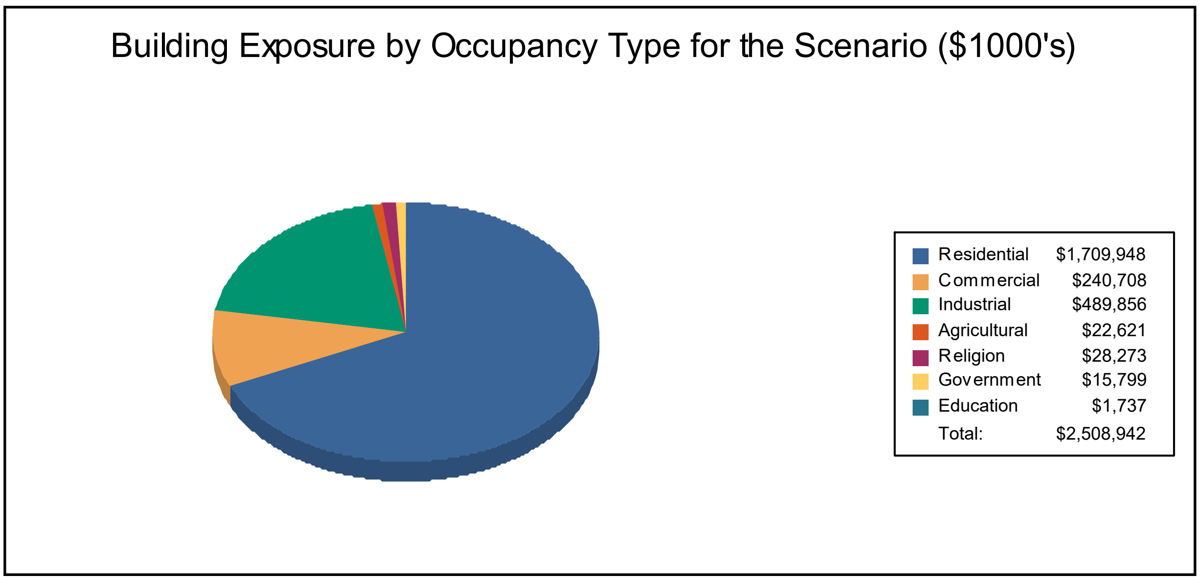


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,709,948	68.2%
Commercial	240,708	9.6%
Industrial	489,856	19.5%
Agricultural	22,621	0.9%
Religion	28,273	1.1%
Government	15,799	0.6%
Education	1,737	0.1%
Total	**2,508,942**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

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Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_2
Scenario Name:	Multi
Return Period Analyzed:	Annual
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure

Analysis has not been performed for this Scenario.
AAL results are not available for Essential Facilities. Please select a return period to view Essential Facilities results.

Building Damage

General Building Stock Damage

Analysis has not been performed for this Scenario.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**

Analysis has not been performed for this Scenario.

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**

Analysis has not been performed for this Scenario.

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

Analysis has not been performed for this Scenario.

Social Impact

Shelter Requirements

Analysis has not been performed for this Scenario.

Economic Loss

The total economic loss estimated for the flood is 8.74 million dollars, which represents 0.35 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 6.18 million dollars. 29% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 47.94% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

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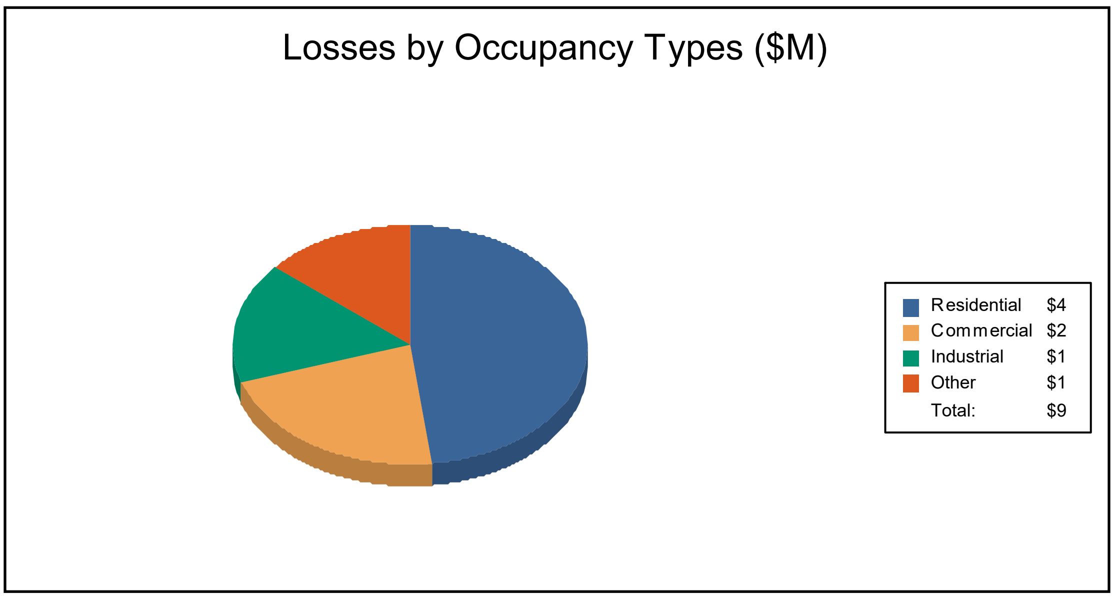
Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	2.36	0.27	0.33	0.08	3.03
	Content	1.21	0.65	0.86	0.27	2.99
	Inventory	0.00	0.02	0.12	0.02	0.16
	Subtotal	**3.57**	**0.94**	**1.31**	**0.36**	**6.18**
Business Interruption						
	Income	0.02	0.44	0.04	0.06	0.56
	Relocation	0.40	0.08	0.03	0.01	0.52
	Rental Income	0.15	0.06	0.00	0.00	0.21
	Wage	0.05	0.42	0.04	0.77	1.28
	Subtotal	**0.62**	**0.99**	**0.11**	**0.85**	**2.56**
ALL	**Total**	**4.19**	**1.93**	**1.42**	**1.21**	**8.74**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	39,698	5,212,418	1,118,597	6,331,015
Total	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**
Total Study Region	**39,698**	**5,212,418**	**1,118,597**	**6,331,015**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_3

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 73 square miles and contains 2,890 census blocks. The region contains over 41 thousand households and has a total population of 106,724 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 36,786 buildings in the region with a total building replacement value (excluding contents) of 15,635 million dollars. Approximately 90.42% of the buildings (and 78.16% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 36,786 buildings in the region which have an aggregate total replacement value of 15,635 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	12,220,022	78.2%
Commercial	2,296,995	14.7%
Industrial	454,425	2.9%
Agricultural	26,557	0.2%
Religion	222,953	1.4%
Government	170,628	1.1%
Education	243,455	1.6%
Total	**15,635,035**	**100%**

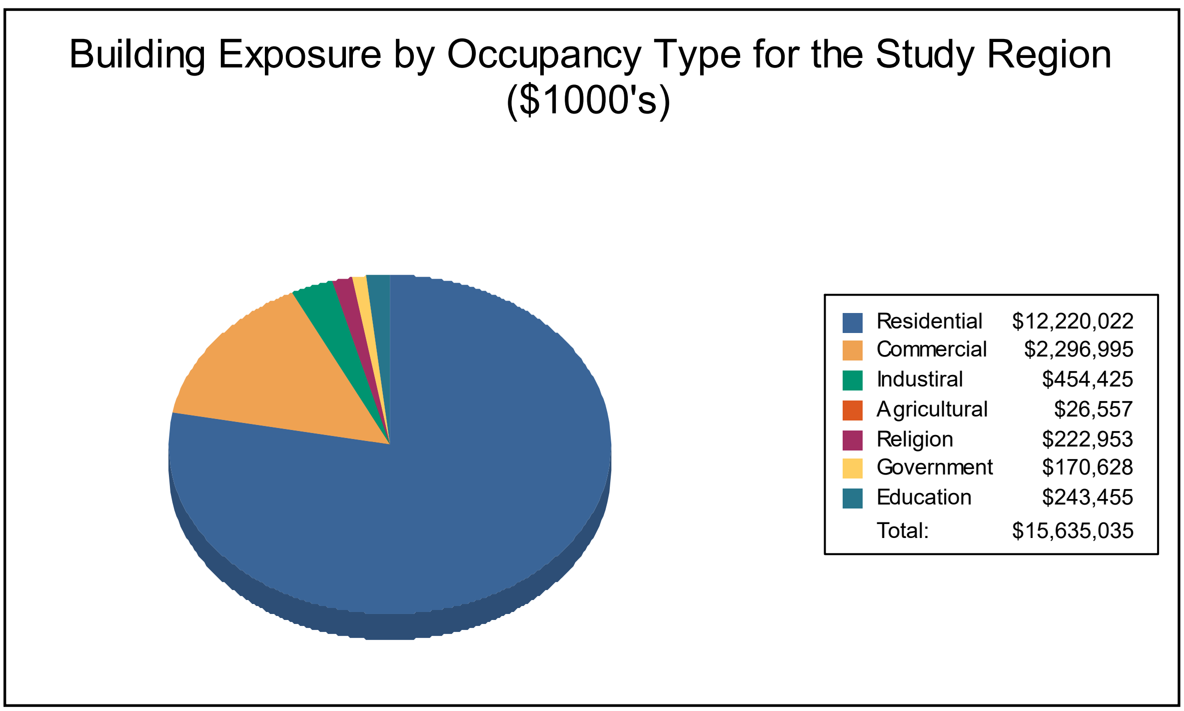
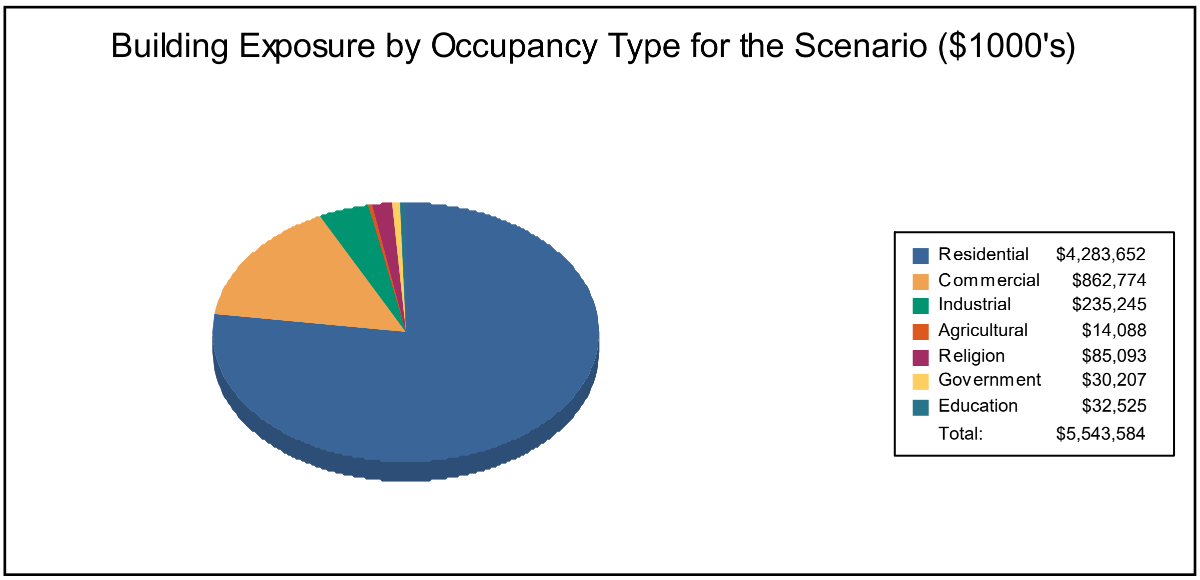


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	4,283,652	77.3%
Commercial	862,774	15.6%
Industrial	235,245	4.2%
Agricultural	14,088	0.3%
Religion	85,093	1.5%
Government	30,207	0.5%
Education	32,525	0.6%
Total	**5,543,584**	**100%**



Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 48 schools, 10 fire stations, 7 police stations and 2 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_3
Scenario Name:	Multi
Return Period Analyzed:	Annual
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure

Analysis has not been performed for this Scenario.
AAL results are not available for Essential Facilities. Please select a return period to view Essential Facilities results.

Building Damage

General Building Stock Damage

Analysis has not been performed for this Scenario.

Table 3: Expected Building Damage by Occupancy

Occupancy	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)

Analysis has not been performed for this Scenario.

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)

Analysis has not been performed for this Scenario.

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 308 hospital beds available for use. On the day of the scenario flood event, the model estimates that 308 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	2	0	0	0
Fire Stations	10	0	0	0
Hospitals	1	0	0	0
Police Stations	7	0	0	0
Schools	48	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

Analysis has not been performed for this Scenario.

Social Impact

Shelter Requirements

Analysis has not been performed for this Scenario.

Economic Loss

The total economic loss estimated for the flood is 32.34 million dollars, which represents 0.58 % of the total replacement value of the scenario buildings.

Building-Related Losses

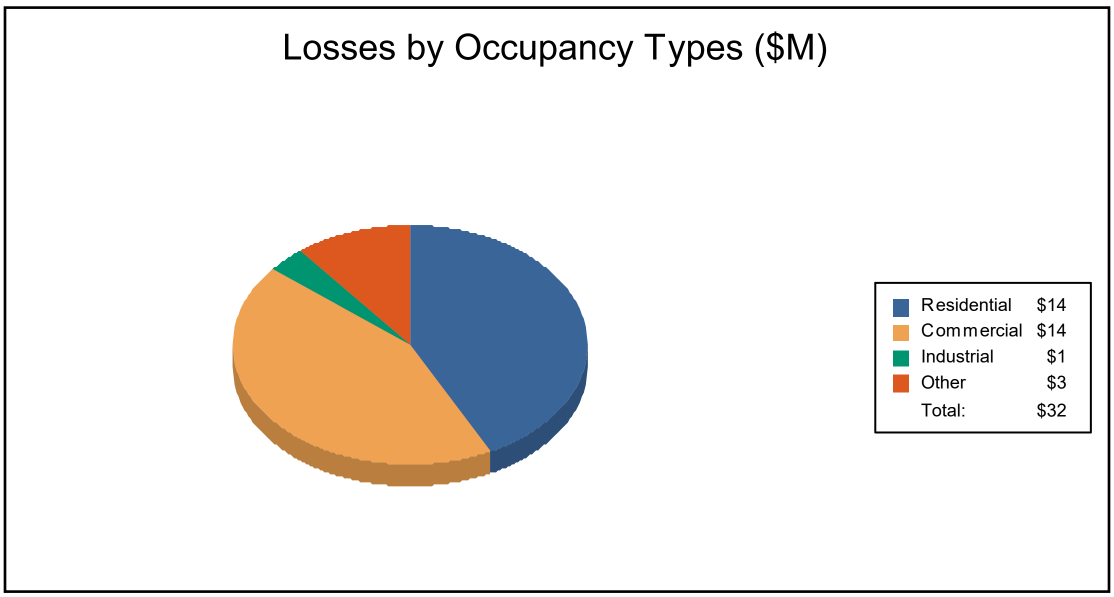
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 18.90 million dollars. 42% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 42.37% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	7.09	1.76	0.32	0.13	9.31
	Content	3.80	4.26	0.65	0.74	9.45
	Inventory	0.00	0.04	0.10	0.00	0.14
	Subtotal	**10.89**	**6.07**	**1.06**	**0.88**	**18.90**
Business Interruption						
	Income	0.11	3.42	0.02	0.24	3.79
	Relocation	1.75	0.81	0.02	0.11	2.68
	Rental Income	0.70	0.57	0.00	0.01	1.28
	Wage	0.25	3.20	0.03	2.20	5.68
	Subtotal	**2.81**	**8.00**	**0.06**	**2.56**	**13.44**
ALL	**Total**	**13.70**	**14.07**	**1.13**	**3.44**	**32.34**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	106,724	12,220,022	3,415,013	15,635,035
Total	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**
Total Study Region	**106,724**	**12,220,022**	**3,415,013**	**15,635,035**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_4

Flood Scenario: Multi

Print Date: Wednesday, August 4, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 138 square miles and contains 1,074 census blocks. The region contains over 9 thousand households and has a total population of 27,180 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 10,335 buildings in the region with a total building replacement value (excluding contents) of 3,945 million dollars. Approximately 91.67% of the buildings (and 88.71% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 10,335 buildings in the region which have an aggregate total replacement value of 3,945 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	3,499,625	88.7%
Commercial	238,367	6.0%
Industrial	89,655	2.3%
Agricultural	29,561	0.7%
Religion	45,679	1.2%
Government	5,013	0.1%
Education	37,265	0.9%
Total	**3,945,165**	**100%**

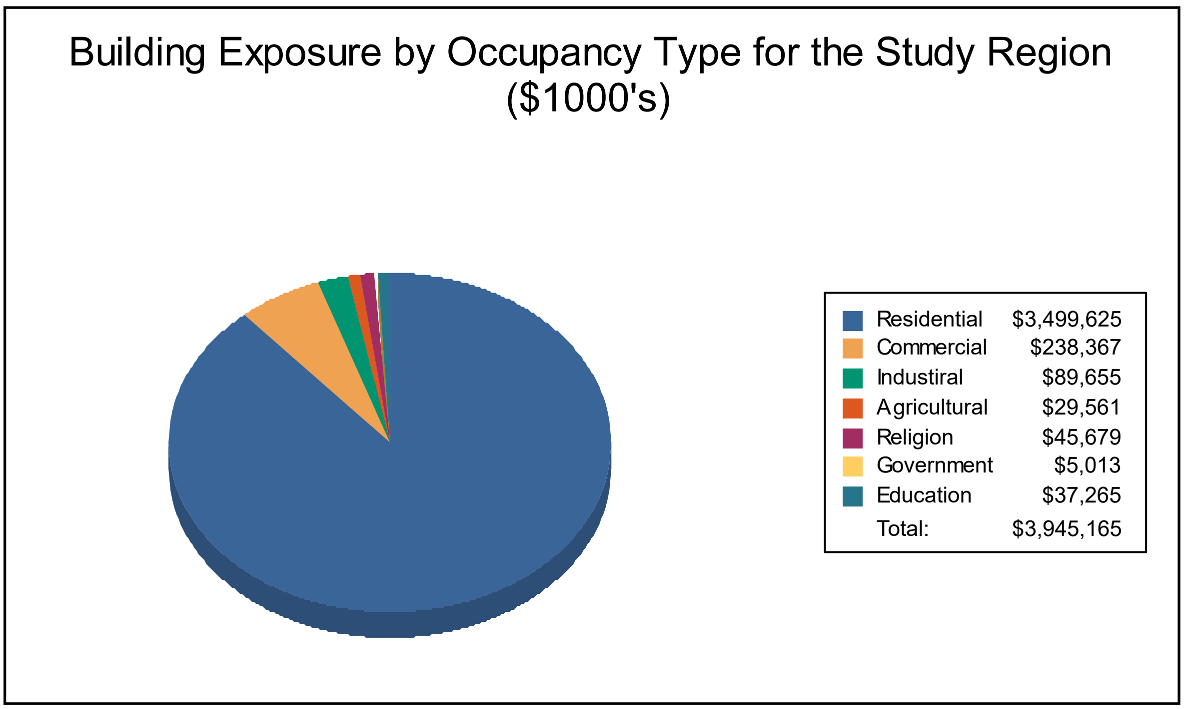
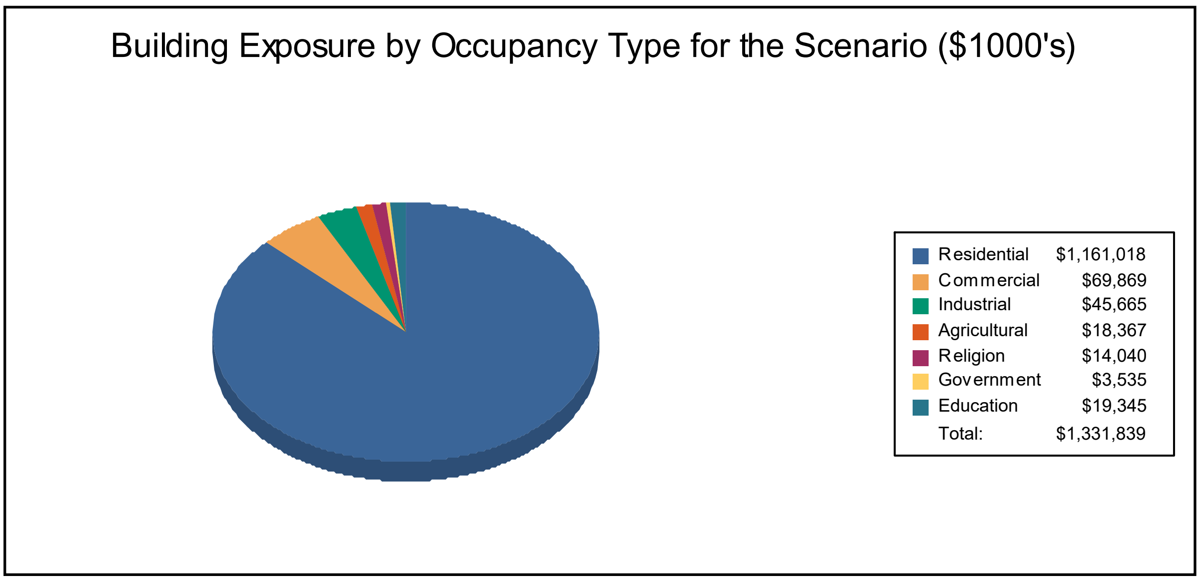


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,161,018	87.2%
Commercial	69,869	5.2%
Industrial	45,665	3.4%
Agricultural	18,367	1.4%
Religion	14,040	1.1%
Government	3,535	0.3%
Education	19,345	1.5%
Total	**1,331,839**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 12 schools, 4 fire stations, no police stations and no emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_4
Scenario Name:	Multi
Return Period Analyzed:	Annual
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure

Analysis has not been performed for this Scenario.
AAL results are not available for Essential Facilities. Please select a return period to view Essential Facilities results.

Building Damage

General Building Stock Damage

Analysis has not been performed for this Scenario.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**

Analysis has not been performed for this Scenario.

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**

Analysis has not been performed for this Scenario.

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	4	0	0	0
Hospitals	0	0	0	0
Police Stations	0	0	0	0
Schools	12	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

Analysis has not been performed for this Scenario.

Social Impact

Shelter Requirements

Analysis has not been performed for this Scenario.

Economic Loss

The total economic loss estimated for the flood is 3.14 million dollars, which represents 0.24 % of the total replacement value of the scenario buildings.

Building-Related Losses

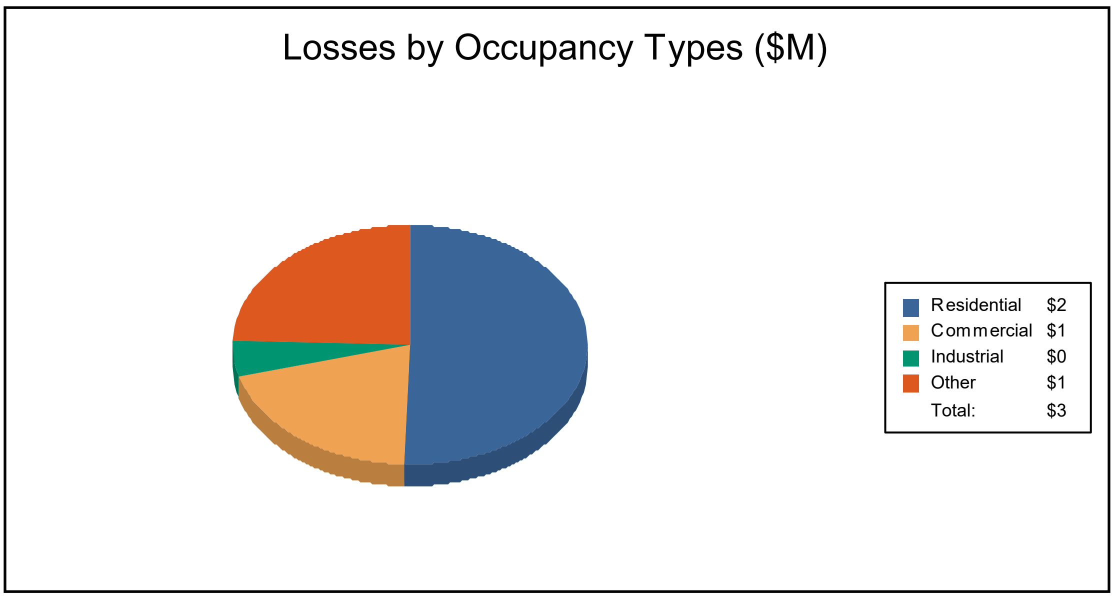
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 1.89 million dollars. 40% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 50.51% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	0.90	0.04	0.04	0.02	1.00
	Content	0.45	0.17	0.10	0.16	0.88
	Inventory	0.00	0.00	0.02	0.00	0.02
	Subtotal	**1.34**	**0.21**	**0.15**	**0.18**	**1.89**
Business Interruption						
	Income	0.00	0.20	0.00	0.07	0.27
	Relocation	0.19	0.02	0.00	0.03	0.24
	Rental Income	0.05	0.01	0.00	0.00	0.06
	Wage	0.00	0.19	0.00	0.49	0.68
	Subtotal	**0.24**	**0.42**	**0.00**	**0.58**	**1.25**
ALL	**Total**	**1.58**	**0.63**	**0.15**	**0.77**	**3.14**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Frederick	27,180	3,499,625	445,540	3,945,165
Total	**27,180**	**3,499,625**	**445,540**	**3,945,165**
Total Study Region	**27,180**	**3,499,625**	**445,540**	**3,945,165**

Hazus: Flood Global Risk Report

Region Name: FrederickMD_FLD_5

Flood Scenario: Multi

Print Date: Thursday, August 5, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

Increasing Resilience Together

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 173 square miles and contains 1,430 census blocks. The region contains over 9 thousand households and has a total population of 24,832 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 9,774 buildings in the region with a total building replacement value (excluding contents) of 3,437 million dollars. Approximately 90.65% of the buildings (and 84.66% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 9,774 buildings in the region which have an aggregate total replacement value of 3,437 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,909,982	84.7%
Commercial	227,400	6.6%
Industrial	98,717	2.9%
Agricultural	22,332	0.6%
Religion	118,912	3.5%
Government	39,615	1.2%
Education	20,149	0.6%
Total	**3,437,107**	**100%**

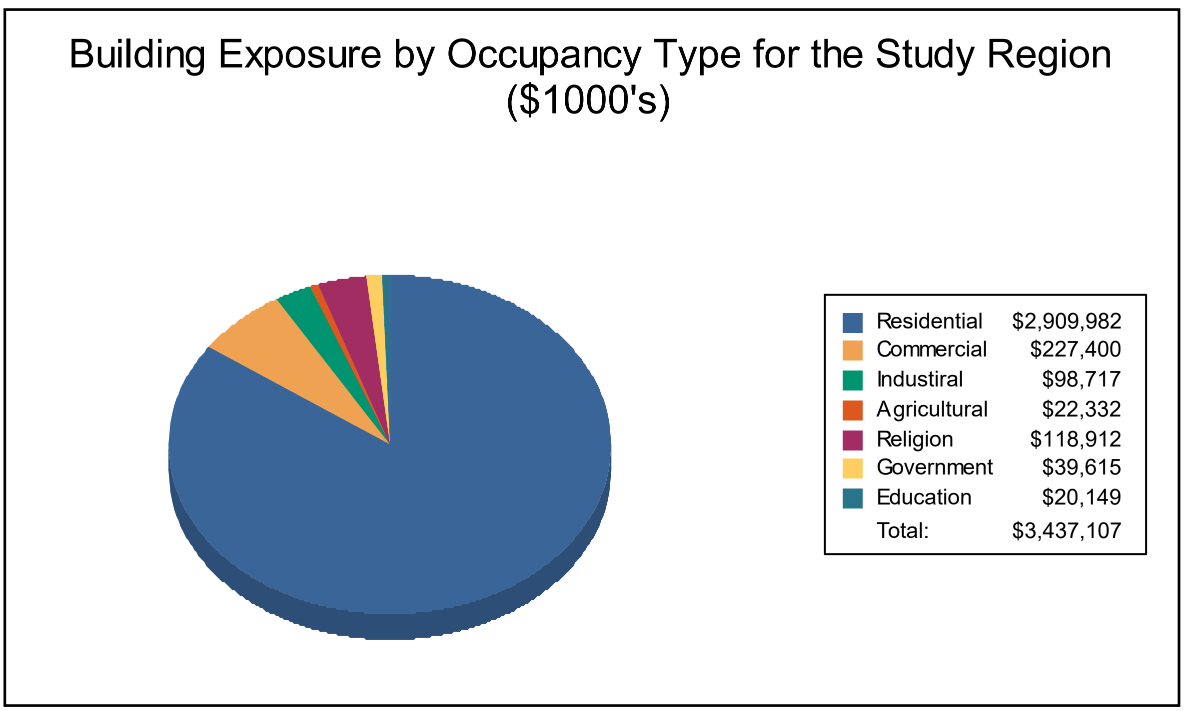
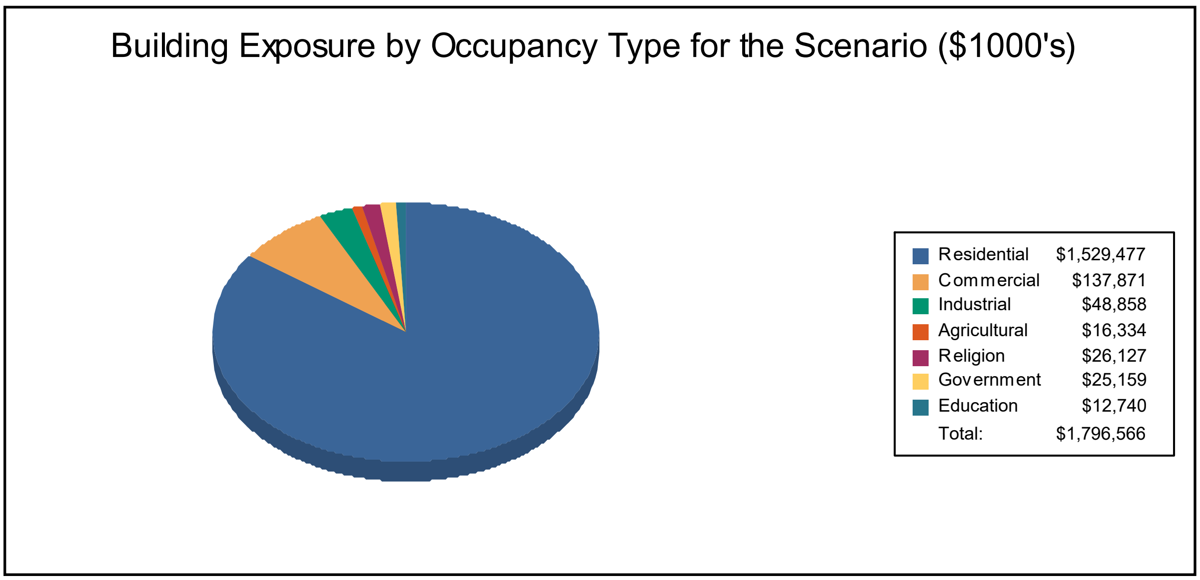


Table 2

Building Exposure by Occupancy Type for the Scenario

Occupancy	**Exposure ($1000)**	**Percent of Total**
Residential	1,529,477	85.1%
Commercial	137,871	7.7%
Industrial	48,858	2.7%
Agricultural	16,334	0.9%
Religion	26,127	1.5%
Government	25,159	1.4%
Education	12,740	0.7%
Total	**1,796,566**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 11 schools, 7 fire stations, 2 police stations and no emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	FrederickMD_FLD_5
Scenario Name:	Multi
Return Period Analyzed:	Annual
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure

Analysis has not been performed for this Scenario.
AAL results are not available for Essential Facilities. Please select a return period to view Essential Facilities results.

Building Damage

General Building Stock Damage

Analysis has not been performed for this Scenario.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)

Analysis has not been performed for this Scenario.

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)

Analysis has not been performed for this Scenario.

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	7	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	11	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

Analysis has not been performed for this Scenario.

Social Impact

Shelter Requirements

Analysis has not been performed for this Scenario.

Economic Loss

The total economic loss estimated for the flood is 6.02 million dollars, which represents 0.34 % of the total replacement value of the scenario buildings.

Building-Related Losses

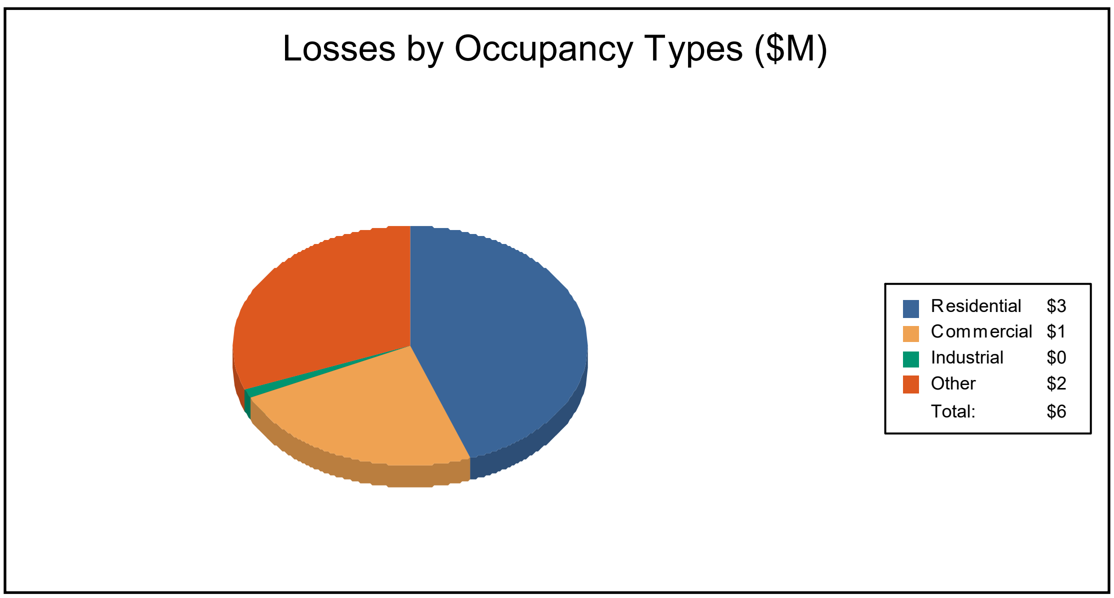
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2.69 million dollars. 55% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 44.34% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	1.26	0.10	0.03	0.03	1.42
	Content	0.67	0.37	0.05	0.18	1.26
	Inventory	0.00	0.00	0.00	0.01	0.01
	Subtotal	**1.93**	**0.47**	**0.08**	**0.22**	**2.69**
Business Interruption						
	Income	0.07	0.43	0.00	0.07	0.58
	Relocation	0.37	0.05	0.00	0.04	0.46
	Rental Income	0.14	0.03	0.00	0.00	0.17
	Wage	0.16	0.44	0.00	1.52	2.13
	Subtotal	**0.74**	**0.95**	**0.00**	**1.64**	**3.33**
ALL	**Total**	**2.67**	**1.42**	**0.08**	**1.86**	**6.02**



Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	24,832	2,909,982	527,125	3,437,107
Total	**24,832**	**2,909,982**	**527,125**	**3,437,107**
Total Study Region	**24,832**	**2,909,982**	**527,125**	**3,437,107**

Hurricane Wind

HAZUS EARTHQUAKE - WIND - FLOOD - TSUNAMI

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RiskMAP
Increasing Resilience Together

Quick Assessment Report

August 3, 2021

Study Region : FrederickMD_HUR

Scenario : Probabilistic

Regional Statistics

Area (Square Miles)	667
Number of Census Tracts	61
Number of People in the Region	233,385

General Building Stock

Occupancy	*Building Count*	*Dollar Exposure ($ K)*
Residential	77,638	28,211,495
Commercial	4,574	3,448,470
Other	2,929	2,572,342
Total	85,141	34,232,307

Scenario Results

Number of Residential Buildings Damaged

Return Period	*Minor*	*Moderate*	*Severe*	*Destruction*	*Total*
10	0	0	0	0	0
20	0	0	0	0	0
50	5	0	0	0	5
100	25	0	0	0	25
200	106	1	0	0	107
500	667	22	0	0	689
1000	1,913	85	0	1	1,999

Number of Buildings Damaged

Return Period	*Minor*	*Moderate*	*Severe*	*Destruction*	*Total*
10	0	0	0	0	0
20	0	0	0	0	0
50	11	0	0	0	11
100	44	0	0	0	45
200	136	2	0	0	138
500	735	25	0	0	760
1000	2,049	95	2	1	2,146

Shelter Requirements

Return Period	*Displaced Households (#Households)*	*Short Term Shelter (#People)*
10	0	0
20	0	0
50	0	0
100	0	0
200	0	0
500	0	0
1000	0	0

Economic Loss (x 1000)

	Property Damage (Capital Stock) Losses		**Business Interruption (Income) Losses**
ReturnPeriod	***Residential***	***Total***	
10	0	0	0
20	0	0	0
50	3	3	0
100	4,060	4,115	0
200	18,780	19,366	13
500	53,534	54,788	813
1000	96,825	99,148	4,421
Annualized	464	486	23

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

Hazus: Hurricane Global Risk Report

Region Name: FrederickMD_HUR

Hurricane Scenario: Probabilistic 10-year Return Period

Print Date: Tuesday, August 3, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 667.37 square miles and contains 61 census tracts. There are over 84 thousand households in the region and a total population of 233,385 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 85 thousand buildings in the region with a total building replacement value (excluding contents) of 34,232 million dollars (2014 dollars). Approximately 91% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 85,141 buildings in the region which have an aggregate total replacement value of 34,232 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

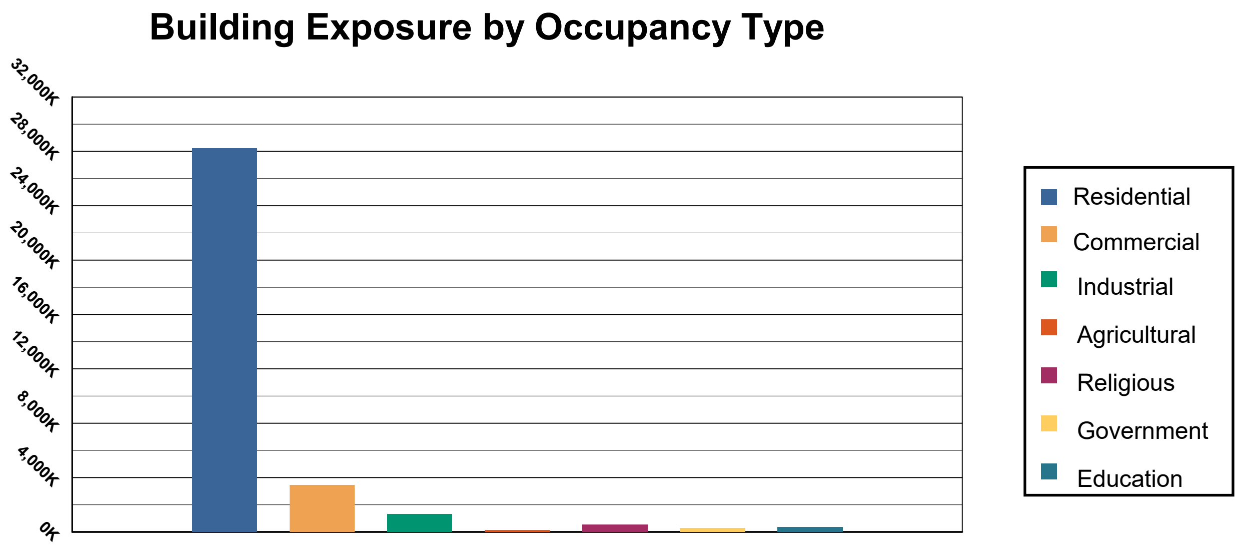


Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	28,211,495	82.41%
Commercial	3,448,470	10.07%
Industrial	1,321,984	3.86%
Agricultural	135,374	0.40%
Religious	511,568	1.49%
Government	258,351	0.75%
Education	345,065	1.01%
Total	**34,232,307**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 97 schools, 31 fire stations, 11 police stations and 2 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Expected Building Damage by Occupancy

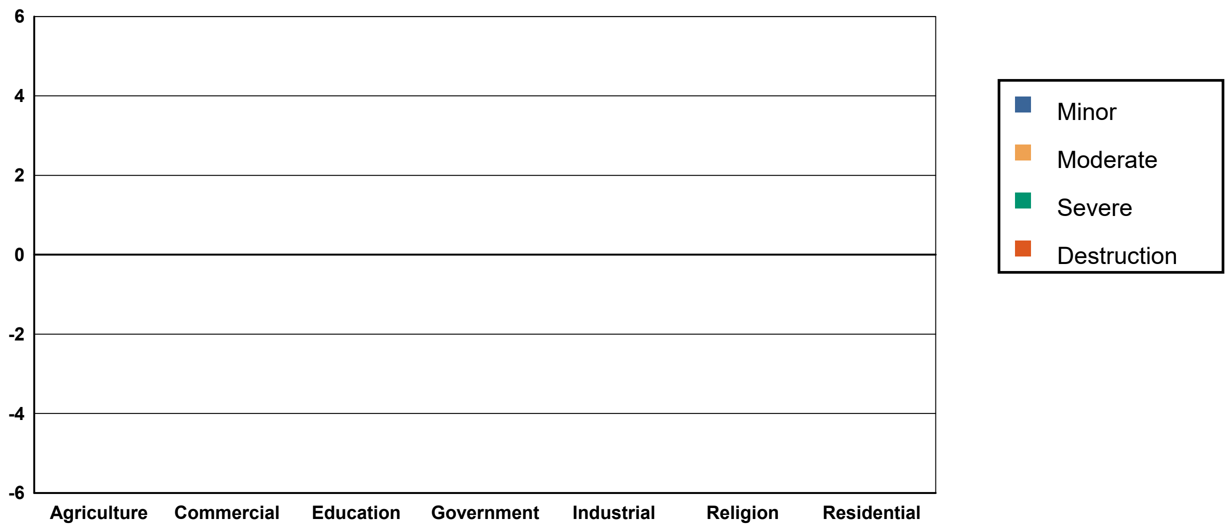


Table 2: Expected Building Damage by Occupancy : 10 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	452.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	4,574.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Education	171.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government	203.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industrial	1,544.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Religion	559.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential	77,638.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**85,141.00**		**0.00**		**0.00**		**0.00**		**0.00**	

Table 3: Expected Building Damage by Building Type : 10 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	790	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	22,525	100.00	0	0.00	0	0.00	0	0.00	0	0.00
MH	571	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	3,125	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	54,732	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 308 hospital beds available for use. On the day of the hurricane, the model estimates that 308 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

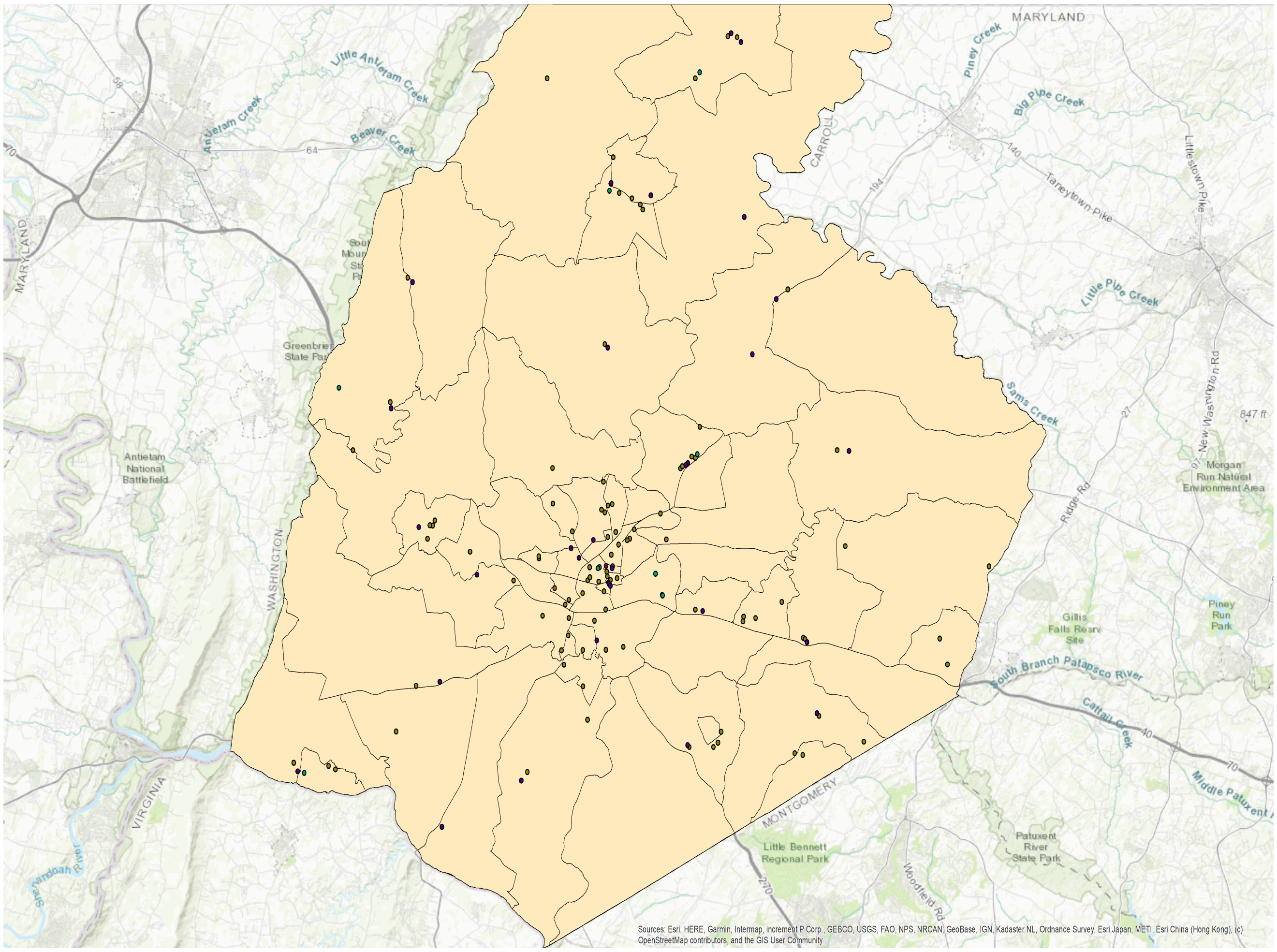
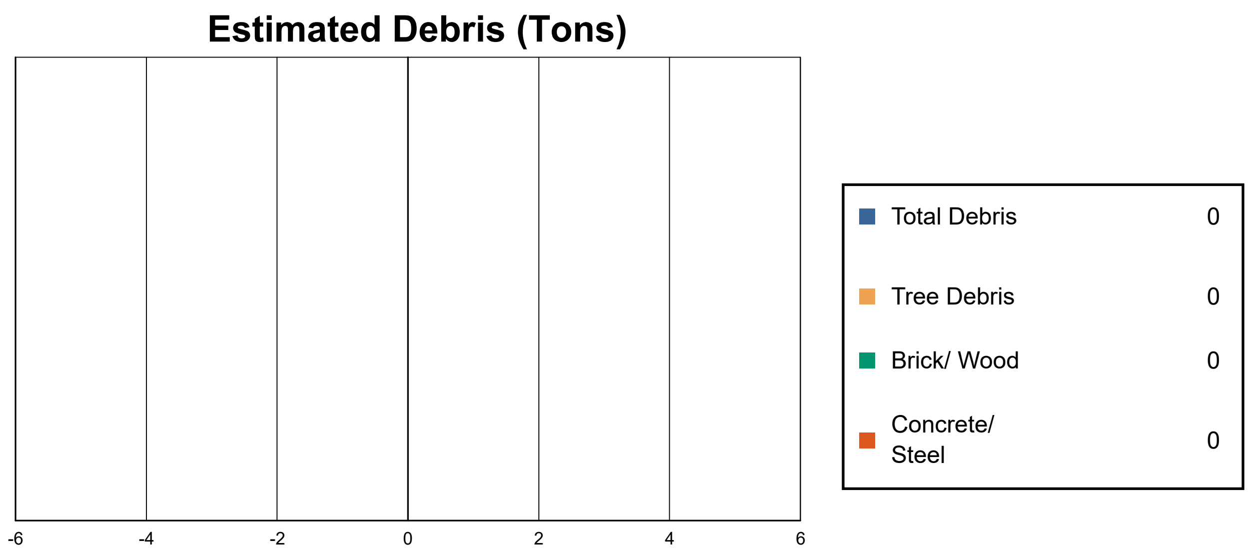


Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	2	0	0	2
Fire Stations	31	0	0	31
Hospitals	1	0	0	1
Police Stations	11	0	0	11
Schools	97	0	0	97

Induced Hurricane Damage

Debris Generation

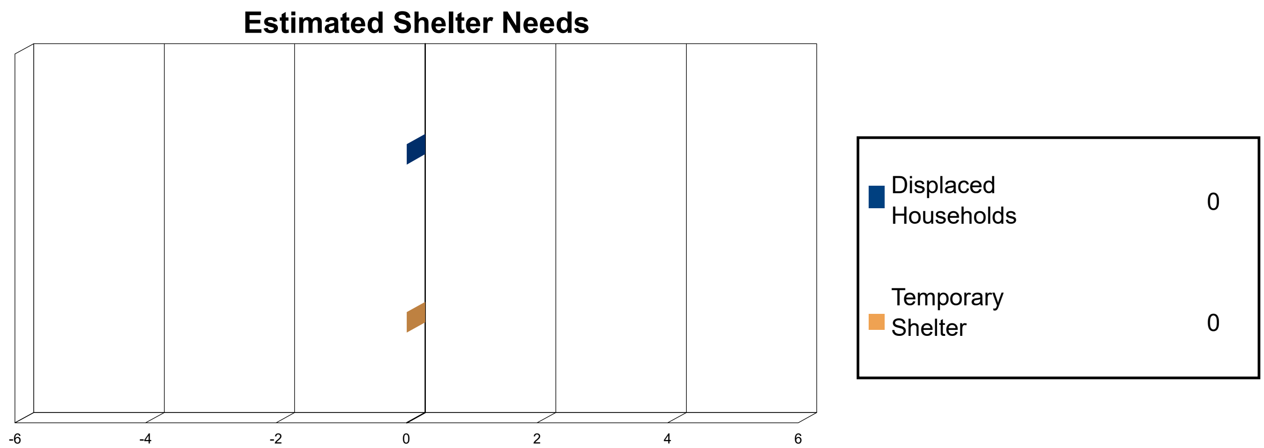


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 0 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier , uncompacted debris.

Social Impact

Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 233,385) will seek temporary shelter in public shelters.

Economic Loss

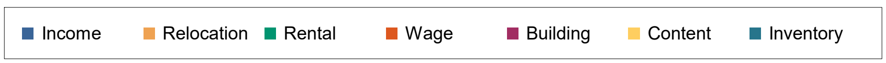
The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 0% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left)
and Building Damage Type (right)



Loss Type by General Occupancy

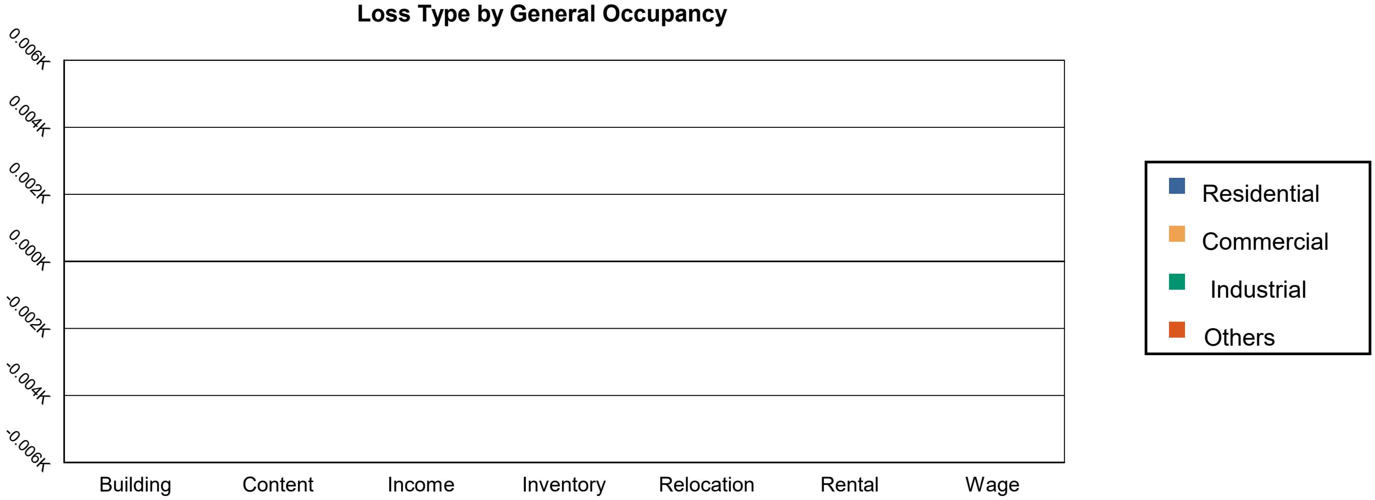


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	0.00	0.00	0.00	0.00	0.00
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Total

Total	0.00	0.00	0.00	0.00	0.00

Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Maryland				
Frederick	233,385	28,211,495	6,020,812	34,232,307
Total	**233,385**	**28,211,495**	**6,020,812**	**34,232,307**
Study Region Total	**233,385**	**28,211,495**	**6,020,812**	**34,232,307**

Hazus: Hurricane Global Risk Report

Region Name: FrederickMD_HUR

Hurricane Scenario: Probabilistic 20-year Return Period

Print Date: Tuesday, August 3, 2021

Disclaimer:

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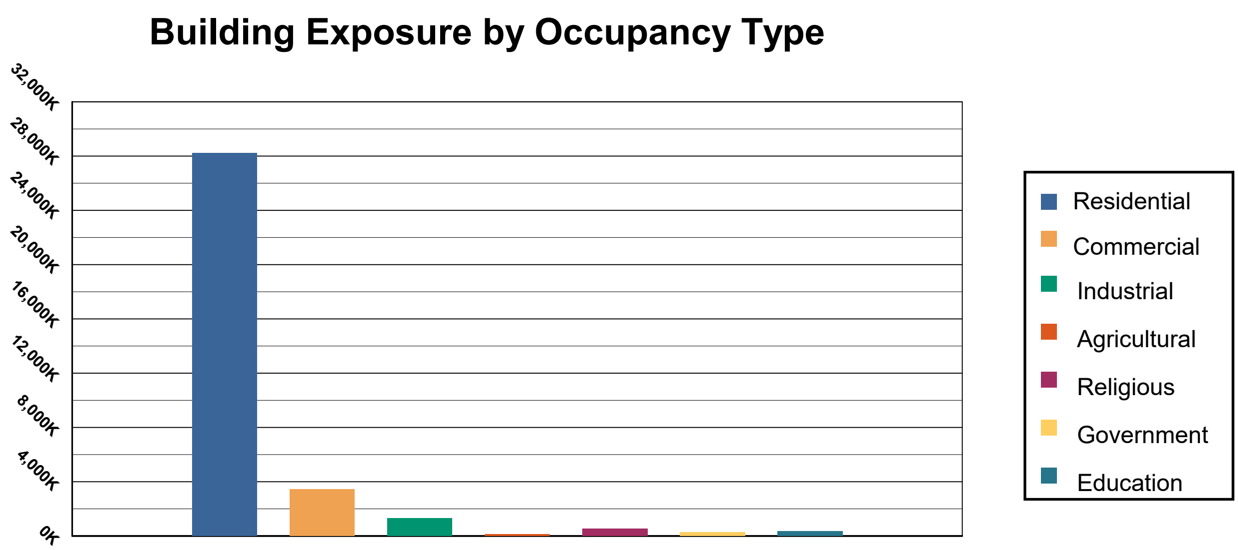

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Government	258,351	0.75%
Education	345,065	1.01%
Total	**34,232,307**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 97 schools, 31 fire stations, 11 police stations and 2 emergency operation facilities.

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Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
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General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

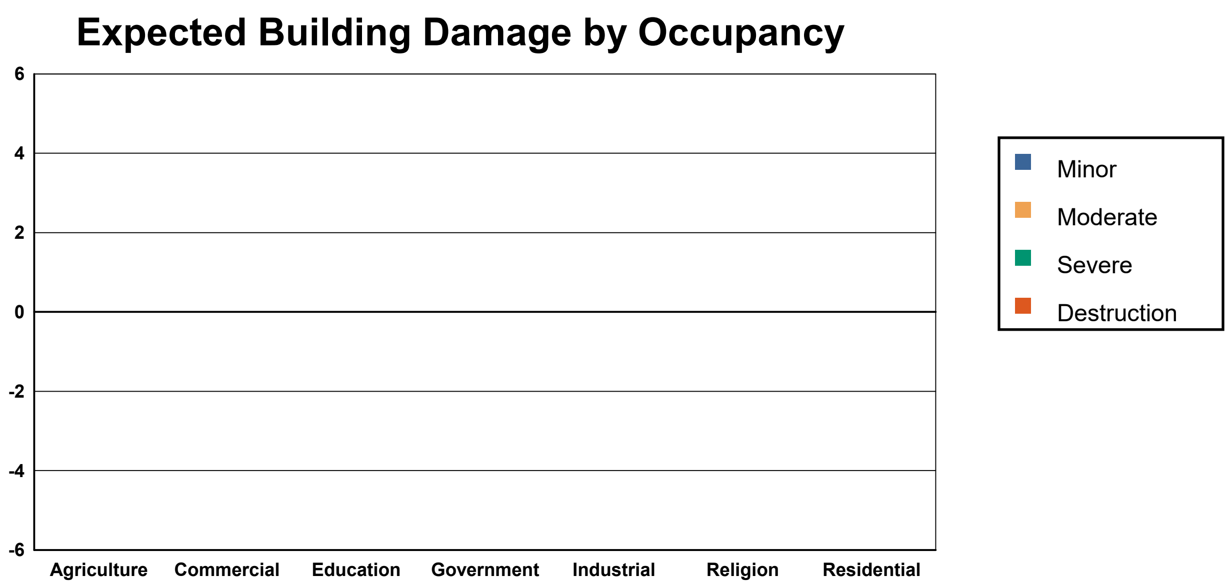

Table 2: Expected Building Damage by Occupancy : 20 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	452.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	4,574.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Education	171.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government	203.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industrial	1,544.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Religion	559.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential	77,638.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**85,141.00**		**0.00**		**0.00**		**0.00**		**0.00**	

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Table 3: Expected Building Damage by Building Type : 20 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	790	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	22,525	100.00	0	0.00	0	0.00	0	0.00	0	0.00
MH	571	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	3,125	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	54,732	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 308 hospital beds available for use. On the day of the hurricane, the model estimates that 308 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

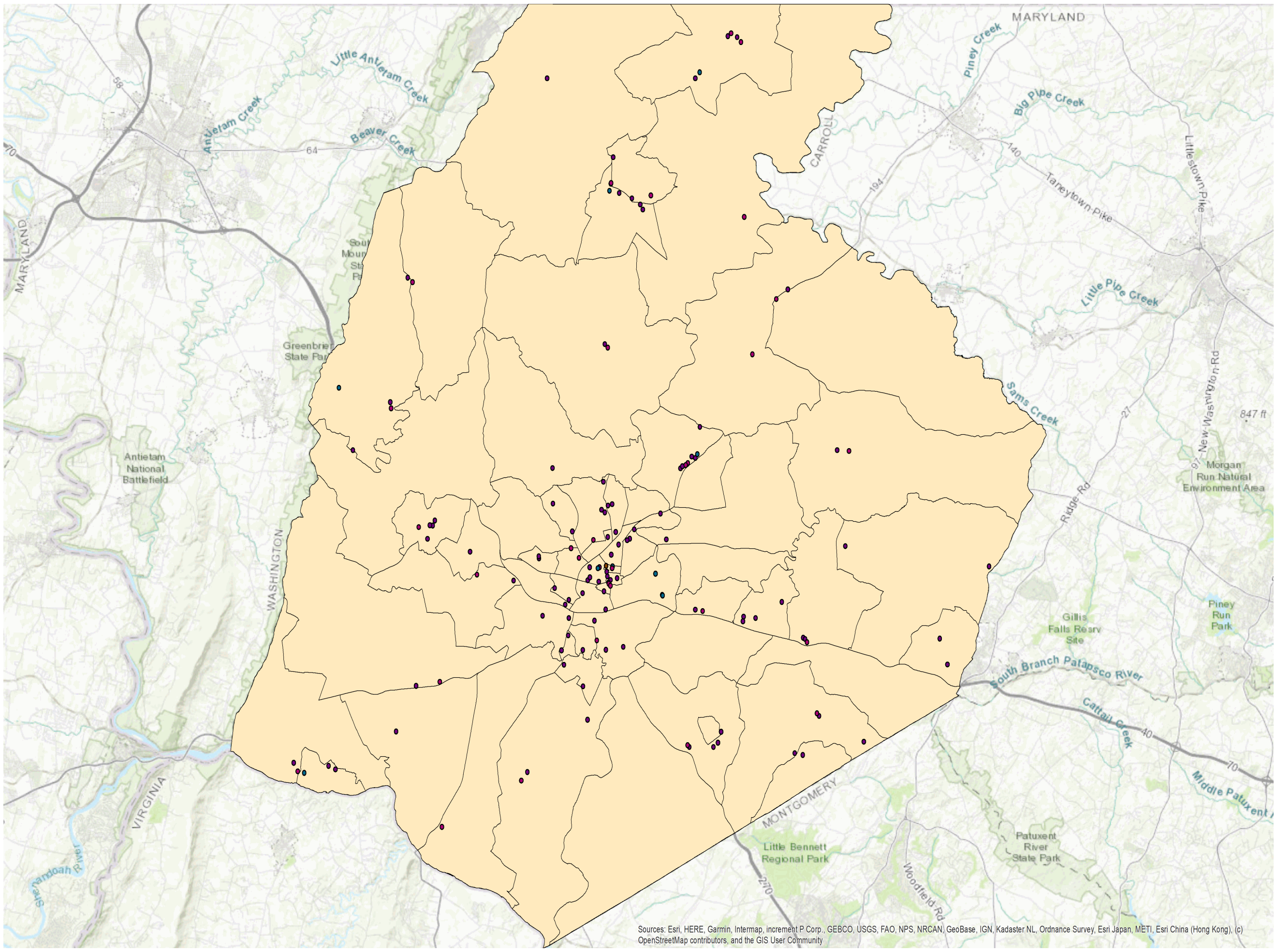
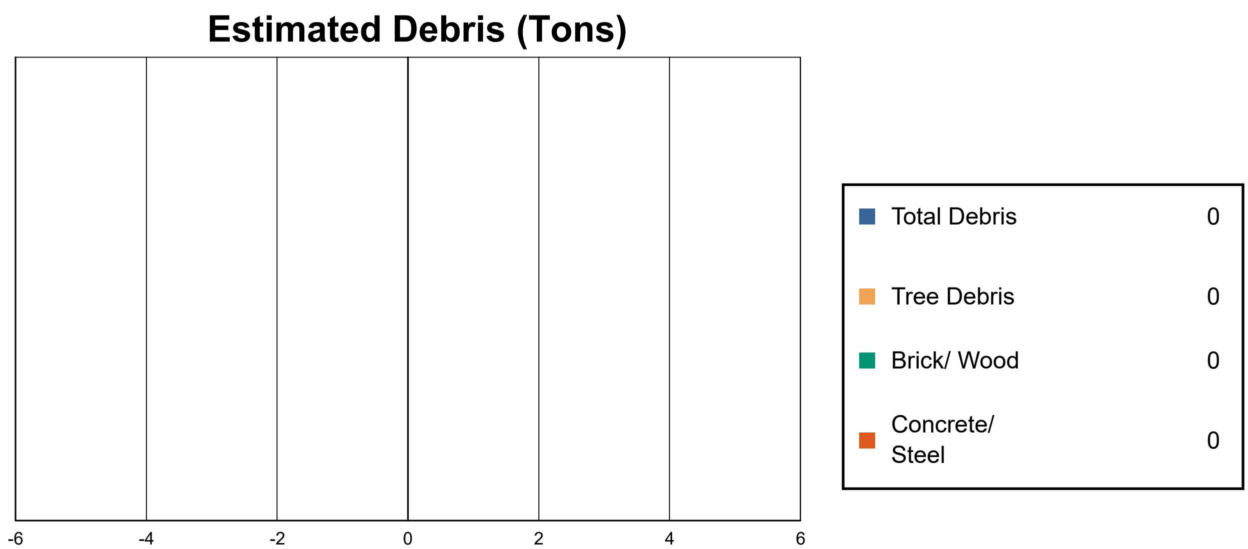


Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	2	0	0	2
Fire Stations	31	0	0	31
Hospitals	1	0	0	1
Police Stations	11	0	0	11
Schools	97	0	0	97

Induced Hurricane Damage

Debris Generation

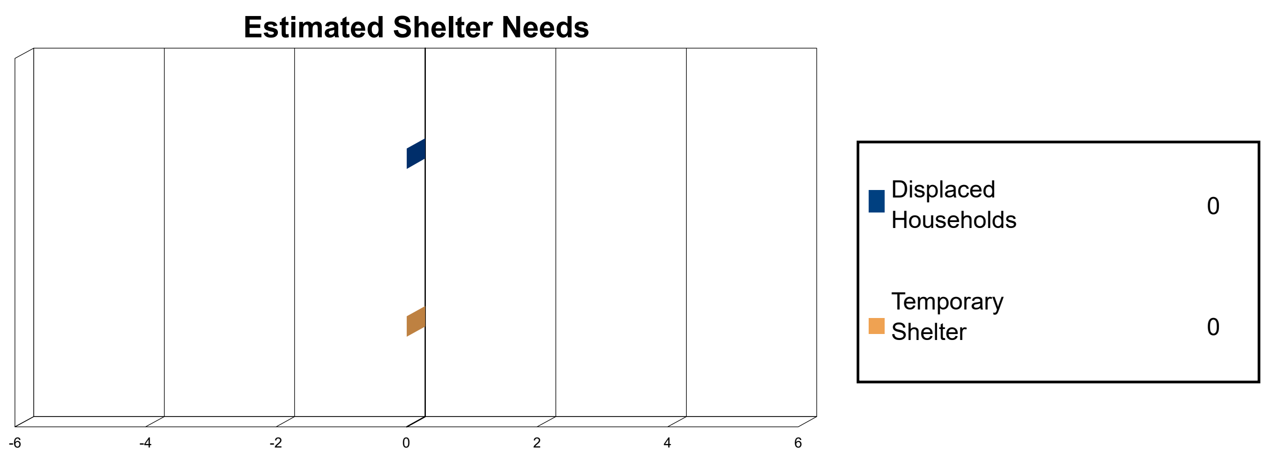


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 0 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 233,385) will seek temporary shelter in public shelters.

Economic Loss

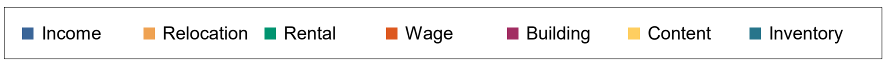
The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 0% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left)
and Building Damage Type (right)



Loss Type by General Occupancy

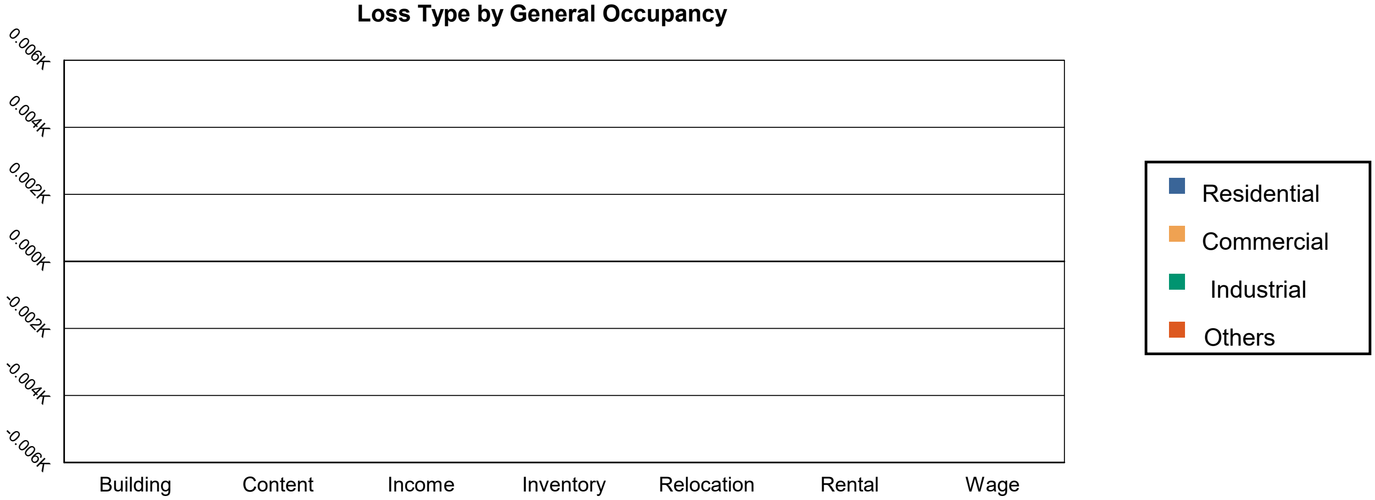


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	0.00	0.00	0.00	0.00	0.00
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

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<u>Total</u>

Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	233,385	28,211,495	6,020,812	34,232,307
Total	**233,385**	**28,211,495**	**6,020,812**	**34,232,307**
Study Region Total	**233,385**	**28,211,495**	**6,020,812**	**34,232,307**

Hazus: Hurricane Global Risk Report

Region Name: FrederickMD_HUR

Hurricane Scenario: Probabilistic 50-year Return Period

Print Date: Tuesday, August 3, 2021

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

HAZUS EARTHQUAKE • WIND • FLOOD • TSUNAMI

FEMA

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 667.37 square miles and contains 61 census tracts. There are over 84 thousand households in the region and a total population of 233,385 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 85 thousand buildings in the region with a total building replacement value (excluding contents) of 34,232 million dollars (2014 dollars). Approximately 91% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 85,141 buildings in the region which have an aggregate total replacement value of 34,232 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

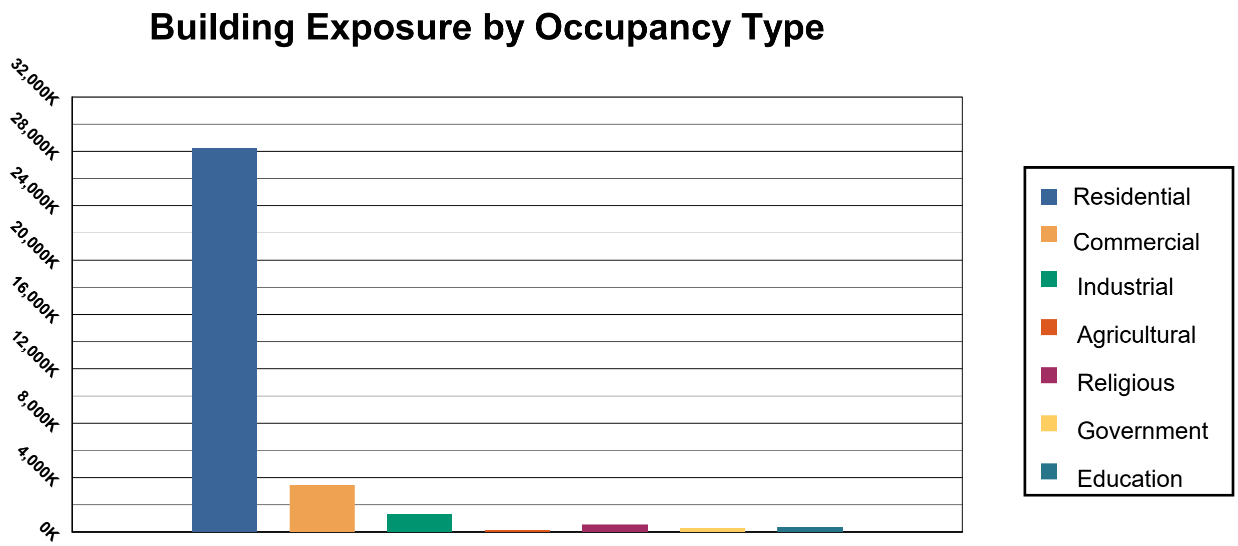


Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	28,211,495	82.41%
Commercial	3,448,470	10.07%
Industrial	1,321,984	3.86%
Agricultural	135,374	0.40%
Religious	511,568	1.49%
Government	258,351	0.75%
Education	345,065	1.01%
Total	**34,232,307**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 97 schools, 31 fire stations, 11 police stations and 2 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

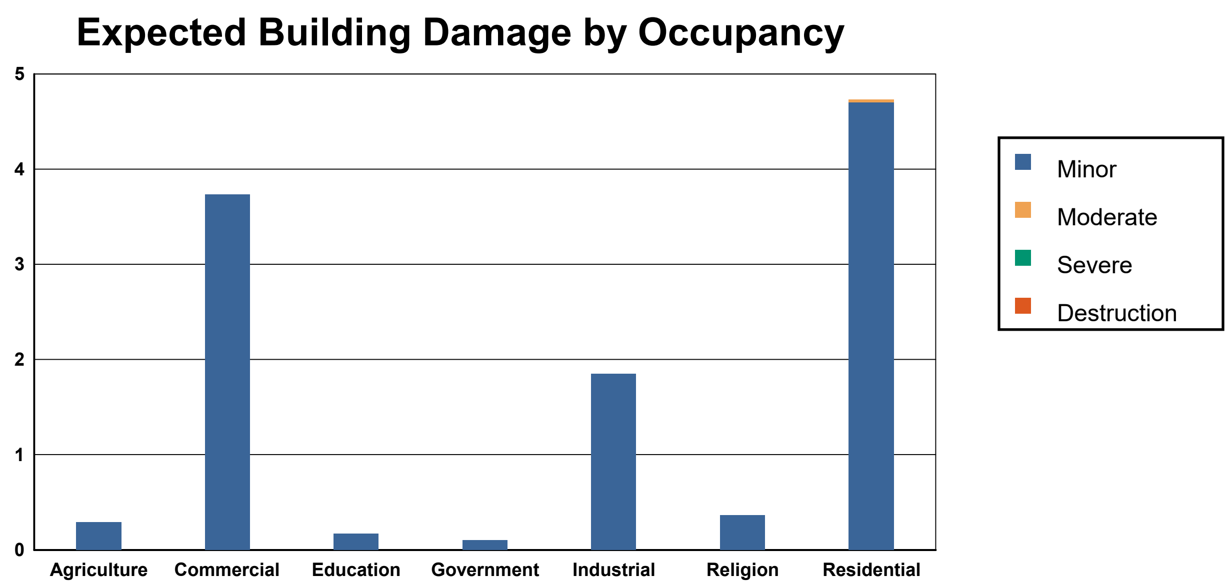


Table 2: Expected Building Damage by Occupancy : 50 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	451.71	99.94	0.29	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	4,570.27	99.92	3.73	0.08	0.00	0.00	0.00	0.00	0.00	0.00
Education	170.83	99.90	0.17	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Government	202.90	99.95	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Industrial	1,542.15	99.88	1.85	0.12	0.00	0.00	0.00	0.00	0.00	0.00
Religion	558.63	99.93	0.37	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Residential	77,633.26	99.99	4.70	0.01	0.03	0.00	0.00	0.00	0.00	0.00
Total	**85,129.76**		**11.21**		**0.03**		**0.00**		**0.00**	

Table 3: Expected Building Damage by Building Type : 50 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	789	99.88	1	0.12	0	0.00	0	0.00	0	0.00
Masonry	22,519	99.97	6	0.03	0	0.00	0	0.00	0	0.00
MH	571	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	3,122	99.90	3	0.10	0	0.00	0	0.00	0	0.00
Wood	54,732	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 308 hospital beds available for use. On the day of the hurricane, the model estimates that 308 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

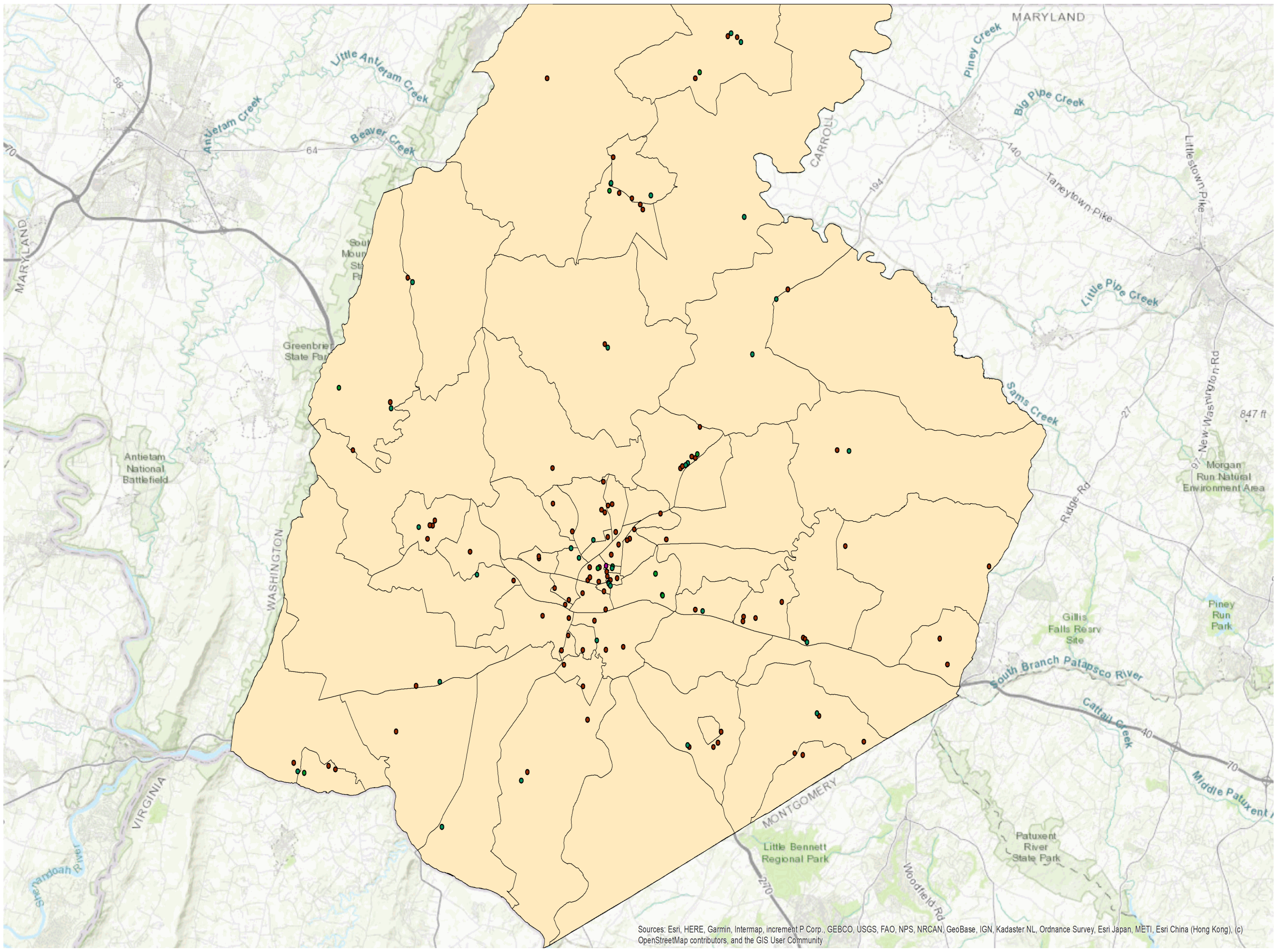
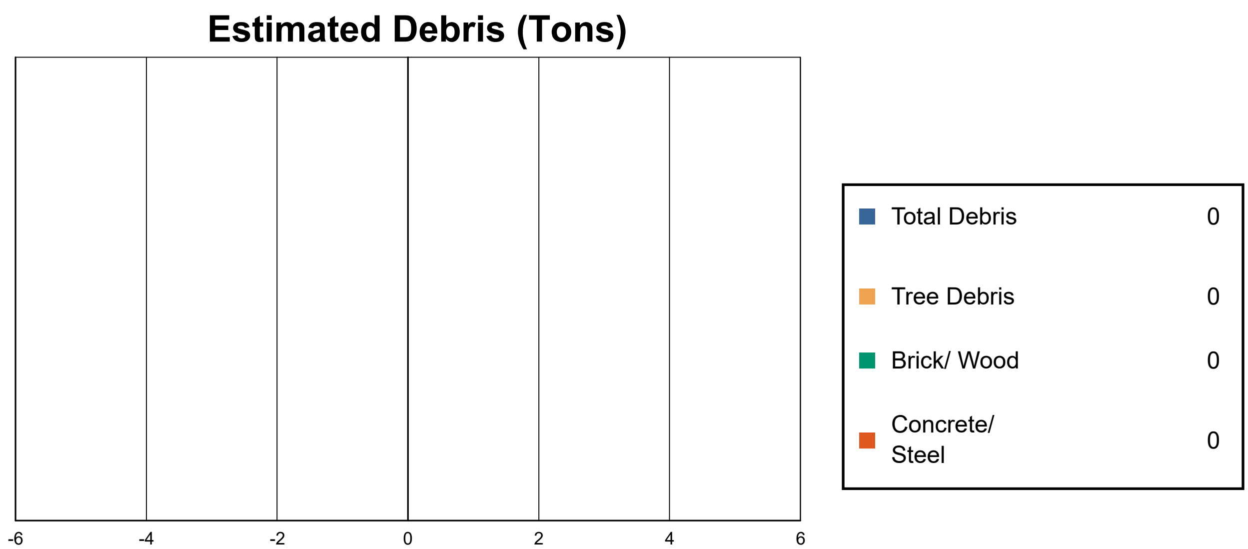


Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	2	0	0	2
Fire Stations	31	0	0	31
Hospitals	1	0	0	1
Police Stations	11	0	0	11
Schools	97	0	0	97

Induced Hurricane Damage

Debris Generation

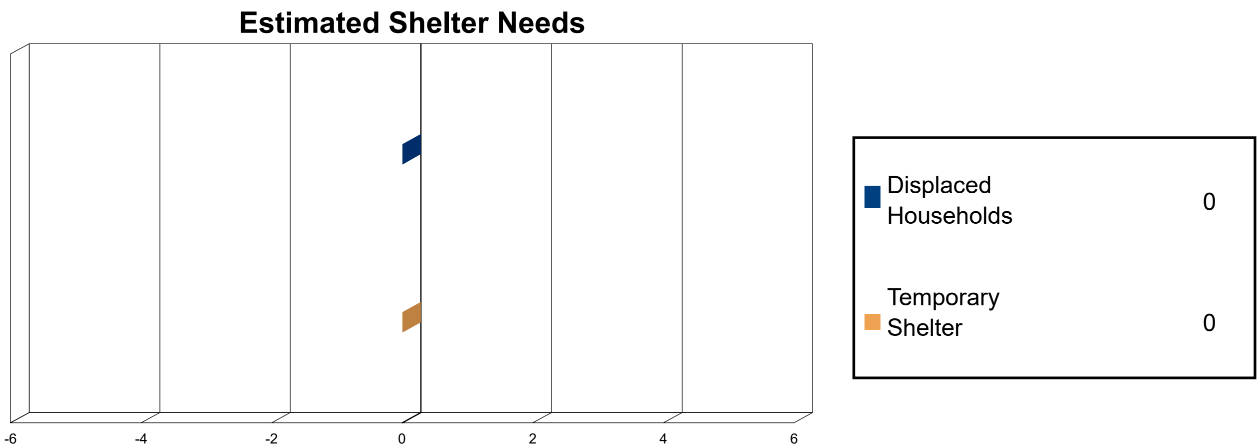


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 0 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 233,385) will seek temporary shelter in public shelters.

Economic Loss

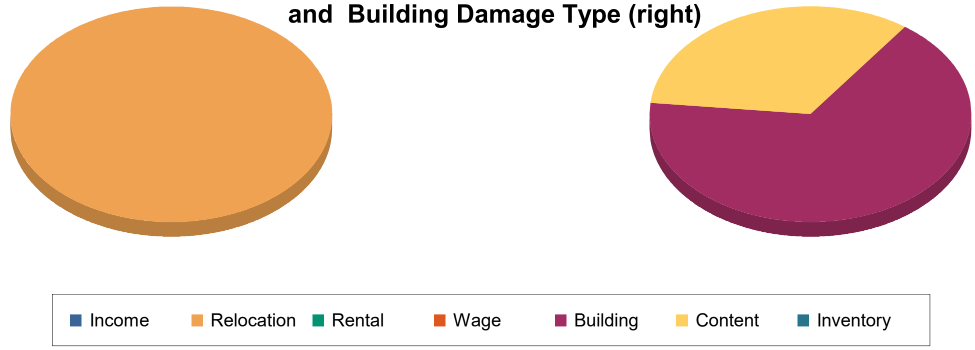
The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 2% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 100% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left)
and Building Damage Type (right)



Loss Type by General Occupancy

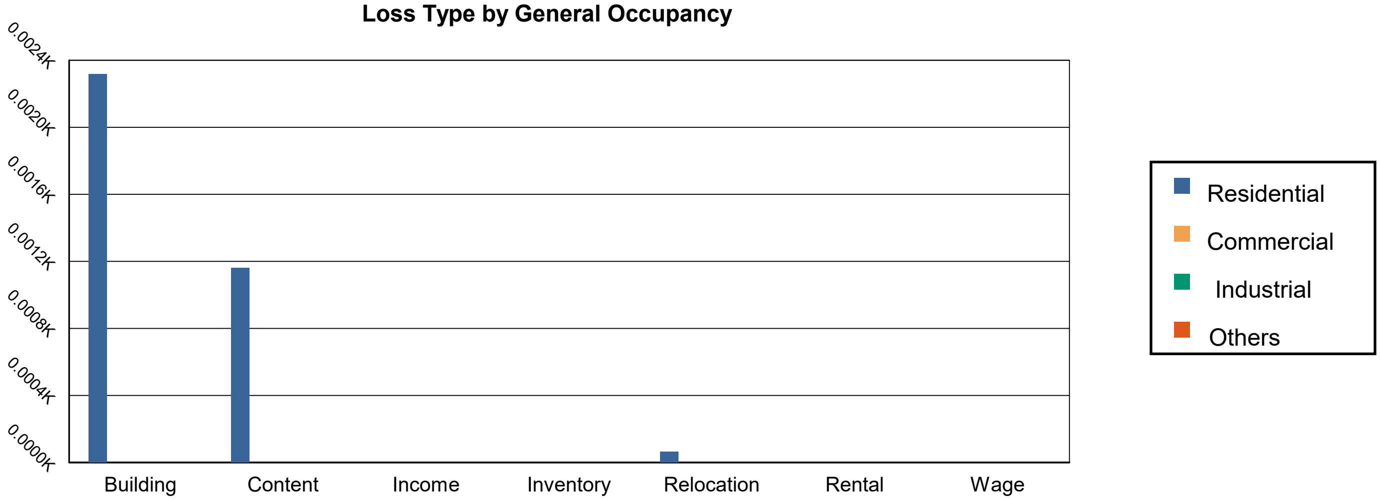


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	2.32	0.00	0.00	0.00	2.32
	Content	1.16	0.00	0.00	0.00	1.16
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**3.48**	**0.00**	**0.00**	**0.00**	**3.48**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.06	0.00	0.00	0.00	0.06
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.06**	**0.00**	**0.00**	**0.00**	**0.06**

Total

Total	**3.54**	**0.00**	**0.00**	**0.00**	**3.54**

Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

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Hazus: Hurricane Global Risk Report

Region Name: FrederickMD_HUR

Hurricane Scenario: Probabilistic 100-year Return Period

Print Date: Tuesday, August 3, 2021

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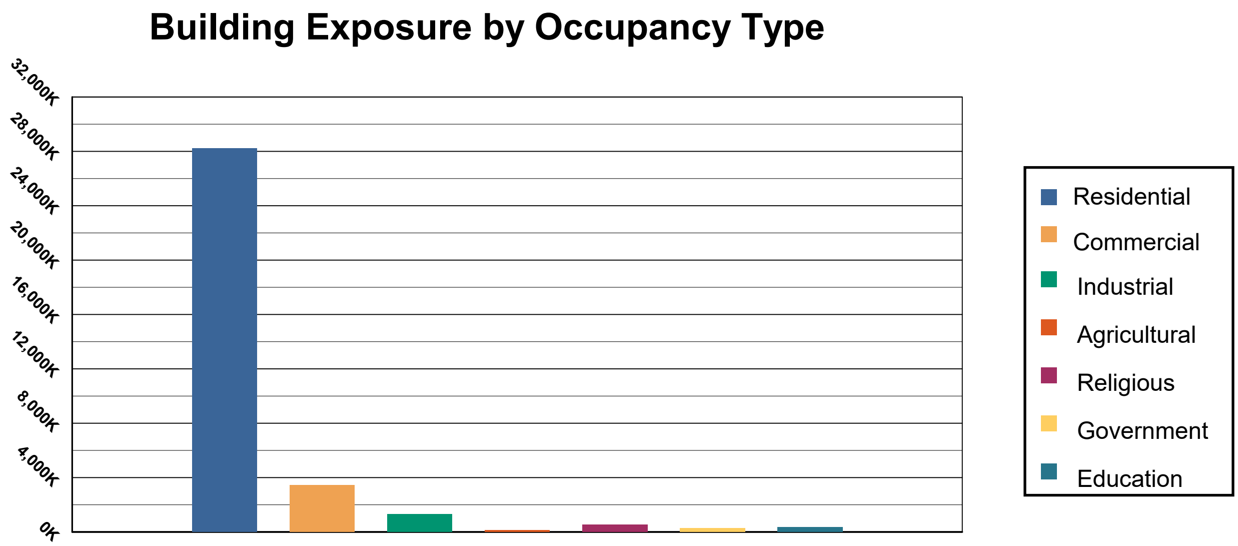

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General Building Stock Damage

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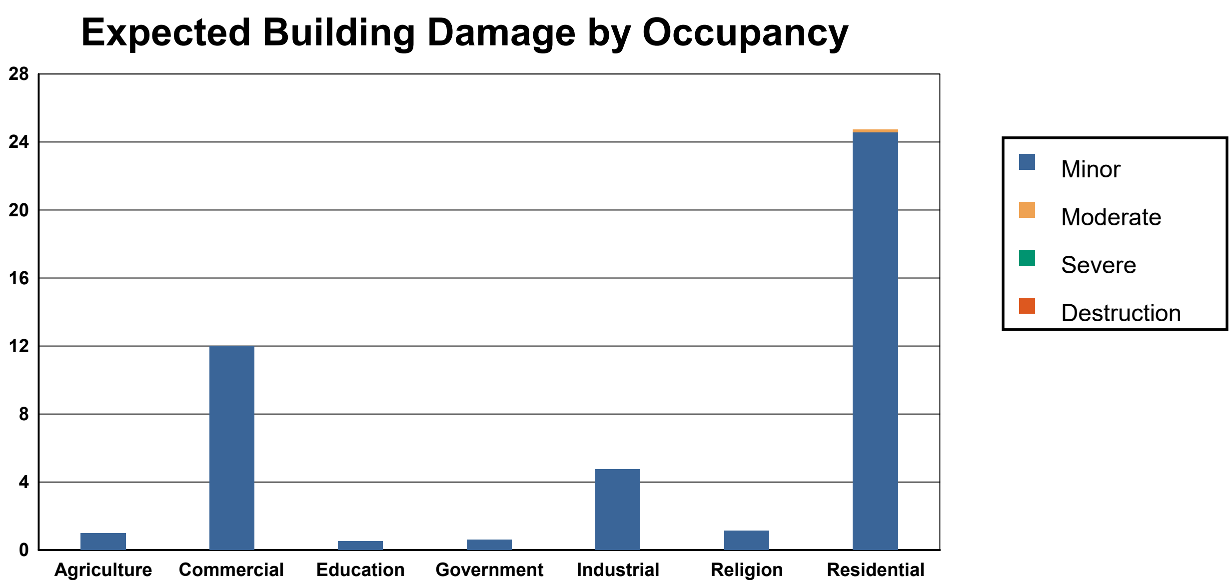


Table 2: Expected Building Damage by Occupancy : 100 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	451.03	99.78	0.97	0.22	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	4,562.02	99.74	11.98	0.26	0.00	0.00	0.00	0.00	0.00	0.00
Education	170.50	99.70	0.50	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Government	202.40	99.71	0.60	0.29	0.00	0.00	0.00	0.00	0.00	0.00
Industrial	1,539.28	99.69	4.72	0.31	0.00	0.00	0.00	0.00	0.00	0.00
Religion	557.86	99.80	1.14	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Residential	77,613.26	99.97	24.57	0.03	0.17	0.00	0.00	0.00	0.00	0.00
Total	**85,096.35**		**44.47**		**0.17**		**0.00**		**0.00**	

Table 3: Expected Building Damage by Building Type : 100 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	787	99.66	3	0.34	0	0.00	0	0.00	0	0.00
Masonry	22,501	99.89	24	0.10	0	0.00	0	0.00	0	0.00
MH	571	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	3,115	99.68	10	0.32	0	0.00	0	0.00	0	0.00
Wood	54,728	99.99	4	0.01	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 308 hospital beds available for use. On the day of the hurricane, the model estimates that 308 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

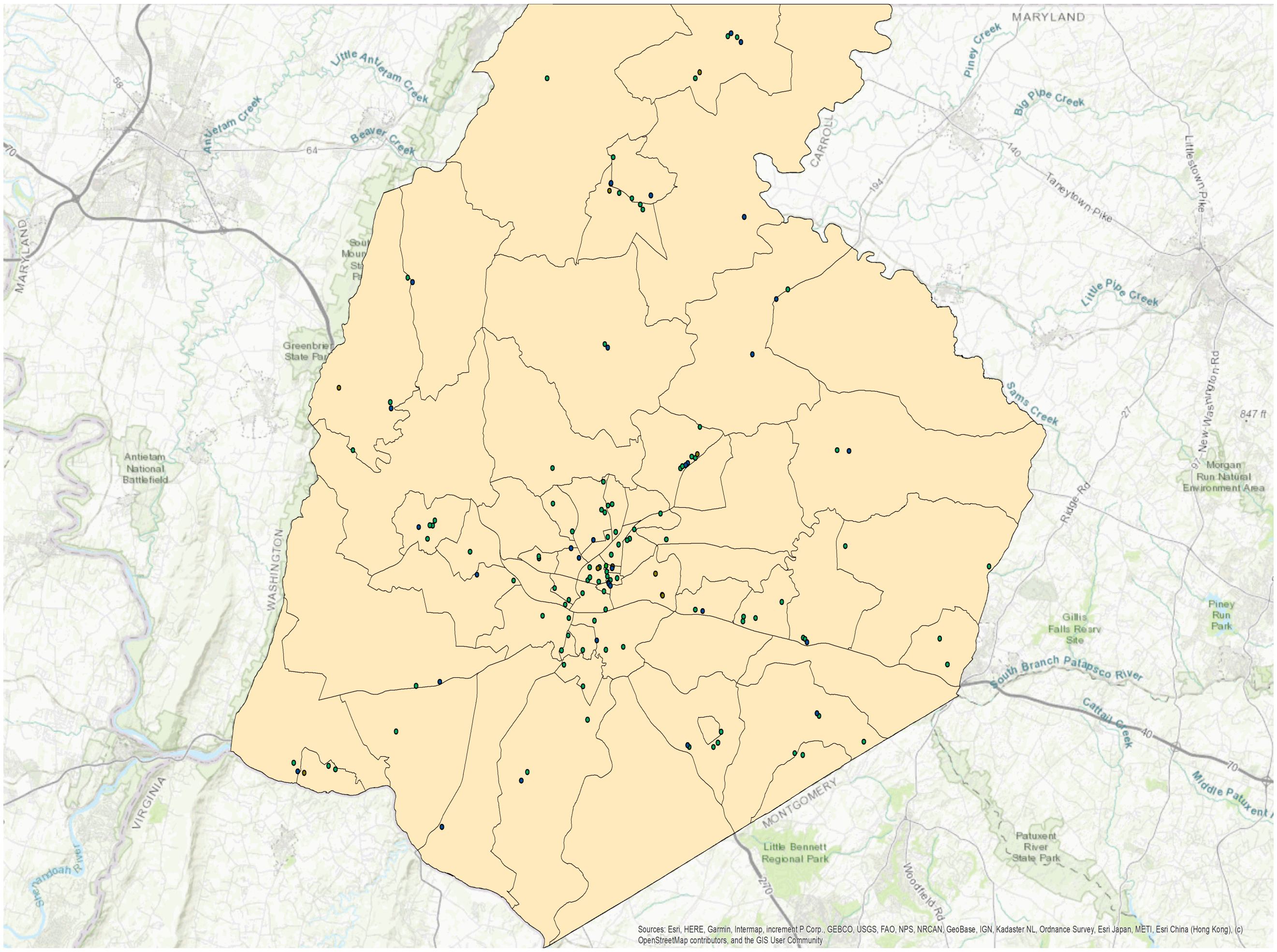
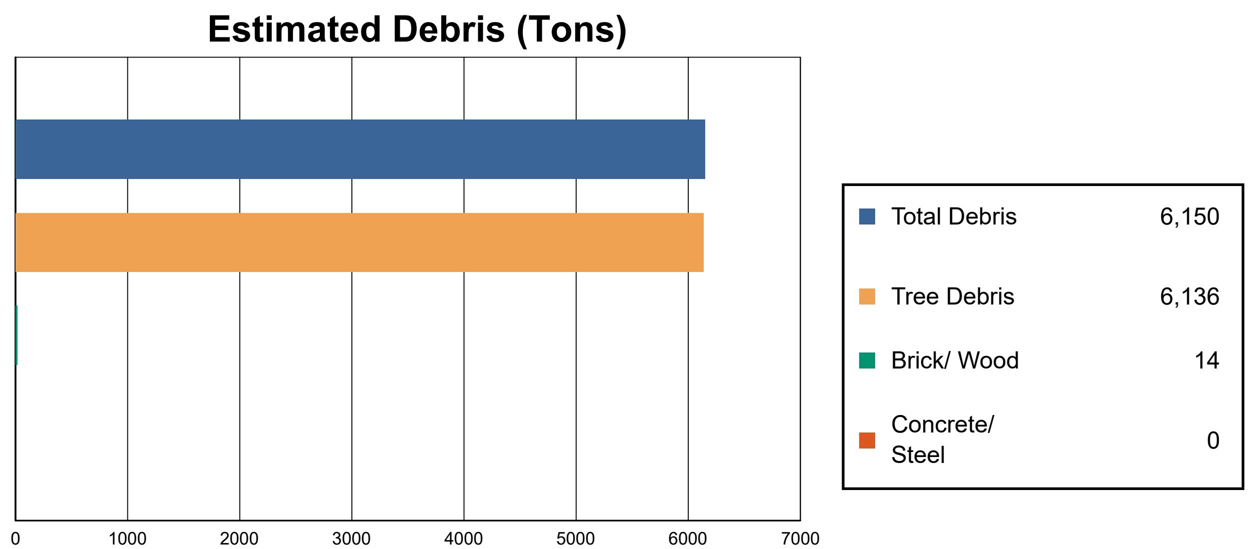


Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	2	0	0	2
Fire Stations	31	0	0	31
Hospitals	1	0	0	1
Police Stations	11	0	0	11
Schools	97	0	0	97

Induced Hurricane Damage

Debris Generation

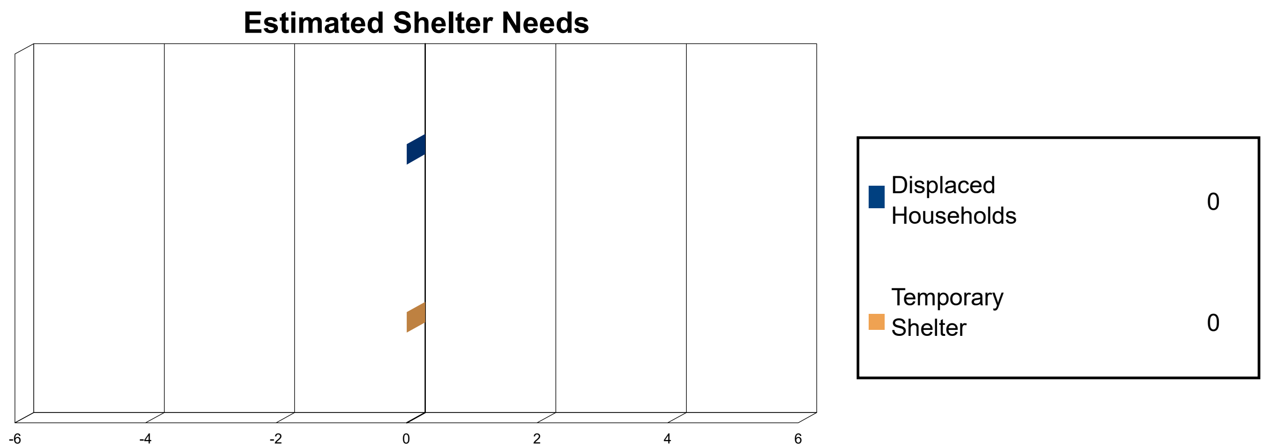


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 6,150 tons of debris will be generated. Of the total amount, 5,291 tons (86%) is Other Tree Debris. Of the remaining 859 tons, Brick/Wood comprises 2% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 1 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 845 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 233,385) will seek temporary shelter in public shelters.

Economic Loss

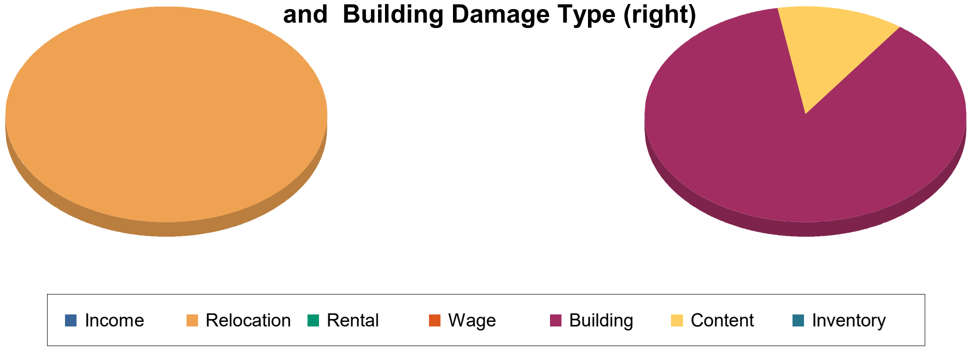
The total economic loss estimated for the hurricane is 4.1 million dollars, which represents 0.01 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 4 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 99% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left) and Building Damage Type (right)



Loss Type by General Occupancy

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	3,532.92	29.87	13.13	11.38	3,587.30
	Content	527.57	0.00	0.00	0.00	527.57
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**4,060.49**	**29.87**	**13.13**	**11.38**	**4,114.87**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.36	0.00	0.00	0.00	0.37
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.36**	**0.00**	**0.00**	**0.00**	**0.37**

Total

Total	**4,060.85**	**29.87**	**13.13**	**11.38**	**4,115.24**

Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

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Hazus: Hurricane Global Risk Report

Region Name: FrederickMD_HUR

Hurricane Scenario: Probabilistic 200-year Return Period

Print Date: Tuesday, August 3, 2021

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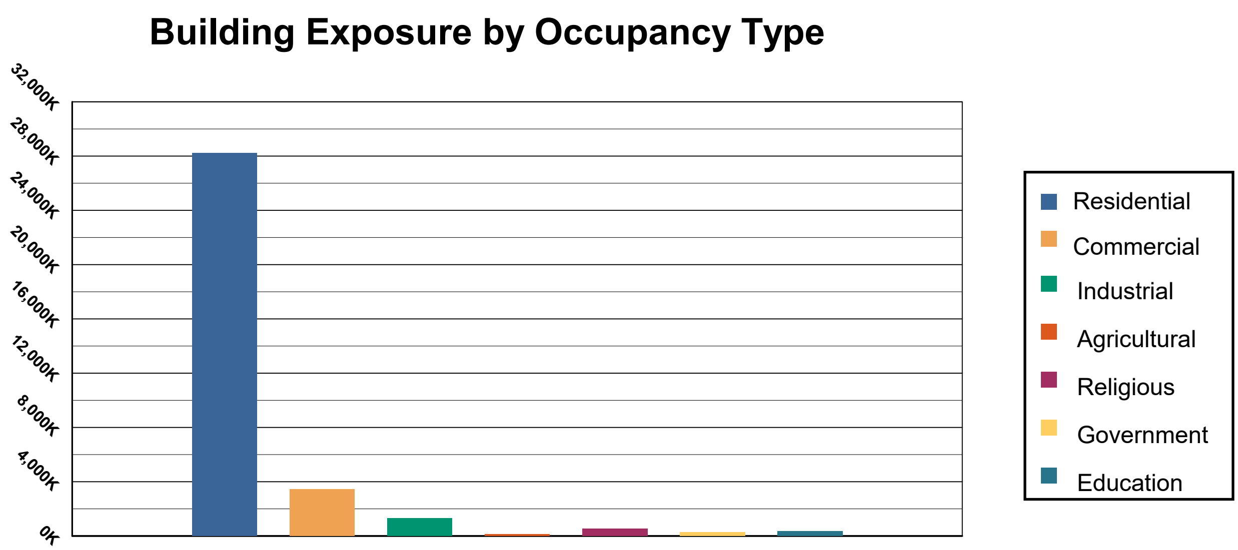

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Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 97 schools, 31 fire stations, 11 police stations and 2 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 2 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

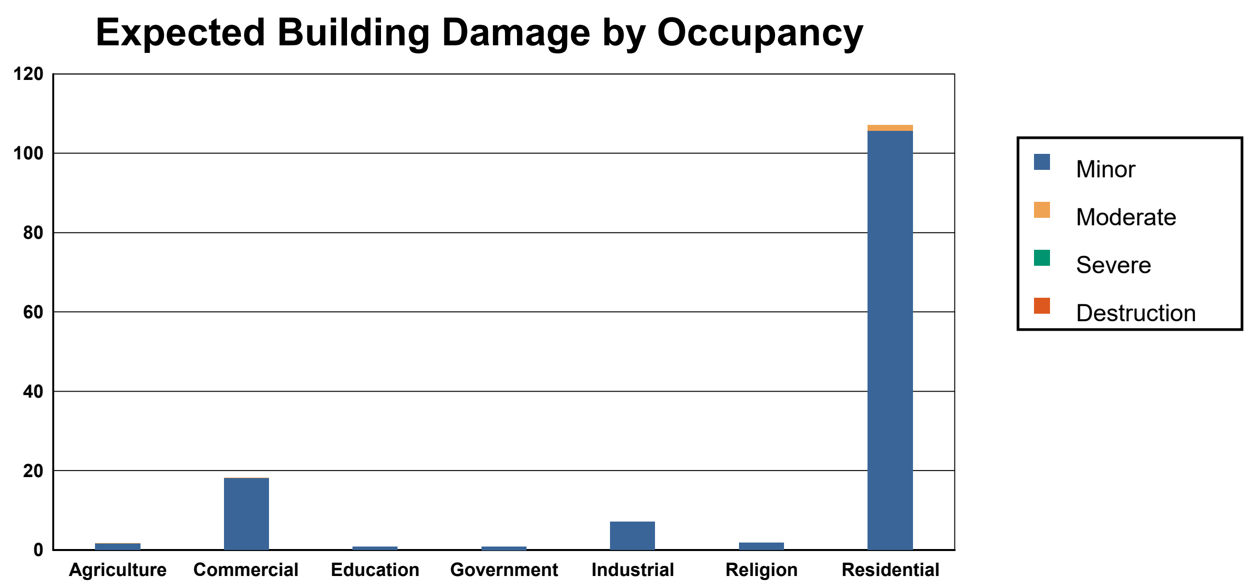


Table 2: Expected Building Damage by Occupancy : 200 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	450.27	99.62	1.68	0.37	0.04	0.01	0.01	0.00	0.00	0.00
Commercial	4,555.73	99.60	18.18	0.40	0.09	0.00	0.00	0.00	0.00	0.00
Education	170.24	99.55	0.76	0.45	0.00	0.00	0.00	0.00	0.00	0.00
Government	202.11	99.56	0.89	0.44	0.00	0.00	0.00	0.00	0.00	0.00
Industrial	1,536.85	99.54	7.14	0.46	0.02	0.00	0.00	0.00	0.00	0.00
Religion	557.26	99.69	1.74	0.31	0.00	0.00	0.00	0.00	0.00	0.00
Residential	77,530.84	99.86	105.69	0.14	1.46	0.00	0.00	0.00	0.00	0.00
Total	**85,003.30**		**136.08**		**1.62**		**0.01**		**0.00**	

Table 3: Expected Building Damage by Building Type : 200 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	786	99.48	4	0.52	0	0.00	0	0.00	0	0.00
Masonry	22,467	99.74	57	0.25	1	0.01	0	0.00	0	0.00
MH	571	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	3,110	99.52	15	0.48	0	0.00	0	0.00	0	0.00
Wood	54,681	99.91	51	0.09	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 308 hospital beds available for use. On the day of the hurricane, the model estimates that 308 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

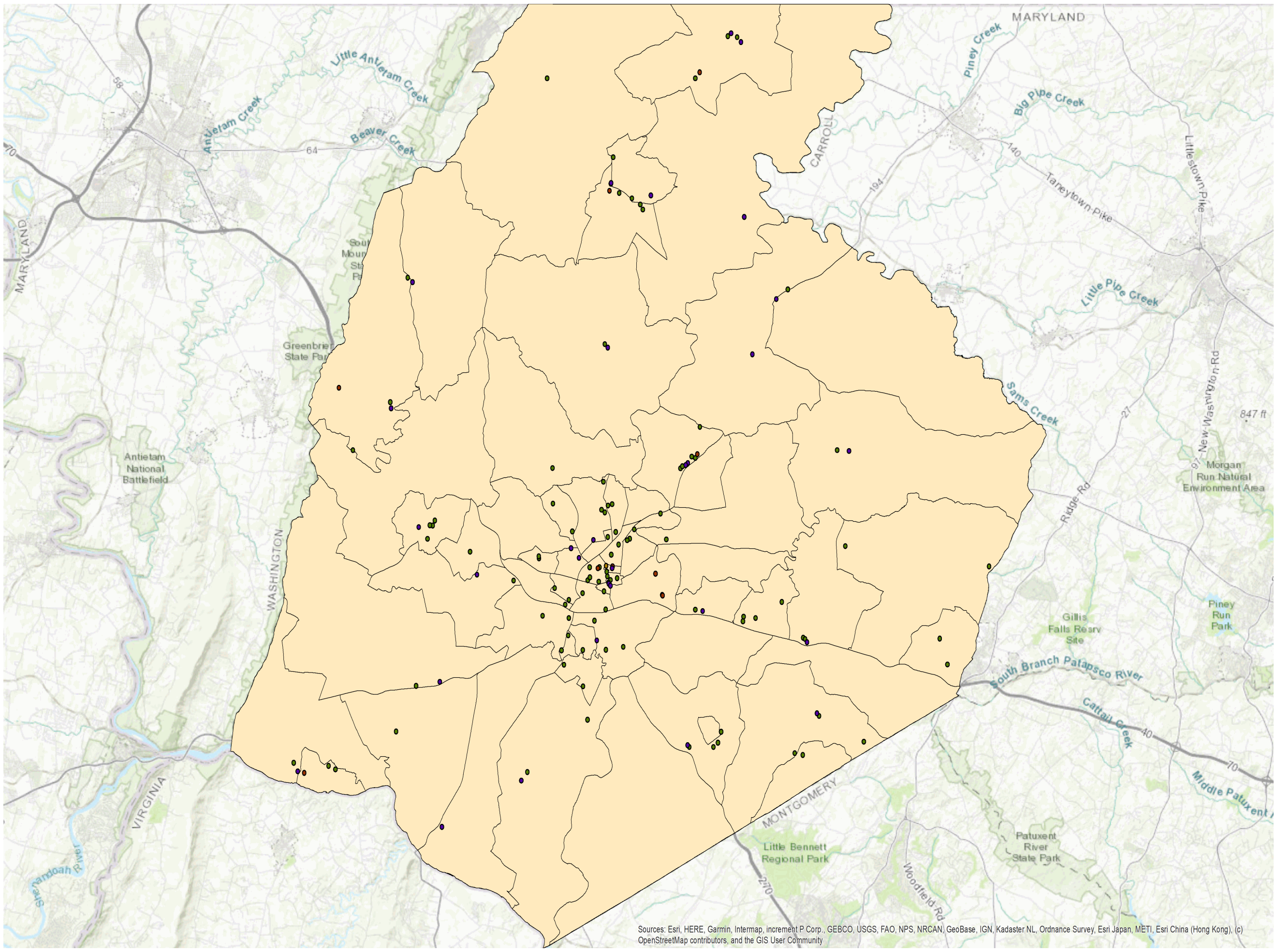
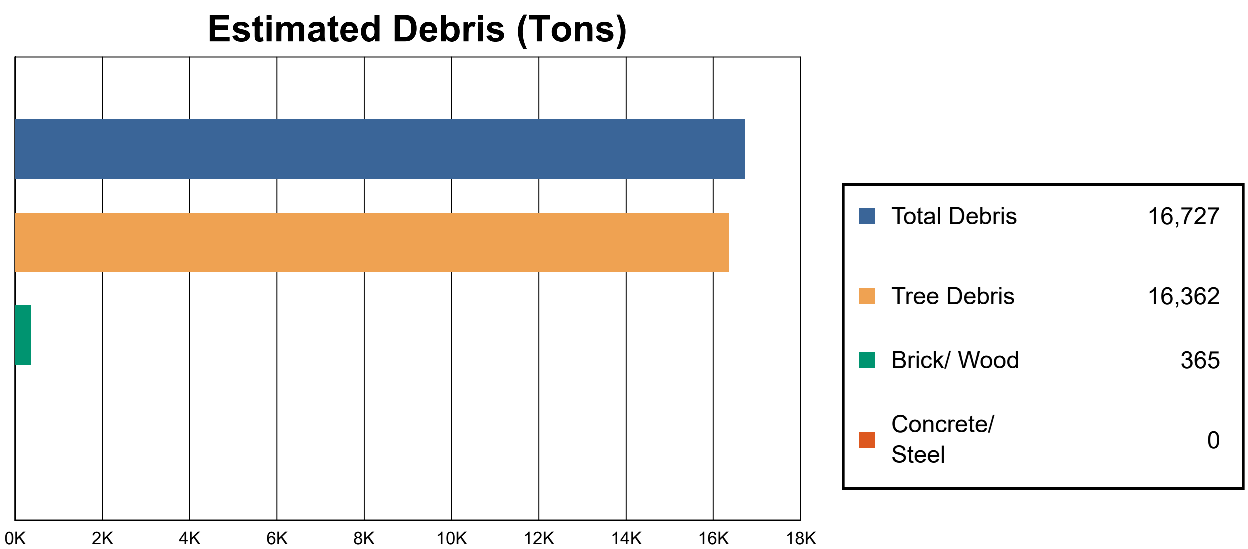


Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	2	0	0	2
Fire Stations	31	0	0	31
Hospitals	1	0	0	1
Police Stations	11	0	0	11
Schools	97	0	0	97

Induced Hurricane Damage

Debris Generation

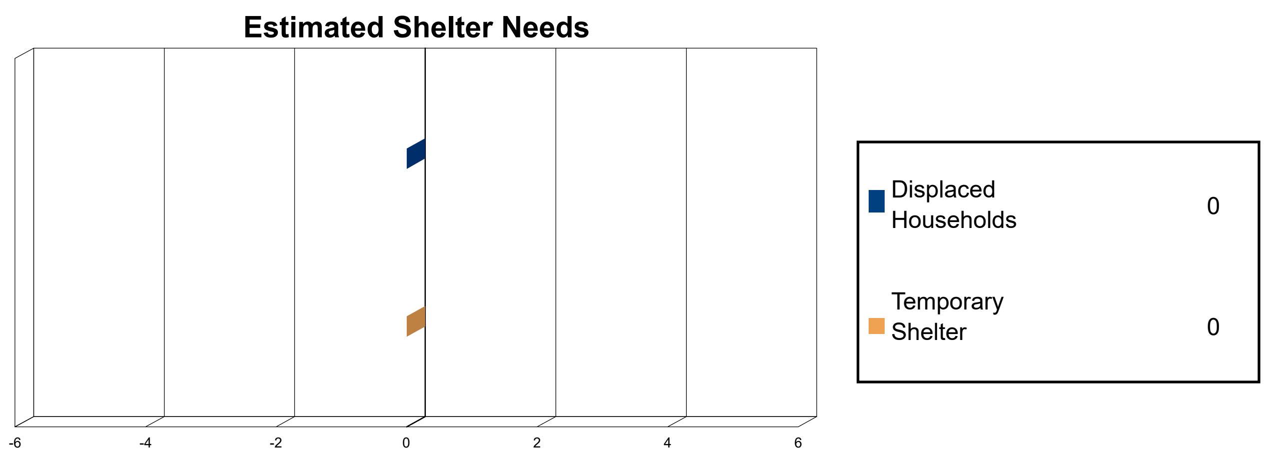


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 16,727 tons of debris will be generated. Of the total amount, 14,067 tons (84%) is Other Tree Debris. Of the remaining 2,660 tons, Brick/Wood comprises 14% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 15 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,295 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 233,385) will seek temporary shelter in public shelters.

Economic Loss

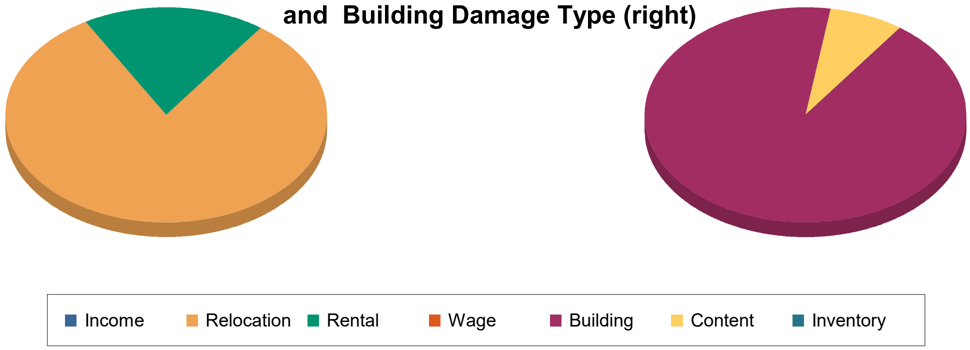
The total economic loss estimated for the hurricane is 19.4 million dollars, which represents 0.06 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 19 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 97% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left)
and Building Damage Type (right)



Loss Type by General Occupancy

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	17,343.25	337.75	131.31	116.33	17,928.64
	Content	1,436.76	0.00	0.01	0.12	1,436.89
	Inventory	0.00	0.00	0.00	0.01	0.02
	Subtotal	**18,780.01**	**337.75**	**131.33**	**116.46**	**19,365.55**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	9.96	0.48	0.02	0.12	10.58
	Rental	2.39	0.00	0.00	0.00	2.39
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**12.35**	**0.48**	**0.02**	**0.12**	**12.97**

Total

Total	**18,792.37**	**338.24**	**131.34**	**116.58**	**19,378.52**

Appendix A: County Listing for the Region

Maryland
- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	233,385	28,211,495	6,020,812	34,232,307
Total	**233,385**	**28,211,495**	**6,020,812**	**34,232,307**
Study Region Total	**233,385**	**28,211,495**	**6,020,812**	**34,232,307**

Hazus: Hurricane Global Risk Report

Region Name: FrederickMD_HUR

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date: Tuesday, August 3, 2021

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 667.37 square miles and contains 61 census tracts. There are over 84 thousand households in the region and a total population of 233,385 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 85 thousand buildings in the region with a total building replacement value (excluding contents) of 34,232 million dollars (2014 dollars). Approximately 91% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 85,141 buildings in the region which have an aggregate total replacement value of 34,232 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

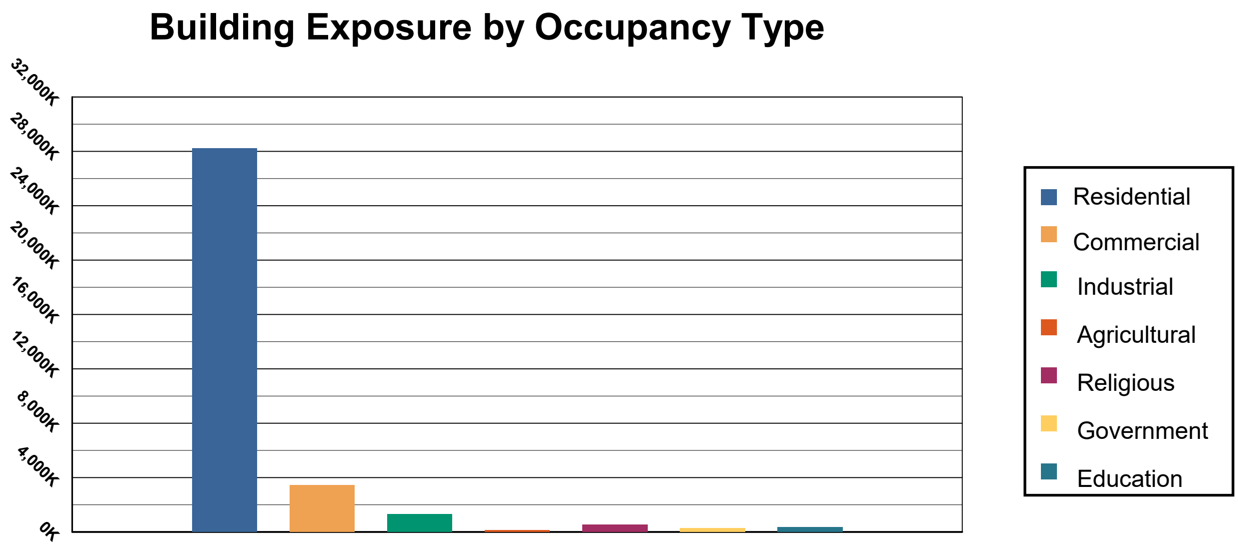


Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	28,211,495	82.41%
Commercial	3,448,470	10.07%
Industrial	1,321,984	3.86%
Agricultural	135,374	0.40%
Religious	511,568	1.49%
Government	258,351	0.75%
Education	345,065	1.01%
Total	**34,232,307**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 97 schools, 31 fire stations, 11 police stations and 2 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 25 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

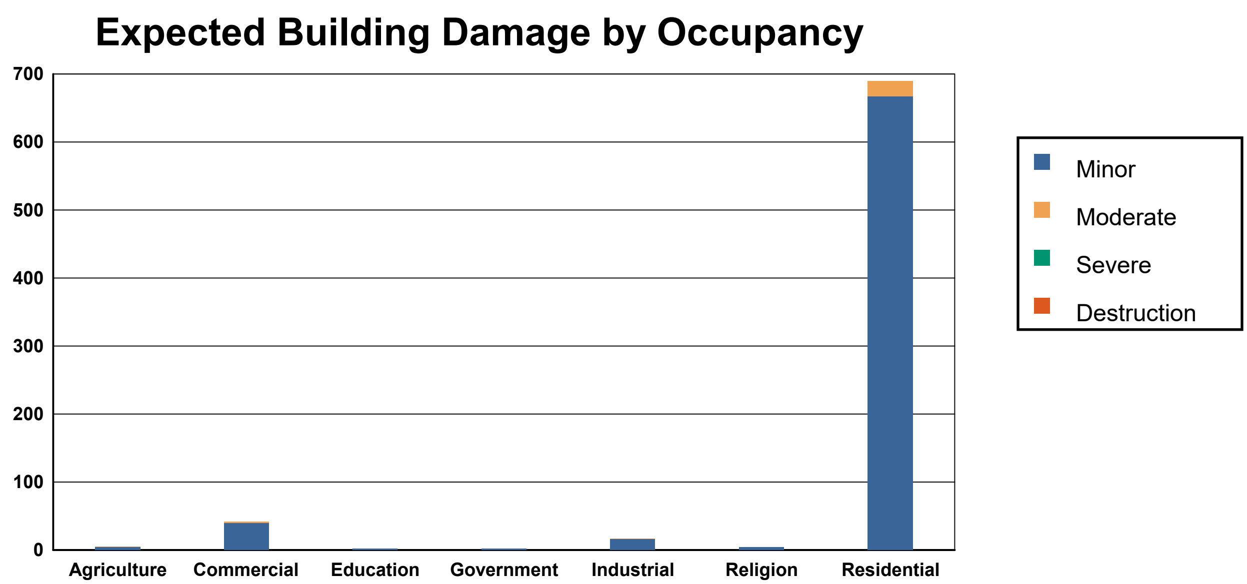


Table 2: Expected Building Damage by Occupancy : 500 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	446.97	98.89	4.55	1.01	0.34	0.08	0.13	0.03	0.01	0.00
Commercial	4,532.42	99.09	39.92	0.87	1.60	0.03	0.06	0.00	0.00	0.00
Education	169.37	99.05	1.61	0.94	0.01	0.01	0.00	0.00	0.00	0.00
Government	201.15	99.09	1.84	0.91	0.02	0.01	0.00	0.00	0.00	0.00
Industrial	1,527.63	98.94	15.92	1.03	0.37	0.02	0.07	0.00	0.00	0.00
Religion	554.87	99.26	4.10	0.73	0.03	0.01	0.00	0.00	0.00	0.00
Residential	76,948.71	99.11	666.87	0.86	22.26	0.03	0.13	0.00	0.04	0.00
Total	**84,381.13**		**734.80**		**24.63**		**0.39**		**0.05**	

Table 3: Expected Building Damage by Building Type : 500 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	781	98.87	9	1.12	0	0.01	0	0.00	0	0.00
Masonry	22,271	98.87	239	1.06	15	0.07	0	0.00	0	0.00
MH	571	99.91	0	0.06	0	0.02	0	0.00	0	0.01
Steel	3,093	98.98	31	0.99	1	0.03	0	0.00	0	0.00
Wood	54,311	99.23	415	0.76	6	0.01	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 308 hospital beds available for use. On the day of the hurricane, the model estimates that 308 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

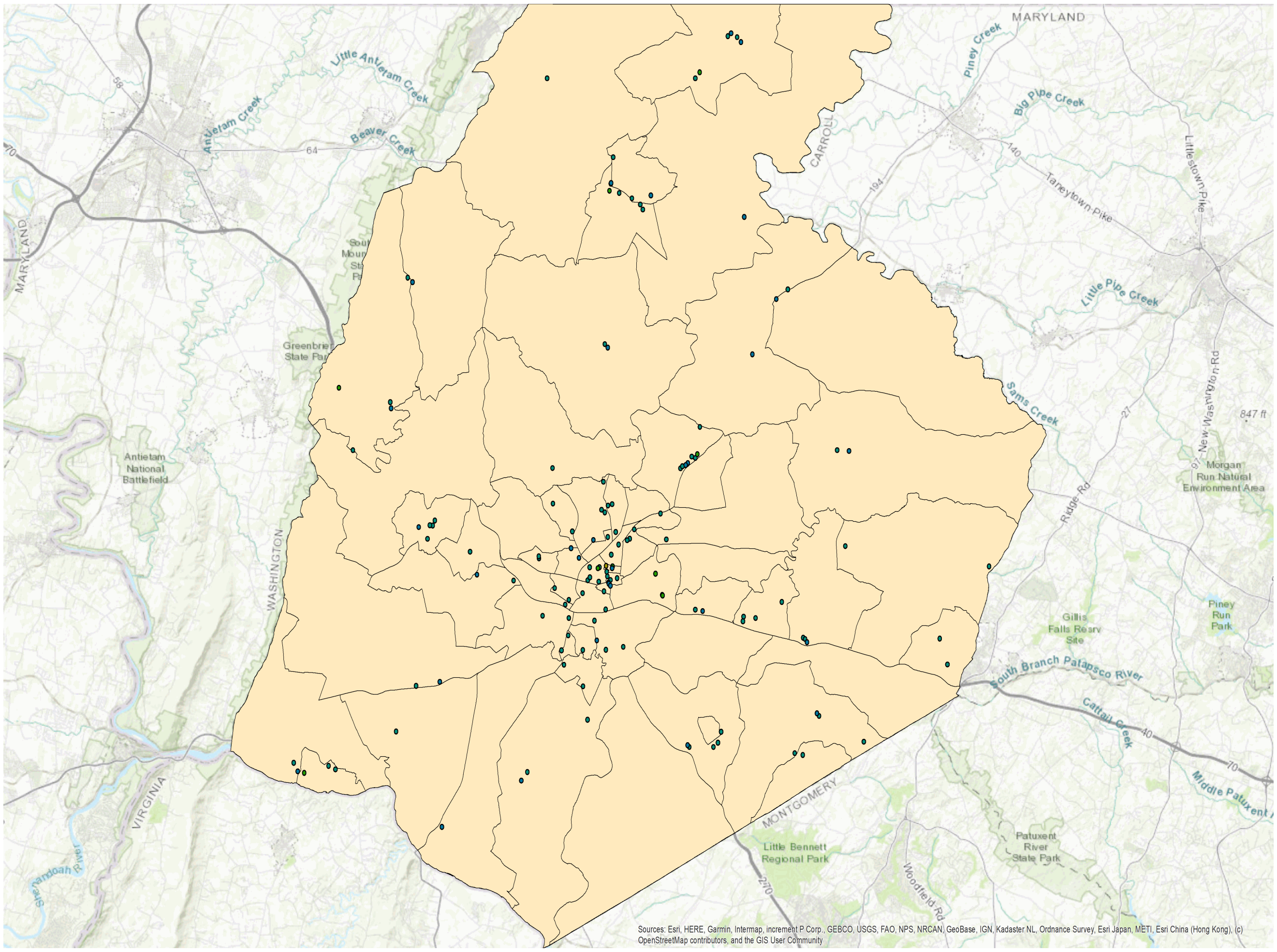
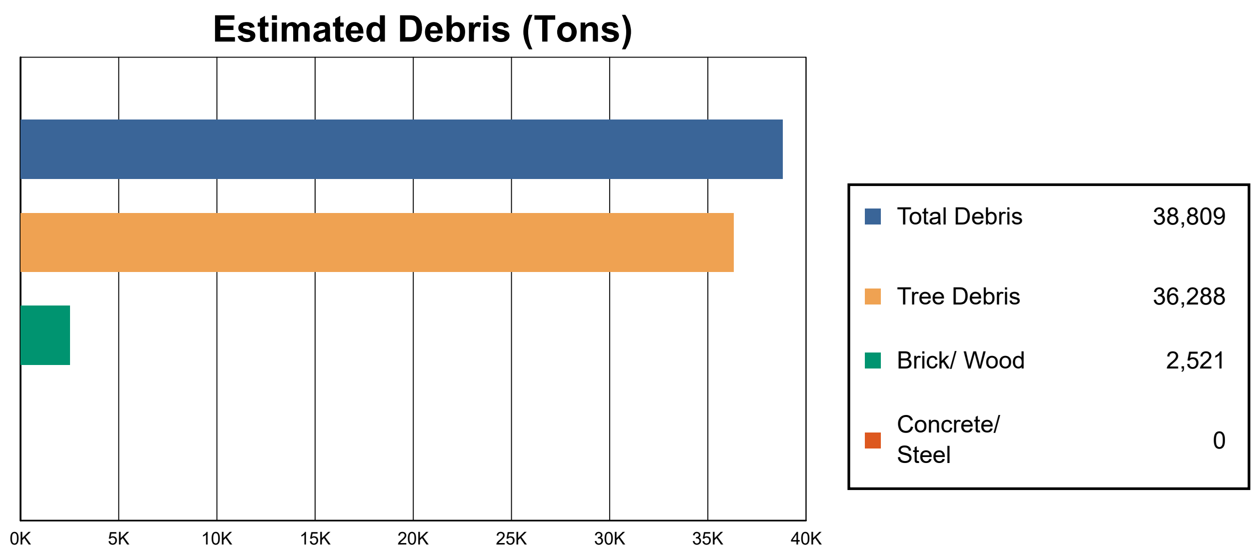


Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	2	0	0	2
Fire Stations	31	0	0	31
Hospitals	1	0	0	1
Police Stations	11	0	0	11
Schools	97	0	0	97

Induced Hurricane Damage

Debris Generation

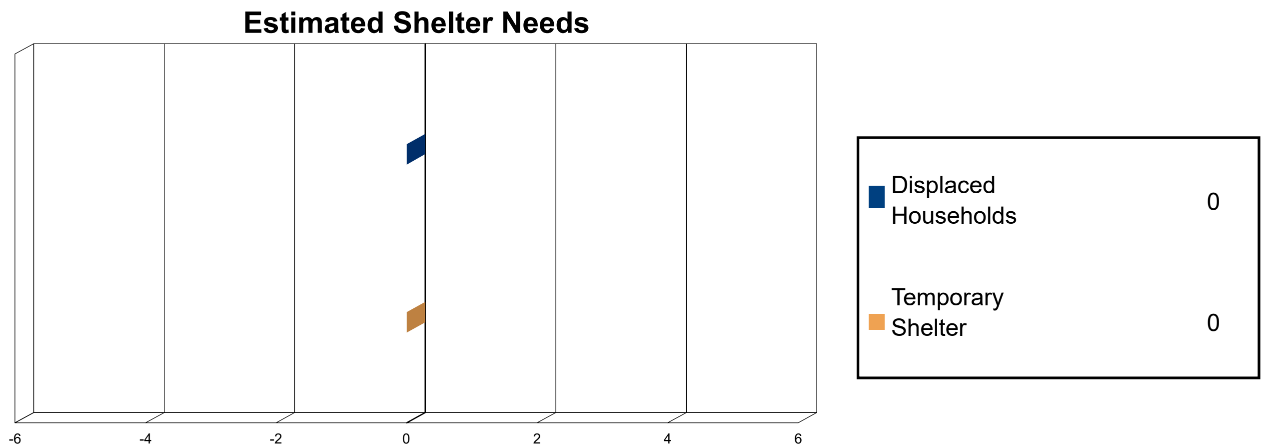


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 38,809 tons of debris will be generated. Of the total amount, 30,556 tons (79%) is Other Tree Debris. Of the remaining 8,253 tons, Brick/Wood comprises 31% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 101 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 5,732 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 233,385) will seek temporary shelter in public shelters.

Economic Loss

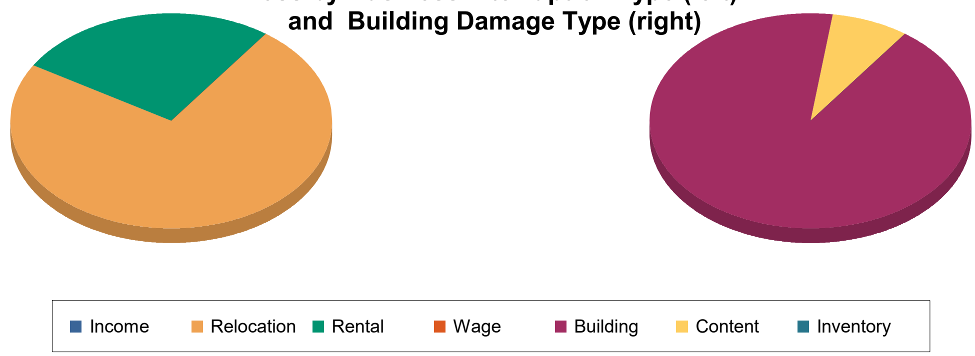
The total economic loss estimated for the hurricane is 55.6 million dollars, which represents 0.16 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 56 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 98% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left) and Building Damage Type (right)



Loss Type by General Occupancy

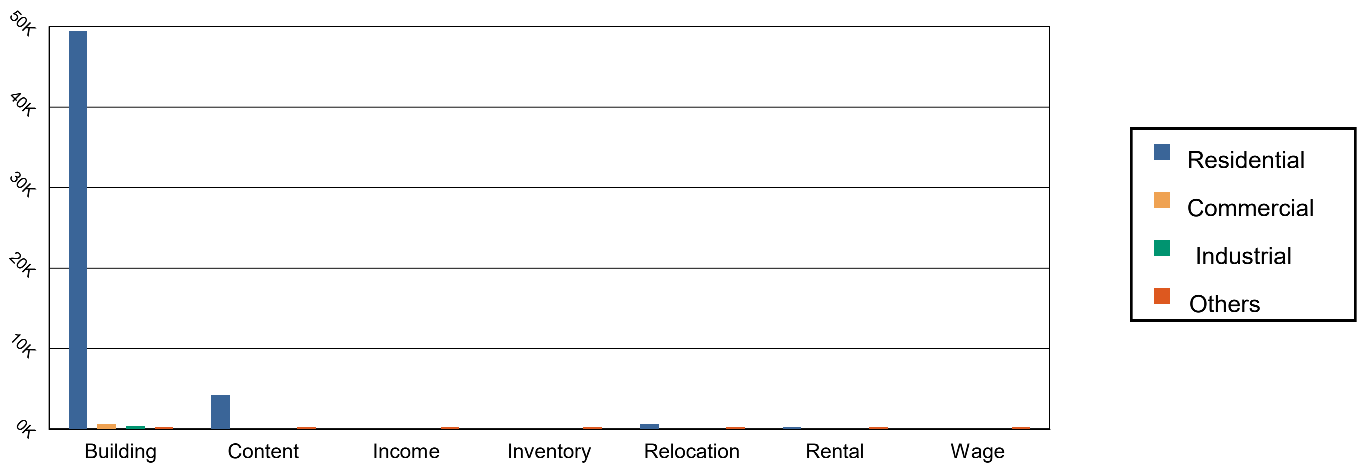


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	49,357.45	648.90	319.23	237.31	50,562.89
	Content	4,176.74	3.87	27.26	10.57	4,218.44
	Inventory	0.00	0.28	4.95	1.10	6.33
	Subtotal	**53,534.19**	**653.04**	**351.45**	**248.98**	**54,787.65**
Business Interruption Loss						
	Income	0.00	0.02	0.00	0.00	0.02
	Relocation	583.08	11.19	3.21	2.07	599.55
	Rental	213.35	0.09	0.00	0.03	213.46
	Wage	0.00	0.04	0.00	0.00	0.04
	Subtotal	**796.43**	**11.34**	**3.21**	**2.10**	**813.07**

Total

Total	**54,330.62**	**664.38**	**354.66**	**251.08**	**55,600.73**

Appendix A: County Listing for the Region

Maryland
- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	233,385	28,211,495	6,020,812	34,232,307
Total	**233,385**	**28,211,495**	**6,020,812**	**34,232,307**
Study Region Total	**233,385**	**28,211,495**	**6,020,812**	**34,232,307**

Hazus: Hurricane Global Risk Report

Region Name: FrederickMD_HUR

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Tuesday, August 3, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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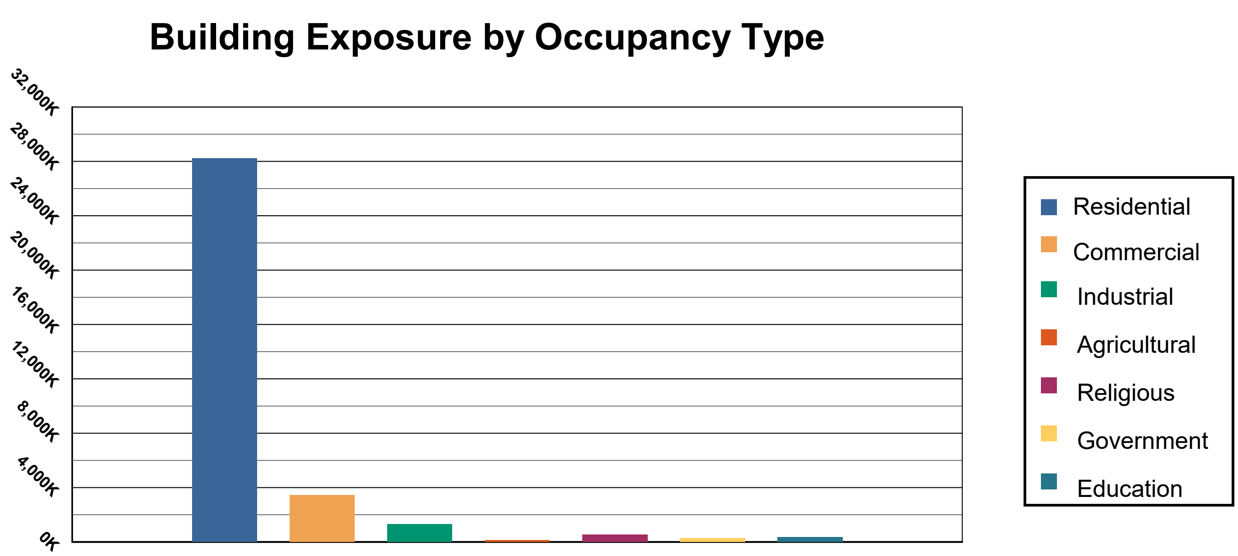
There are an estimated 85 thousand buildings in the region with a total building replacement value (excluding contents) of 34,232 million dollars (2014 dollars). Approximately 91% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 85,141 buildings in the region which have an aggregate total replacement value of 34,232 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



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Residential	28,211,495	82.41%
Commercial	3,448,470	10.07%
Industrial	1,321,984	3.86%
Agricultural	135,374	0.40%
Religious	511,568	1.49%
Government	258,351	0.75%
Education	345,065	1.01%
Total	**34,232,307**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 308 beds. There are 97 schools, 31 fire stations, 11 police stations and 2 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 97 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 1 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Expected Building Damage by Occupancy

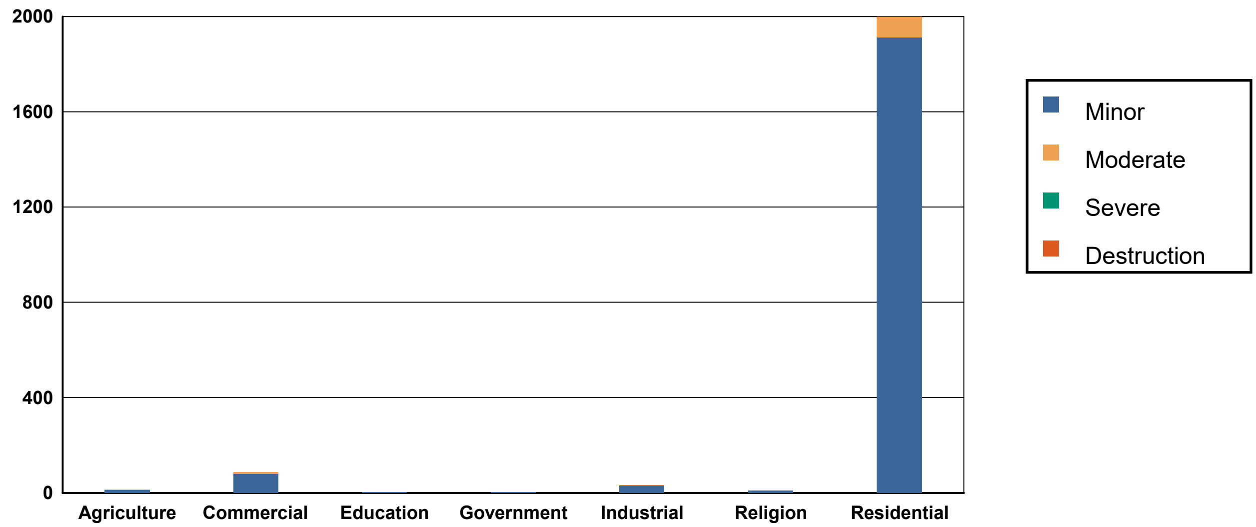


Table 2: Expected Building Damage by Occupancy : 1000 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	439.16	97.16	10.89	2.41	1.34	0.30	0.56	0.12	0.04	0.01
Commercial	4,487.60	98.11	79.99	1.75	6.09	0.13	0.32	0.01	0.00	0.00
Education	167.66	98.05	3.22	1.89	0.11	0.07	0.00	0.00	0.00	0.00
Government	199.41	98.23	3.49	1.72	0.10	0.05	0.00	0.00	0.00	0.00
Industrial	1,512.16	97.94	30.04	1.95	1.55	0.10	0.23	0.02	0.01	0.00
Religion	549.80	98.35	8.97	1.60	0.23	0.04	0.00	0.00	0.00	0.00
Residential	75,638.91	97.43	1,912.57	2.46	85.44	0.11	0.48	0.00	0.59	0.00
Total	**82,994.70**		**2,049.18**		**94.87**		**1.60**		**0.64**	

Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	773	97.89	16	2.05	0	0.06	0	0.00	0	0.00
Masonry	21,872	97.10	602	2.67	49	0.22	1	0.00	0	0.00
MH	570	99.75	1	0.18	0	0.05	0	0.00	0	0.02
Steel	3,063	98.02	58	1.85	4	0.13	0	0.01	0	0.00
Wood	53,429	97.62	1,267	2.32	35	0.06	0	0.00	1	0.00

Essential Facility Damage

Before the hurricane, the region had 308 hospital beds available for use. On the day of the hurricane, the model estimates that 308 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

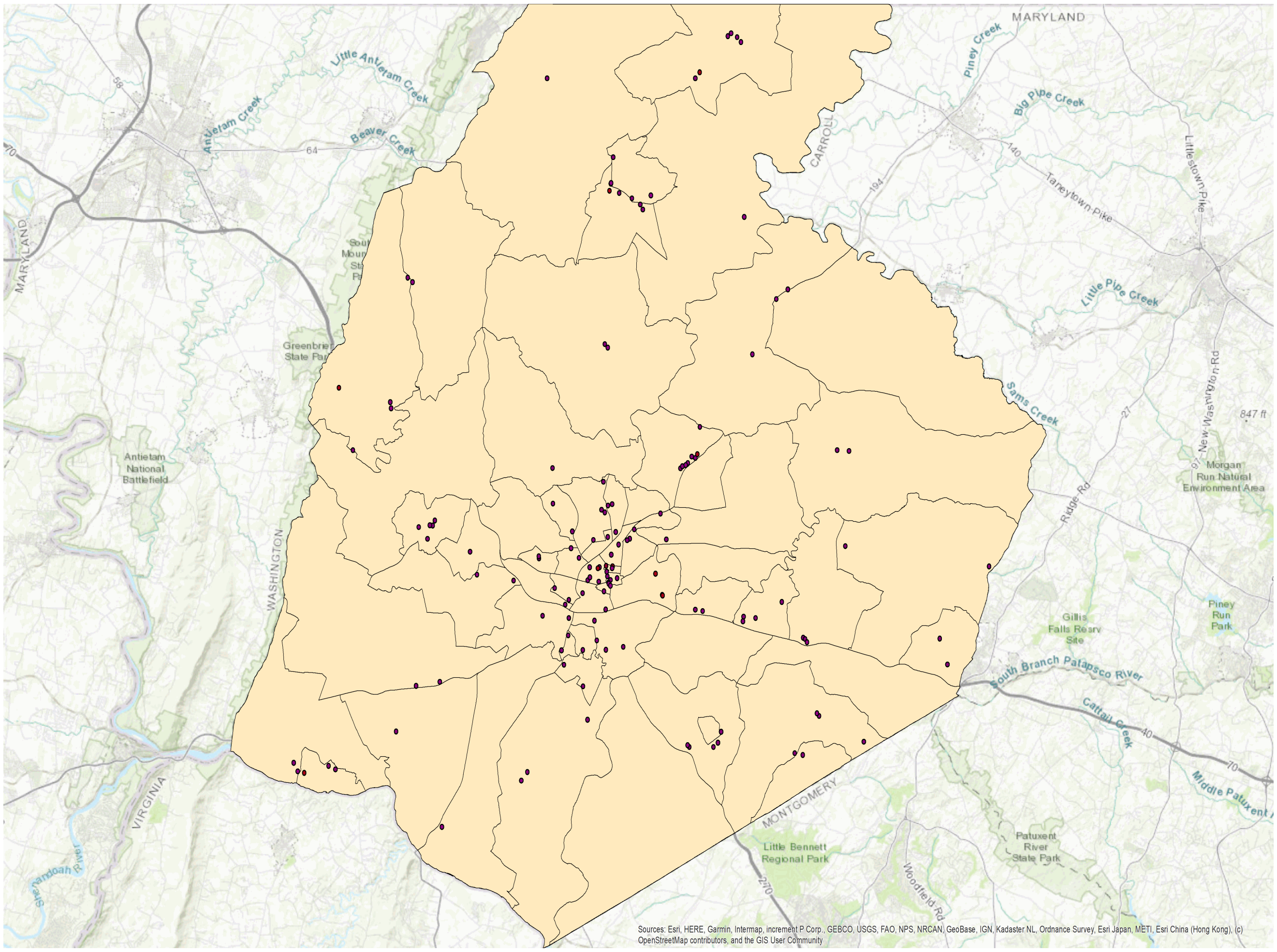
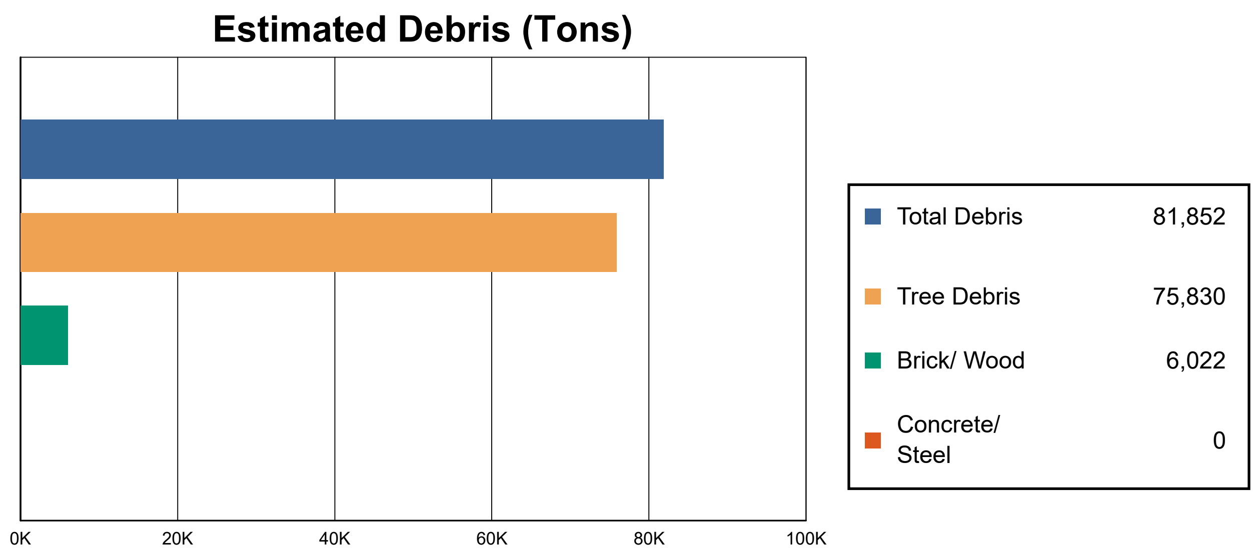


Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	2	0	0	2
Fire Stations	31	0	0	31
Hospitals	1	0	0	1
Police Stations	11	0	0	11
Schools	97	0	0	97

Induced Hurricane Damage

Debris Generation

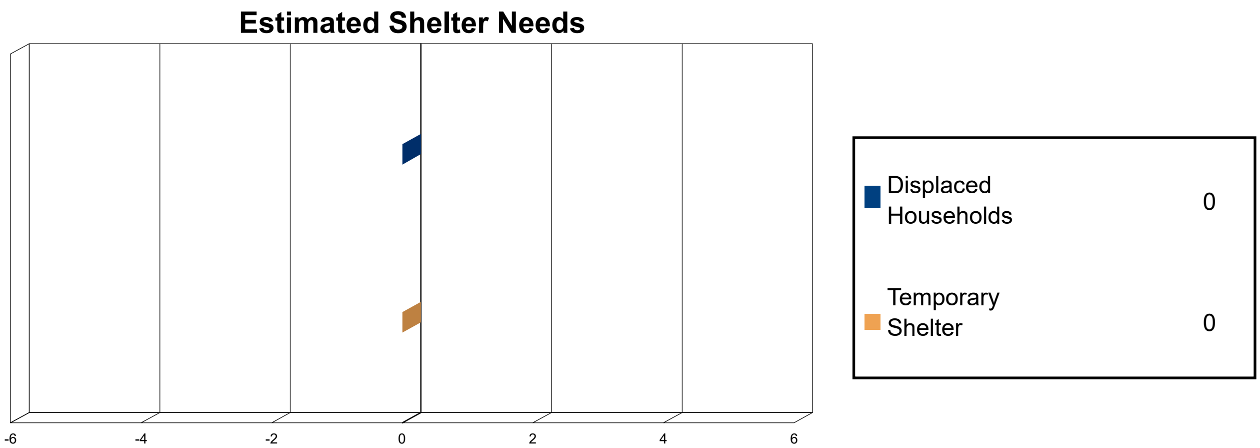


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 81,852 tons of debris will be generated. Of the total amount, 64,485 tons (79%) is Other Tree Debris. Of the remaining 17,367 tons, Brick/Wood comprises 35% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 241 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 11,345 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 233,385) will seek temporary shelter in public shelters.

Economic Loss

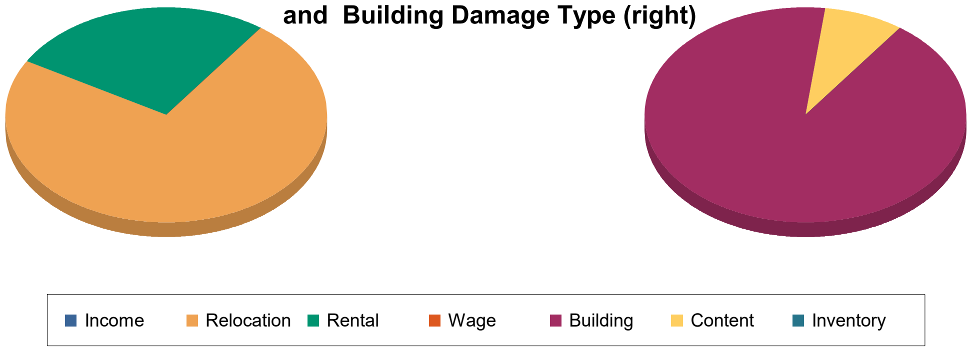
The total economic loss estimated for the hurricane is 103.6 million dollars, which represents 0.30 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 104 million dollars. 4% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 98% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left) and Building Damage Type (right)



Loss Type by General Occupancy

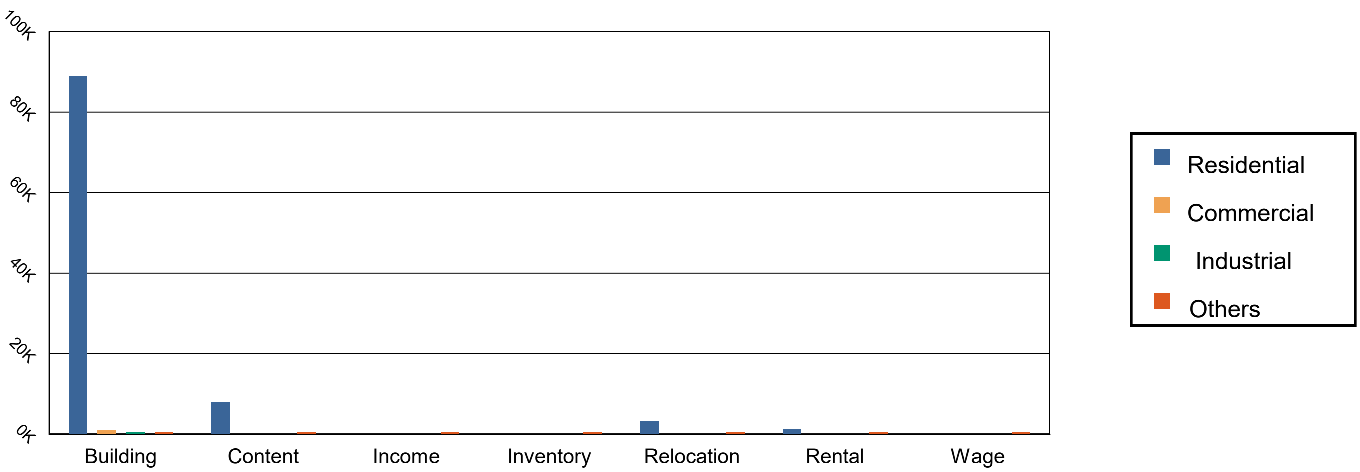


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	88,991.00	1,135.58	527.28	466.81	91,120.66
	Content	7,833.97	19.50	94.09	55.66	8,003.22
	Inventory	0.00	1.05	17.82	5.28	24.14
	Subtotal	**96,824.97**	**1,156.13**	**639.19**	**527.74**	**99,148.03**
Business Interruption Loss						
	Income	0.00	5.13	0.16	0.37	5.66
	Relocation	3,169.07	43.40	8.53	15.19	3,236.19
	Rental	1,169.69	3.09	0.11	0.44	1,173.33
	Wage	0.00	3.81	0.28	1.80	5.89
	Subtotal	**4,338.76**	**55.43**	**9.07**	**17.80**	**4,421.06**

Total

Total	**101,163.72**	**1,211.57**	**648.26**	**545.54**	**103,569.09**

Appendix A: County Listing for the Region

Maryland

- Frederick

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Frederick	233,385	28,211,495	6,020,812	34,232,307
Total	**233,385**	**28,211,495**	**6,020,812**	**34,232,307**
Study Region Total	**233,385**	**28,211,495**	**6,020,812**	**34,232,307**

Frederick County

Hazard Mitigation and Climate Adaptation Plan

Frederick Community College

Annex | March 2022

Dewberry

Frederick Community College

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CHAPTER 1. INTRODUCTION

Plan Purpose

This annex supplements the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan by focusing on Frederick Community College (FCC, or the College) located on Opossumtown Pike in Frederick County, Maryland. The annex focuses on identifying potential hazards and assessing the vulnerability of the campus to these hazards. This plan also assesses the college's existing capabilities to implement the variety of mitigation actions. This plan concludes with implementation and maintenance procedures.

Natural and human-caused hazards can affect higher education institutions through structural damage to buildings and infrastructure or interruptions to daily operations that can last days, weeks, or months at a time. Disruptions to research activities can even threaten a loss of funding or future opportunities. If severe enough, disasters may result in faculty or student departures, causing a loss of educational continuity for students. Institutions may face future financial duress due to rising insurance premiums or costs of necessary repairs and reconstruction in the aftermath of a disaster.

This annex represents one step in a series of proactive actions taken by FCC to reduce the adverse impacts of disasters and to avoid future losses and disruption. This plan focuses on hazard mitigation, but also addresses some aspects of disaster preparedness, response and recovery, which can enhance or hinder this plan's ultimate success. This plan also serves to guide FCC's decision-making regarding land use and development of new buildings, facilities and utilities, and in the renovation of existing structures.

Planning Process

Frederick County included FCC in its mitigation planning process for the 2022 plan update to improve the region's overall resilience to future hazards. This effort resulted in the following annex that specifically addresses the College's unique vulnerabilities and mitigation efforts. FCC conducted a mitigation planning process modeled after Frederick County's strategy and FEMA's *Building a Disaster-Resistant University*, a guide that closely follows state and local requirements outlined in the Disaster Mitigation Act of 2000 (DMA2K).[1] For the 2022 planning process, FCC participated again to verify and update the information applicable to the college to coincide with Frederick County's latest plan update.

FCC participated in the Frederick County Hazard Mitigation Planning Committee (HMPC) and College Planning Teams (CPT) to support the County's plan update and the development of this annex plan. The College participated in CPT meetings with Frederick County and the contracted consultant, Dewberry, to help gather the information needed for the plan update. Table 1.1 lists the members of the FCC CPT, as well as a brief description of their participation.

[1] FEMA. 2003. *Building a Disaster-Resistant University*. Retrieved from https://mitigation.eeri.org/files/FMEA443.disaster.resist.univ.pdf

Table 1.1. FCC College Planning Team Members

Name	Department	Planning Participation
Robin Shusko	Director of Campus Safety and Emergency Management, Security and Emergency Preparedness	• HMPC Member • Coordinated input from FCC • Attended meetings to develop plan and plan annex • Contributed to survey and provided other information as requested • Final Draft Review Workshop
Lewis Godwin	Chief of Operations, Operations - Operations	• Attended meetings to develop plan annex • Provided other information as requested • Final Draft Review Workshop
John Anzinger	Director of Capital Planning and Project Management, Capital Planning - Operations	• Attended meetings to develop plan annex • Provided other information as requested

Guided by the County, the FCC CPT participated in the hazard mitigation plan development process by attending meetings, communicating with the contracted consultant via phone and e-mail, and reviewing and commenting on draft documents. Between meetings, FCC participated in informal conversations and communication via telephone and e-mail to ensure constant and consistent communication between stakeholders. The HMPC and FCC CPT met several times throughout the hazard mitigation planning, outlined in Table 1.2.

Table 1.2. Meetings Throughout the Hazard Mitigation Planning Process

Meeting	Date	Purpose	# of Attendees
CPT Kick-Off	June 23, 2021	Coordinate on hazard mitigation planning process	8
Hazard Mitigation Planning Committee Kick-Off	July 13, 2021	Review the hazard mitigation planning process and discuss new hazard issues/mitigation needs	31
Local/College Planning Team Update Workshops	August 25 – September 16, 2021	Collect updates on hazard mitigation needs, completed projects, 2016 strategy progress, capability assessment, etc. since the 2016 plan	1-17 (varied on specific meeting)
Hazard Identification and Risk Assessment (HIRA) Workshop	October 14, 2021	Review findings from the risk assessment and discuss new goals/objectives	31

Meeting	Date	Purpose	# of Attendees
Public Meeting #1	October 28, 2021	Provide an overview of the hazard mitigation planning process, solicit input through the Story Map and Survey, review high-level findings from the risk assessment	11
Resilience Strategy Coordination Meeting #1	November 9, 2021	Discuss opportunities for information sharing between the hazard mitigation plan update and the upcoming operations resilience plan	10
Local/College Planning Team Strategy Workshops	November 30 – December 2, 2021	Provide final feedback on the goals/objectives and make decisions on mitigation and adaptation actions for each town, city, college, university, and county	34 (total)
Community Rating System (CRS) Workshop	December 8, 2021	Complete a CRS toolkit activity and discuss current potential standing and path forward for the county	10
Public Meeting #2	December 9, 2021	Review hazard mitigation planning process until this point, review goals/objectives/actions highlights, review public feedback received, review risk assessment highlights, provide information on the upcoming plan review period	Aired on TV
Resilience Strategy Coordination Meeting #2	December 14, 2021	Discuss feedback on the climate impacts section, HIRA, new goals/objectives, and mitigation and adaptation actions	9
Hazard Mitigation Planning Committee Plan Review Workshop	January 26, 2022	Reviewed the draft plan, discussed major changes, and provided further feedback on final changes	24

The FCC CPT workshop was held on September 23, 2021 to establish a project timeline, identify priorities, establish relationships, and to request assistance with data collection. The strategy workshop was held on November 30, 2021 to determine progress on previous mitigation actions and to identify new strategies to include in the plan annex. The College provided its completed hazard survey in October 2021 and its completed capability assessment in November 2021. In January 2022, the college provided additional information to further contextualize the plan.

Using the results of the HIRA to guide their decision-making process, the College developed a list of comprehensive mitigation actions. In the weeks that followed, FCC prioritized these strategies and developed a mitigation action plan. The plan identifies the departments responsible for implementation of the strategies and potential funding sources. For more information on this process and the actual Mitigation Action Plan, please refer to Chapter 5.

In January 2022, the final draft plan was provided to FCC CPT for a final review. The CPT vetted and confirmed the contents with minor changes. The draft plan was distributed for comment by appropriate college stakeholders.

Existing Studies and Plans Reviewed

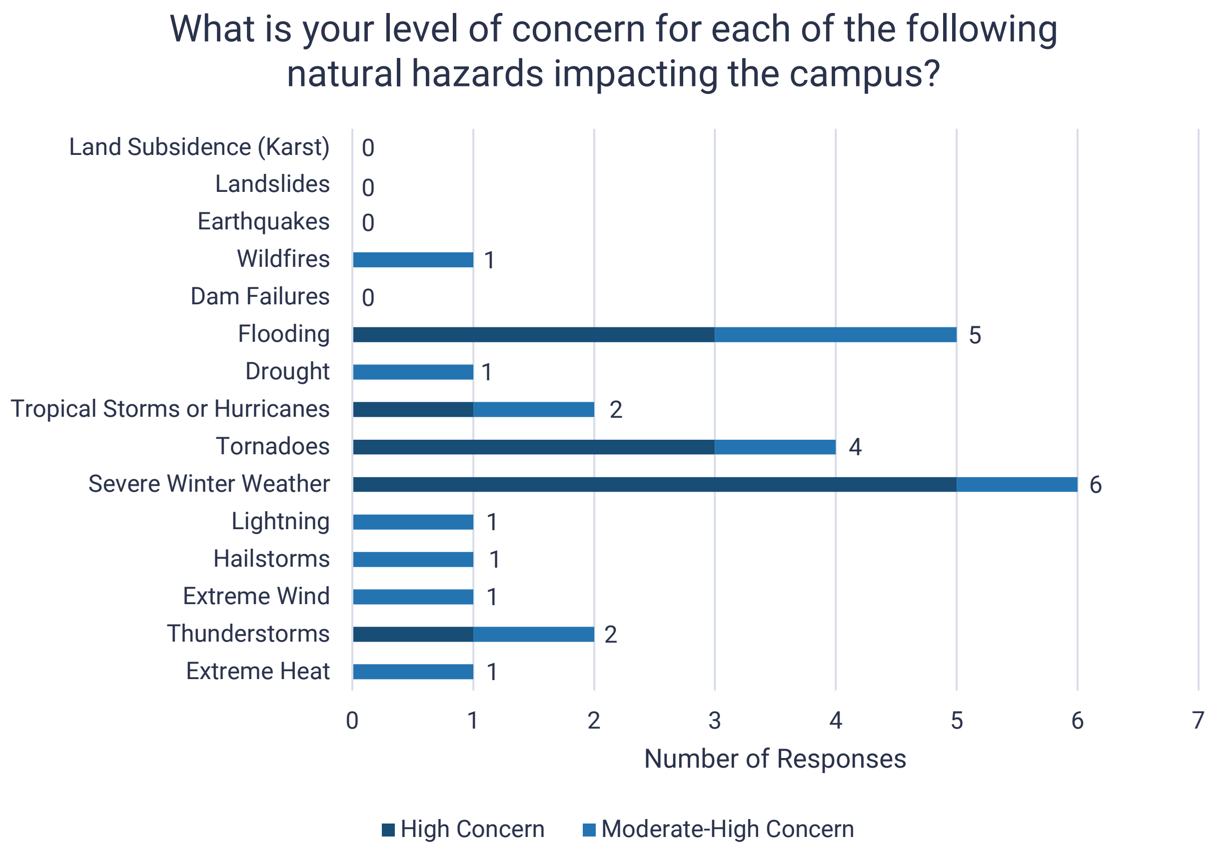
Planning documents, studies, guides, regulations, ordinances, and policies were reviewed and incorporated during the initial plan and each following update. These plans included FEMA documents, emergency services documents, county and local general plans, community plans, local codes and ordinances, and other similar documents, including the following:

- Frederick Community College Facilities Master Plan 2012-2022: Five Year Update – 2017-2022
- FCC Forward: Strategic Plan 2020-2025
- Frederick Community College 2021 Accountability Report
- 2020 Frederick Community College Approved Operating Budget
- Building a Disaster-Resistant University
- FEMA CRS-DMA2K Mitigation Planning Requirements
- 2016 MEMA and FEMA Crosswalk Comments for Frederick County

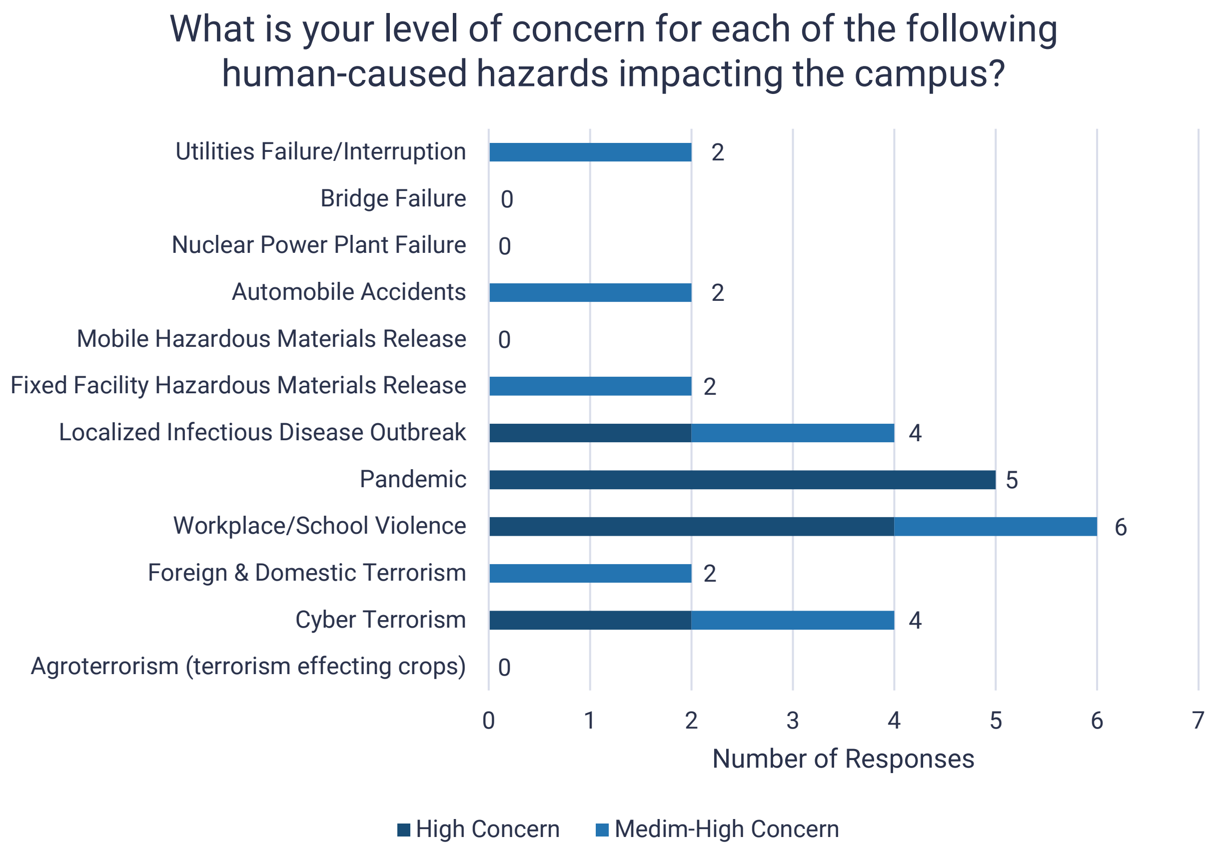
College Survey Results

Of the 684 responses to the Frederick County public survey, 12 participants identified themselves as a student, faculty, or staff member of Frederick Community College. Most respondents (71%) were already aware that the College maintains a hazard mitigation plan.

Respondents most reported moderate-high to high concerns about severe winter weather and flooding affecting Frederick Community College campus. No respondents cited significant concerns about land subsidence, landslides, earthquakes, or dam failures affecting the campus.



Students, faculty, and staff were also asked to rank their levels of concern for human-caused hazards. Respondents most frequently cited medium-high to high concerns about workplace or school violence, pandemics, localized infectious disease outbreaks, and cyberterrorism affecting Frederick Community College's campus. No respondents cited agroterrorism, fixed facility hazardous materials releases, nuclear power plant failures, or bridge failures as medium-high or high concerns.



Several respondents said recent hazard made them more aware of the dangers that hazards pose to their campus, specifically citing flooding and the COVID-19 pandemic. Students, faculty, and staff were asked to rate on a scale from one to 100 how safe from hazards they feel on campus. On average, respondents rated their feelings of safety a 72 out of 100, but responses ranges from a low of 50 to a high of 94. When asked to identify vulnerable areas on campus, respondents cited parking lots both to the north and south of Gambrill Hall, where flood problems are known.

Respondents were asked about important actions the College can take to mitigate hazards and become more resilient. Majority of respondents (72%) identified outreach and education to students, faculty, and staff to help them understand their risks and mitigate hazards, installation or improvement of backup systems, like generators or computer databases, as key mitigation actions. Other frequently cited important actions include elevation of critical services, equipment, and materials to prevent flood damage and improvement of cyber security defenses. When asked to identify one mitigation action the College could take, respondents provided open-ended answers related to reinforcing existing hazard mitigation protocols and coordinating closings with the Frederick County Public School System.

Stakeholder Review

The stakeholder review was conducted in January and February of 2022. A copy of the plan and appendices were emailed to select priority stakeholders and also posted online for the public. A survey was used as a feedback collector for half the feedback, and documents containing direct edits and comments in context were utilized by Frederick Community College. In total, 34 sets of comments were received across the main plan and annexes from participating jurisdictions, neighboring counties, dam stakeholders, college/university stakeholders, and the general public. Frederick Community College received three college-specific reviews as show in Table 1.3.

Table 1.3. Stakeholder Review Comments

Affiliation	Title/Role	Review Comments
Frederick Community College	Digital Resources Librarian	Believed the plan would encourage worthwhile hazard mitigation activities on campus
	Vice President, Marketing & Communications	Believed the plan would encourage worthwhile hazard mitigation activities on campus
	Special Projects Manager	Raised a question about further integrating with the Livable Frederick Master Plan and adding new hazards that were not historically present in the plan Believed the plan would encourage worthwhile hazard mitigation activities on campus

CHAPTER 2. PLANNING CONTEXT

Frederick Community College

History

Founded in 1957, FCC is a public college located in Frederick County. The mission of FCC is to be a student-centered, community-focused learning college that provides affordable, flexible access to lifelong education that responses to the needs of diverse learners and the community. Over the past 65 years, Frederick Community College has grown from 77 students to more than 6,000 students enrolled per semester.

Location

FCC is located on a 98.2-acre site at 7932 Opossumtown Pike in Frederick County. Between 1957 and 1970, FCC was previously located at Frederick High School and a facility on North Market Street, before moving to its current, permanent location.

The College has 14 buildings on campus, outlined in Table 2.1 and Figure 2.1. FCC has one off-site facility, Monroe Center, which is located at 200 Monroe Avenue and contains labs; classroom space; and equipment for building, healthcare, and culinary vocational training. Originally developed with a focus on construction trades, the facility was recognized as the largest college construction training facility in Maryland. In 2008, Monroe Center was renovated with support from the Frederick County Commissioners, as well as a $1.9 million, three-year grant from the Department of Labor.

Table 2.1. FCC Campus Buildings and Structures

Building Name	Functions
Annapolis Hall	Adult Services, Veteran Services, Disability Access Services, President, Institutional Effectiveness, Mail Room, Administrative Offices, Capital Planning, Copy Center, Office of Diversity, Equity, and Inclusion, Marketing, Receiving Operations
Braddock Hall	Math Learning Center, Faculty Offices, Classrooms
Catoctin Hall	Science Land, Computer Labs, Faculty Offices, Classrooms, Student Lounge
Athletics Center	Gymnasium, Weight Room, Classrooms, Athletics, Faculty Offices, Locker Rooms
Conference Center	Large and Small Meeting Rooms, Technology Labs, Continuing Education & Workforce Development, Adult Education and ESL
Visual & Performing Arts Center	JBK Theatre, MCH Art Gallery, FCC Studio Theatre, Music Classrooms & Practice Rooms, Art Classrooms, Mac Classroom & Lab, Faculty Offices
Gambrill Hall	Human Resources, Purchasing, Fiscal Services, IT Services, Administrative Offices

Student Center	Welcome Center, Cougar Grille, Bookstore, Multicultural Student Services, Public Safety and Security, Center for Student Engagement, Student Government Association, Honors College Classroom & Lounge, Faculty Offices, Student Lounges, Behavioral Health & Wellness
Jefferson Hall	Welcome Center; Admissions; Registration & Records; Student Accounts; Counseling & Advising; Career & Transfer Center; Financial Aid; Student Affairs Offices
Mercer-Akre Kiln	Art Studio
Linganore Hall	Library, Allied Health/Nursing Labs, Testing Center, Writing Center, Video Classroom & Lab, Language Lab, Faculty Offices, Classrooms, Student Lounge, Center for Teaching & Learning, Online Learning & Instructional Innovation
The Carl and Norma Miller Children's Center	Childcare
Plant Operations	Administration/Physical Operations of College
Sweadner Hall	Lecture Hall
Parking Deck	Large parking structure

Welcome to Frederick Community College

A Annapolis Hall
Adult Services, Veteran Services, Services for Students with Disabilities, Adult Education (GED©, ESL), President, Institutional Advancement, Mail Room, Administrative Offices

B Braddock Hall
Math Learning Center, Faculty Offices, Classrooms

C Catoctin Hall
Science Labs, Computer Labs, Faculty Offices, Classrooms, Student Lounge in Upper B/C Knuckle

D Athletics Center
Gymnasium, Weight Room, Classrooms, Athletics, Faculty Offices, Locker Rooms

E Conference Center
Large and Small Meeting Rooms, Technology Labs, Continuing Education & Workforce Development

F Visual & Performing Arts Center
JBK Theater, MCH Art Gallery, FCC Studio Theater, Music Classrooms & Practice Rooms, Art Classrooms, Mac Classroom & Lab, Faculty Offices

G Gambrill Hall
Human Resources, Purchasing, Fiscal Services, IT Services, Risk Management and Public Services, Administrative Offices

H Student Center
Cougar Grille, Bookstore, Multicultural Student Services, Security, Center for Student Engagement, Student Government Association, Honors College Classroom & Lounge, Tutorial Services, Faculty Offices, Student Lounges

J Jefferson Hall
Welcome Center, Admissions, Registration & Records, Student Accounts, Counseling & Advising, Career & Transfer Center, Financial Aid, Office of Diversity, Equity, and Inclusion, Learning Support Offices

K Mercer-Akre Kiln

L Linganore Hall
Learning Commons, Allied Health/Nursing Labs, Testing Center, Video Classroom & Lab, Language Lab, Faculty Offices, Classrooms, Student Lounge, Staff Lounge, Distributed Learning offices, IT Help desk, Dual Enrollment

M The Carl and Norma Miller Children's Center

P Plant Operations

S Sweadner Hall
Lecture Hall

In case of an emergency, Call 2453 or 4444 on campus or 301.846.2453 off campus or on your cell.

Evacuation Locations
Accessible Parking
Electric Car Charging

For information on accessible routes, please visit our website at frederick.edu

Figure 2.1. FCC Campus Map

Regional Context

FCC is located in the City of Frederick in Frederick County. Founded in 1748, Frederick County, Maryland is about an hour northwest of Washington, D.C. and an hour west of Baltimore. Its area encompasses a total of 662.7 square miles[2] and contains approximately 391.7 persons per square mile. Based on the most recent data available from the U.S. Census Bureau, the estimated population in 2019 was 259,547, an 11.2% increase since 2010.[3] Table 2.2 indicates recent and projected change in Frederick County population from 2020 to 2045.

In the County, the City of Frederick is the second largest in Maryland and has a 50-block historic district with many buildings dating back to the 18th and 19th centuries. Frederick has a variety of attractions, including Civil War sites, museums, parks, recreational facilities, wineries, antique shops, restaurants, and entertainment venues.

Table 2.2. Population Projections in Frederick County[4]

Year	Household	Population	Employment
2020	98,400	263,900	117,300
2025	106,300	284,300	123,200
2030	115,400	304,500	128,600
2035	122,400	320,000	135,300
2040	128,100	334,600	141,100
2045	132,100	346,600	145,500

Table 2.3 shows the 2019 U.S. Census population estimates and the 2021 Frederick County Planning estimates for Frederick County municipalities.

Table 2.3. 2019 and 2021 Population Estimates in Frederick County

Municipalities	2019 U.S. Census Population Estimates	2021 Frederick County Population Estimates
Brunswick	6,491	7,826
Burkittsville	165	151
Emmitsburg	3,198	2,866

[2] Maryland Department of Commerce. 2021. "Brief Economic Facts: Frederick County, Maryland." Retrieved from https://commerce.maryland.gov/Documents/ResearchDocument/FrederickBef.pdf
[3] U.S. Census Bureau. 2021. "Quickfacts: Frederick County, Maryland Population Estimates." Retrieved from https://www.census.gov/quickfacts/frederickcountymaryland
[4] Frederick County Planning Department, 2021.

Frederick City	72,244	72,097
Middletown	4,792	4,516
Mount Airy	9,458	3,785*
Myersville	1,838	1,713
New Market	738	1,241
Rosemont	322	296
Thurmont	6,895	6,286
Woodsboro	1,269	1,161
Walkersville	6,415	6,182
Unincorporated County	145,722	86,191
		77,189**
Total	**259,547**	**271,500**

*Portion within Frederick County

** “Other Small Areas”

Land Use and Development Trends

FCC’s main campus occupies 98.2 acres, and currently, there are no properties adjacent to the main campus that are available for acquisition. Future development is limited to FCC’s existing land area and future acquisitions. The College’s most recent Facility Master Plan notes that FCC plans to accommodate growing programs and needs by revitalizing and repurposing exiting resources and facilities, rather than construct new buildings. Over the past several years, the College has implemented upgrades at several facilities. In the past five years, the College’s fire alarm systems have all been updated, and the last phase of integrating these new systems is in progress. Additionally, in 2018, the College augmented the generator capacity for the main campus, which includes the College’s data center.

FCC is currently working on its five-year update to its Facility Master Plan, which will determine future projects for existing buildings and structures. Among these projects, the Monroe Center’s Building E is slated for interior renovations.

Curriculum Overview

FCC is a two-year college with seven academic departments which offer degrees in Associates of Arts, Associates of Science, Associates of Arts in Teaching, Associates of Applied Sciences, Certificates and Letters of Recognition in more than 80 fields of study. The college offers distance learning programs. FCC is the only college in the country contracted with FEMA's Emergency Management Institute (EMI) to provide college credit for the Emergency Management Independent Study Program.[5]

Asset Inventory

FEMA guidelines emphasize the use of "best available" data for hazard mitigation plans. The following sections provide information on the data collected and data gaps that currently exist. These gaps may be considered as mitigation actions in future planning cycles.

General Building and Facility Information

FCC's main campus includes 20 buildings totaling 557,658 gross square feet (GSF) and 261,034 net assignable square feet (NASF). The College's one off-site space, the Monroe Center, occupies 55,452 GFF and 39,376 NASF. The College's total facility inventory occupies 612,9990 GSF and 300,410 NASF.[6]

Daily Occupancy/Hours of Use

In 2020, FCC served roughly 13,900 students, of which 8,700 were credit-earning students and 5,600 were continuing education students.[7] Approximately half (393) of the College's employees are part-time, while the remaining are full-time (390).[8] The population during the summer months is expected to be significantly lower, though the campus does hold summer classes as well as other events. There are no dormitories on campus.

Total Replacement Value

The total replacement value for the buildings (buildings and contents) included in this plan is estimated at over $166 million for the Main Campus and $15 million for Monroe Campus (both values adjusted for inflation).[9]

Utilities

The campus has no unique on-site systems such as septic systems or wastewater treatment plants. All buildings, except Gambrill Hall, Jefferson Hall, Mercer-Akre Kiln, The Carl and Norma Miller Children's Center, and the Parking Garage are on the central heated and chilled water supply system fed from Central Plant boilers, chillers and cooling towers.

According to FCC's HVAC maintenance contractor, the property's chillers and the central plant building are in good condition. A pressure loss does occur in Chiller #3, installed in 2009, when three circulator pumps are operating so that the system does not maintain the proper water flow. Based on the estimated useful life of the chillers, they will all require replacement over the evaluation period and an engineer should be retained to analyze the pressure loss problem.

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[5] Frederick Community College. "Emergency Management." https://www.frederick.edu/programs/public-safety/emergency-management-(1).aspx

[6] Frederick Community College. 2017. *Frederick Community College Facilities Master Plan 2012-2022: Five Year Update – 2017-2022.* Retrieved from https://apps.frederick.edu/Flipbook/FacilitiesMasterPlan/files/assets/common/downloads/FacilitiesMasterPlan.pdf

[7] Frederick Community College. 2021. *2021 Accountability Report*. https://www.frederick.edu/about-fcc/downloads/opair/performanceaccountabilityreport.aspx

[8] Frederick Community College. 2017. *Frederick Community College Facilities Master Plan 2012-2022: Five Year Update – 2017-2022.* Retrieved from https://apps.frederick.edu/Flipbook/FacilitiesMasterPlan/files/assets/common/downloads/FacilitiesMasterPlan.pdf

[9] Frederick Community College. 2017. *Frederick Community College Facilities Master Plan 2012-2022: Five Year Update – 2017-2022.* Retrieved from https://apps.frederick.edu/Flipbook/FacilitiesMasterPlan/files/assets/common/downloads/FacilitiesMasterPlan.pdf

The two cooling towers are reported in fair condition but based on the estimated useful life of the chillers, they will require replacement over the evaluation period. Boiler B-01, installed in 2010, appears to be in good condition and boilers B-02 and B-03 are reported in poor condition. Both boilers are reported to be antiquated and have significant rusting. B-02 was offline during the assessment due to leaking. Based on the estimated useful life of Boilers 2 and 3, they will require replacement over the evaluation period.

The vast majority of the hot and cold-water distribution system is more than 40 years old. Replacement of some sections of the underground loop was done approximately three years ago. Photos of the replaced sections indicate rusting and deterioration that could be indicative of the condition of the remaining sections of the loop. Based on the estimated useful life of the hot and cooled water loop piping, much of it will require replacement over the evaluation period.

In general, circulating pumps for chilled water, heat reclaim water and condenser water are in fair condition but will require replacement over the evaluation period along with air compressors that are more than 30 years old. Electrical systems for central HVAC equipment appear adequate for demands however, replacement of the original 1,200-amp switchboard should be anticipated over the evaluation period.

In general, most buildings have Category 3 low voltage cabling for telephone lines and Category 5 or 5e cabling for data lines; upgrading both the phone and data to Category 6 would be needed to be able to download and e-mail gigs.

CHAPTER 3.HAZARD IDENTIFICATION AND RISK ASSESSMENT

The purpose of the Hazard Identification and Risk Assessment (HIRA) is to identify the hazards that could affect Frederick Community College and assess what unique risk the campus may have to those hazards. Hazards were identified as part of the Frederick County Hazard Mitigation and Climate Adaptation Plan Update and were validated and prioritized for the campus by the FCC CPT during the 2022 plan update process.

The following chapter profiles and assesses risk for hazards identified high or medium-high priorities by the FCC CPT. These sections include an abbreviated profile of the hazard that is more fully described in the main Frederick County Hazard Mitigation and Climate Adaptation Plan, with specific focus on the FCC campus and the City of Frederick, where the main campus is located. The 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan should be referenced for a complete hazard review.

Hazard Identification

FCC CPT members were asked to identify major concerns with respect to the campus and hazards that were likely to impact the College. Frederick County assessed natural hazards for the 2022 plan update and previously, examined human-caused hazards. The County decided not to assess human-caused hazards during this planning process, but FCC has decided to assess them.

In alignment with the County's plan update, the risk assessment is organized by the primary climate change interaction each hazard faces. The 2016 Plan was organized by hazard type (i.e., atmospheric, hydrologic, wildfire, geologic), but setting each hazard in the context of climate change will allow for a better understanding of how risk from each hazard may change in the future. The primary climate change interactions included are:

- Changes in precipitation,
- Rising temperatures, and
- Extreme weather.

Earthquake and human-caused hazards are organized under a "non-climate-influenced" hazard category.

The hazards are given priority levels as a part of the hazard profiling process. They are determined based on FCC CPT input as well as the five criteria summarized below to assign a quantitative ranking. Each criterion identifies and categorizes the comparative probability and potential vulnerability for the identified hazards. The framing criteria/questions are shown in the list below and Table 3.1 provides the thresholds for each of the risk levels.

The five main parameters include:

1. **Probability/History**: Has the hazard occurred in the area before, and if so, how often based on the historical record? Weighting Factor: 0.25
2. **Vulnerability**: If the expected event does occur, how many people might be killed, injured, or contaminated, and how much property might be damaged or destroyed (e.g., the percent of people or property vulnerable to the hazard)? Weighting Factor: 0.20

3. **Maximum Threat**: What is the worst-case scenario of the hazard and how bad can it get? What will the loss of life and property damage be if the worst-case scenario occurs (e.g., the percent of the campus impacted by the hazard)? Weighting Factor: 0.10
4. **Warning Time**: How much time is the campus given to prepare for an event? Weighting Factor: 0.10
5. **Ranking in Previous Plan**: The ranking from the 2011 Hazard Mitigation Plan (Significant, Moderate, Limited) was factored in the 2016 ranking. Weighting Factor: 0.35

Table 3.1. Hazard Priority Ranking Criteria

Probability / History	Vulnerability	Maximum Threat (Geographic Area Affected)	Warning Time	2016 Ranking
Weighting Factor: 0.25	*Weighting Factor: 0.20*	*Weighting Factor: 0.10*	*Weighting Factor: 0.10*	*Weighting Factor: 0.35*
Unlikely No documented occurrence with annual probability <0.01	**Negligible** 1 to 10% of people or property	**Isolated** < 5% of community impacted	**Extended** More than 3 days	**Low**
Somewhat Unlikely Infrequent occurrence with at least one documented event and annual probability between 0.5 and 0.01	**Slight** 10% to 20% of people or property	**Minor** 5 to 15% of community impacted	**Slight** 3 days	**Medium-Low**
Somewhat Likely Moderate occurrence with at least two documented events and annual probability between 0.5 and 0.01	**Limited** 20 to 30% of people or property	**Small** 15 to 25% of community impacted	**Limited** 2 days	**Medium**
Likely Frequent occurrence with at least three documented events and annual probability between 1 and 0.5	**Critical** 25 to 50% of people or property	**Medium** 25 to 50% of community impacted	**Minimal** 1 day	**Medium-High**
Highly Likely Common events with annual probability >1	**Catastrophic** > 50% of people or property	**Large** > 50% of community impacted	**No Notice** < 24 hours	**High**

Table 3.2 and Table 3.3 summarize the Frederick County and FCC assigned priority levels. For natural hazards, the FCC CPT identified winter weather as a high priority and floods and thunderstorms as medium-high priorities. For human-caused hazards, FCC assigned medium-high priorities to workplace or school violence, pandemics, and localized infectious disease outbreaks.

In the 2021 college survey, FCC cited a couple of major concerns regarding the above human-caused hazards. Major concerns included the following: college community impact and continuity of operations, structure integrity, property damage, and recovery. When asked which natural and human-caused hazards were most likely to affect FCC, severe winter weather, tropical cyclones, and workplace or school violence were listed.

Table 3.2. Natural Hazard Priority Level Comparison

Natural Hazards Type	2022 Priority Level	
	Frederick County	Frederick Community College
Primary Climate Change Interaction: Changes in Precipitation		
Flood	High	Medium-High
Dam and Levee Failure	Low	Low
Karst and Land Subsidence	Medium-High	Low
Drought	Medium	Low
Landslide	Medium-Low	Low
Wildfire	Medium	Low
Primary Climate Change Interaction: Rising Temperatures		
Extreme Heat	Medium	Medium-Low
Primary Climate Change Interaction: Extreme Weather		
Winter Storm	High	High
Thunderstorm	Medium-High	Medium-High
Tornado	Medium-High	Medium-Low
Tropical Cyclone	Medium	Medium
Non-Climate-Influenced Hazards		
Earthquake	Medium-Low	Low

Table 3.3. Human-Caused Hazard Priority Level Comparison

Human-Caused Hazards Type	Frederick Community College 2022 Priority Level
Non-Climate-Influenced Hazards	
Agroterrorism	Low
Cyberterrorism	Medium
Foreign & Domestic Terrorism	Medium-Low
Civil Disobedience	Medium
Workplace or School Violence	Medium-High
Pandemic	Medium-High
Localized Infectious Disease Outbreak	Medium-High
Fixed Facility Hazardous Materials Release	Medium
Mobile Hazardous Materials Release	Medium-Low
Automobile Accidents	Medium-Low
Rail Accidents	Low
Air Accidents	Medium-Low
Nuclear Power Plant Failure	Low
Bridge Failure	Low
Utilities Failure or Interruption	Medium-Low

Areas of Concern

As part of the campus survey, FCC CPT members provided additional areas of impact and vulnerability. Vulnerable areas and reoccurring problems were taken into consideration during the analysis phase. Questions posed to committee members included the following:

- What are your major concerns with respect to the campus and the hazards identified?
- Have there been noteworthy events in the past? Were there major consequences?
- What events do you think are likely to occur?
- What specific vulnerabilities exist on the campus?

For the 2022 plan update, areas of concern fell into two main categories: entrances and evacuation efficiency, and stormwater drainage. These areas are summarized in Table 3.4. This list only indicates concerns held by members of the FCC CPT, but it should not be considered comprehensive.

Table 3.4. Institutional Knowledge of Building Vulnerabilities and Areas of Concern

Areas of Concern	Summary of Vulnerability
2016 Plan Update	
Entrances and evacuation efficiency	Concern is centered on design of buildings, specifically entrances, and ability to evacuate efficiently and effectively.
Cyber hacks	Concerns about vulnerability of information technology systems campus-wide.
Drainage/frozen lots	Sidewalks retain water/puddles that freeze. Snow and ice buildup on top level of parking garages freezes, then melts, and re-freezes on parking deck ramps. Chemical snow and ice melt products are not used due to concrete construction. Instead, the area is quarantined to allow sun to melt and dry off. No place to pile snow without losing already limited parking areas. Parking lot drains need to be plowed open to ensure drainage from parking lots.
Proximity to Fort Detrick	Campus shares a border with Fort Detrick. Concerned about spillover threats.
Workplace violence	Concern is centered on inherent vulnerability of open college campus to acts of violence (e.g., active shooter).
IT Server Rooms	Water: IT Server rooms have sprinkler systems rather than Halon/O2/Dry fire extinguishing systems. HVAC: Condensate line leak caused server loss in Dec. 2015 in main IT hub room at a cost over $72,000 and an insurance claim. Blackboard/Peoplesoft/Enterprise systems temporarily lost. 48 hours until recovery by IT personnel.
A/B Knuckle	During torrential rain events, drainage flow enters A/B Knuckle.
Adjacent to Arts Building ("F")	550-gallon buried tank to store diesel fuel for generator.

Fire Hydrants	Fire hydrants are not well marked with visible posts to avoid covering with snow.
Flat Roof Buildings	Flat roofs allow for snow/ice/water building up.
2022 Plan Update	
Entrances and evacuation efficiency	Building design, specifically entrances, and ability to evacuate efficiently and effectively.
Stormwater Drainage Management	Campus evaluation of drainage infrastructure. Parking lot flooding near Gambrill Hall. Retention ponds and storm drain overflow.

Damage History

The data collection effort utilized meetings with FCC CPT members and other officials, existing reports and studies, state and national data sets, and other sources, such as newspaper archives. Hazard data collected at the state or national level, such as the National Centers for Environmental Information's (NCEI) Storm Event Database, is aggregated at a county level and does not provide site-specific information. To the greatest extent possible, information specific to the College was included.

The historical hazard data was used to identify hazard events most likely to occur and to quantify the impacts each type of event had on the College. In each hazard profile, when applicable, damage history claims by hazard type have been summarized in a table. Information regarding insurance claims was provided by Finance Office.

National Centers for Environmental Information (NCEI) Storm Events

NCEI storm events data is published by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The storm events database contains information on storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce from 1950 to March 2021. Records for the majority of weather events were reported starting in 1996, with the exception of tornado, thunderstorm, and hail.

Table 3.5 summarizes the natural hazards profiled for the Frederick County 2022 plan update. Because this data is provided at a county-level, these events occurred throughout the County, and not all may have affected the College. The information summarized in the Table 3.5 supports the hazard identification completed by the FCC CPT. Detailed hazard event information is presented in the Frederick County 2022 Hazard Mitigation and Climate Adaptation Plan and the hazard-specific sections in this annex.

There has been a total of 1,248 events for the hazards profiled in this report. Total property damages from these events exceed $96 million (adjusted for inflation). These estimates may underrepresent the actual losses experienced due to both hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCEI database; this is especially true with crop damages.

As shown in the Table 3.5, several of the hazards are not collected in the NCEI storm events database. Each of the individual hazard sections use the best available national and local data. In most cases, Frederick County departments have provided supplemental data for past events and damages.

Table 3.5. NCEI Storm Events for Frederick County, MD

Hazard Type	Period of Record	Total Events	Property Damage (2021$)	Crop Damage (2021$)	Injuries	Deaths
Primary Climate Change Interaction: Changes in Precipitation						
Flood	1996 - 2021	237	$83,237,213	$67,228	1	6
Dam and Levee Failure	*Data not collected by NCEI. Analysis source to be used: USACE National Inventory of Dams and Levees.*					
Karst and Land Subsidence	*Data not collected by NCEI. Analysis source to be used: USGS Engineering Aspects of Karst data and County historical data.*					
Drought	1996 - 2021	12	$0	$40,277,677**	0	0
Landslide	*Data not collected by NCEI. Analysis source to be used: USGS Landslide susceptibility data.*					
Wildfire	*Data not collected by NCEI. Analysis source to be used: AMS fire database.*					
Primary Climate Change Interaction: Rising Temperatures						
Extreme Heat	1996 - 2021	44	$0	$0	6	2
Primary Climate Change Interaction: Extreme Weather						
Winter Storm	1996 - 2021	265	$406,988	$208,282	0	1
Thunderstorm***	1955 - 2021	496	$2,578,924	$115,983	7	2
Extreme Wind***	1996 - 2021	57	$2,174,353	$145,543	2	1
Hailstorms***	1955 - 2021	79	$6,124	$21,438	0	0
Lightning***	1996 - 2021	22	$1,788,766	$0	5	1
Tornado	1950 - 2021	36	$6,067,480	$84,034	1	0
Tropical Cyclone	1996 - 2021	2*	$5,863	$0	0	0
Non-Climate-Influenced Hazards						

Earthquake	*Data not collected by NCEI. Analysis source to be used: USGS Earthquake Hazards Program data.*				
Total	**1,248**	**$96,265,711**	**$40,920,185**	**22**	**12**

*There are tropical storm/hurricane events were categorized as floods or not recorded in the NCEI database, due to the kind of damage and if damages were recorded.

** Zonal damages for three regional droughts spanning 1997 – 1999.

***Thunderstorms, extreme wind, hailstorms, and lightning are presented collectively under the Thunderstorm hazard profile. Previous plans, including the 2016 plan update, presented these hazards separately.

Federal Disaster Declarations

Presidential disaster declarations are issued for counties, independent cities, and towns when an event has been determined to be beyond the capabilities of state and local governments to respond. An emergency declaration is more limited in scope and does not provide the same long-term federal recovery programs as a presidential disaster declaration.

Two important sources for identifying hazards that can affect a locality are the record of federal disaster declarations and historic storm data. According to FEMA, since 1962, there have been 25 major disaster declarations for Maryland, of which 13 have been declared for Frederick County. Nine of the declarations were for flooding/severe storm and four were for winter weather. In addition, there have been five emergency declarations in Maryland; Frederick County was included in all five declarations. Table 3.6 presents the declared disasters in Frederick County and available FEMA recovery programs since 1962. While these events affected Frederick County, not all may have affected FCC's campus and facilities.

Table 3.6. Presidentially Declared Disaster for Frederick County

Disaster Number	Incident Type	Incident Date	Programs Declared			
			IH	IA	PA	HM
DR-309	Flooding, Severe Storm	8/17/1971		✓	✓	✓
DR-341	Flooding, Heavy Rains (Tropical Storm Agnes)	6/23/1972		✓	✓	✓
DR-489	Flooding, Heavy Rains	10/4/1975		✓	✓	✓
DR-522	Severe Storms, Flooding	10/14/1976		✓	✓	✓
DR-601	Severe Storms, Tornadoes & Flooding	9/14/1979		✓	✓	✓
EM-3100	Severe Snowfall & Winter Storm	3/13/1993			✓	✓
DR-1016	Severe Winter Weather & Ice Storm	2/8/1994			✓	✓
DR-1081	Severe Snow Storm (Blizzard of '96)	1/6/1996			✓	✓
DR-1094	Severe Storms, Flooding	1/19/1996		✓	✓	✓

Disaster Number	Incident Type	Incident Date	Programs Declared			
			IH	IA	PA	HM
DR-1139	Severe Storms, Flooding (Tropical Storm Fran)	9/6/1996		✓		✓
DR-1324	Severe Winter Storm	1/25/2000			✓	✓
EM-3179	Severe Snow Storm	2/14/2003			✓	✓
DR-1492	Flooding, Severe Storms, Wind (Hurricane Isabel)	9/18/2003	✓	✓	✓	✓
EM-3251	Sheltering, Evacuation (Hurricane Katrina)	8/29/2005			✓	
DR-1910	Severe winter storms and snowstorms	2/5/2010			✓	✓
EM-3335	Hurricane (Irene)	8/26/2011			✓	
EM-3349	Hurricane (Sandy)	10/26/2012			✓	
DR-4091	Hurricane (Sandy)	10/26/2012	✓		✓	✓
DR-4261	Severe winter storms and snowstorms	1/22/2016			✓	✓
DR-4374	Severe Storms, Flooding	5/15/2018			✓	
EM-3430	COVID-19	1/20/2020			✓	
DR-4491	COVID-19 Pandemic	1/20/2020		✓		

IH = Individual Housing PA = Public Assistance

IA = Individual Assistance HM = Hazard Mitigation

Source: FEMA Declared Disasters (as of August 2021).

Insurance Claims and Institutional Knowledge

Insurance claims were provided by the Finance Office. Information includes when the loss or event occurred, type of hazard event, and the number of claims for the specific event. Table 3.7 summarizes the number and amount of damages estimated as the result of various types of hazards, based on insurance claims, and institutional knowledge provided by the FCC CPT for events impacting campus.

Table 3.7. Historical Hazard Events and Related Insurance Claims at FCC

Date	Event	Insurance Claims Buildings Impacted
September 2003	Suspicious Package	Changed protocol, disrupted classes

February 5-6, 2010	"Snowmageddon"	
October 23, 2014	Monroe Plane Crash	Evacuation, disrupted classes
December 2015	Server Loss	Pipe leak in IT area of Gambrill Hall. Damages $72,000 filed insurance claim.
2015	Gas Leak	
2015	Off-site events at Frederick High School	Disrupted classes leaving
January 22, 2016	Snowstorm	Ice damaged gutters on Buildings L, H, E, and C. Estimate repair cost $7,700.
February 2018	Escaped liquid damage	Monroe Center – a fitting on a drainpipe separated and caused water damage to floor and carpet; claim filed
August 2015	Lightning	Discoloration was noticed on the precast concrete coping above the east entrance of Gambrill Hall after a lightning thunderstorm in the area; claim filed

Natural Hazards

Primary Climate Change Interaction: Changes in Precipitation

The frequency, severity, and magnitude of floods are affected by the amount of precipitation received in a region. As precipitation patterns change, so too does Frederick County's vulnerability to certain hazards. By the end of this century, Frederick County is projected to receive more than 46 inches of precipitation every year, an increase of roughly 16% compared to historical averages.[10] The region is also expected to experience more frequent and intense severe rainfall events. Given these projections, Frederick County's vulnerability to the following hazard may intensify in the coming decades.

Flood

Hazard Identification

Hazard Description

Flooding is the most frequent and costly natural hazard in the United States. A majority of presidential disaster declarations result from weather events where flooding was a major component. Flooding, as defined by the National Flood Insurance Program for insurance purposes, is "a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from: overflow of inland or tidal waters, unusual and rapid accumulation or runoff of surface waters from any source, or a mudflow."

A flood occurs when an area that is normally dry becomes inundated with water. Flooding can occur at any time of the year, with peak volume in the late winter and early spring. Snowmelt and ice jam breakaway contribute to winter flooding, while seasonal rain patterns contribute to spring flooding. Torrential rains from hurricanes and tropical systems are more likely in late summer. Development of flood-prone areas tends to increase the frequency and degree of flooding.

According to FEMA, there are several different types of inland flooding:

- **Riverine Flooding**: Also known as overbank flooding, it occurs when channels receive more rain or snowmelt from their watershed than normal, or the channel becomes blocked by an ice jam or debris. Excess water spills out of the channel and into the channel's floodplain area.
- **Flash Flooding**: A rapid rise of water along a water channel or low-lying urban area, usually a result of an unusually large amount of rain and/or high velocity of water flow (particularly in hilly areas) within a very short period of time. Flash floods can occur with limited warning.
- **Shallow Flooding**: Occurs in flat areas where a lack of a water channel results in water being unable to drain away easily. The three types of shallow flooding include:
    - **Sheet Flow**: Water spreads over a large area at uniform depth.
    - **Ponding**: Runoff collects in depressions with no drainage ability.
    - **Urban Flooding**: Occurs when man-made drainage systems are overloaded by a larger. amount of water than the system was designed to accommodate.

Frederick County largely suffers from riverine and flash flooding. Flash flooding (stormwater or pluvial flooding) as the name suggests, occurs suddenly after an intense but brief downpour, generally less than 6 hours. They

[10] NOAA. National Weather Service: Climate Prediction Center. 2021. Retrieved from https://www.cpc.ncep.noaa.gov/

move fast and terminate quickly. Although the duration of these events is usually brief, the damages can be quite severe. Flash floods also result as a secondary effect from other types of disasters, including dam breaks and denuded ground from large wildfires. Wildfires remove vegetative cover and alter soil characteristics, increasing the quantity and velocity of storm water runoff, and dam breaks release large quantities of water into receiving drainage ways in a very short timeframe. Flash floods can also deposit large quantities of sediments on floodplains and can be destructive of vegetation cover not adapted to frequent flood conditions. For more details on pluvial flood hazards, refer to Appendix A of the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Riverine (or fluvial) flooding occurs when a channel, such as a stream or river, receives more water than it can hold, and the excess water overflows the channel banks, flooding the surrounding area. Heavy rain and large amounts of snow melt can cause riverine flooding. Riverine flooding is a longer-term event than flash flooding, maybe lasting days or weeks. Riverine floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies use historical records to determine the probability of occurrence for different extents of flooding. The probability of occurrence is expressed as the percentage chance that a flood of a specific extent will occur in any given year. On the other hand, flash floods are more difficult to predict accurately and happen whenever there are heavy storms. For more details on flood hazards, refer to the flood section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Location

According to FEMA, most municipalities in the United States have at least one clearly recognizable area at risk of flooding around a river, stream, or large body of water. In support of the National Flood Insurance Program (NFIP), FEMA identifies and maps areas of flood risk (floodplains). The floods are often described in terms of annual percentage chance of occurrence. Floodplains have been delineated by FEMA to reflect the 1% and 0.2% annual flood events previously known as 100-year and 500-year floods, respectively. The area that has a 1% -annual-chance to flood each year is delineated as a Special Flood Hazard Area (SFHA) for the purposes of the NFIP. This flood is often referred to as the “base flood” or “100-year flood.” The 0.2%-annual-chance floodplain indicates areas of moderate flood hazard.

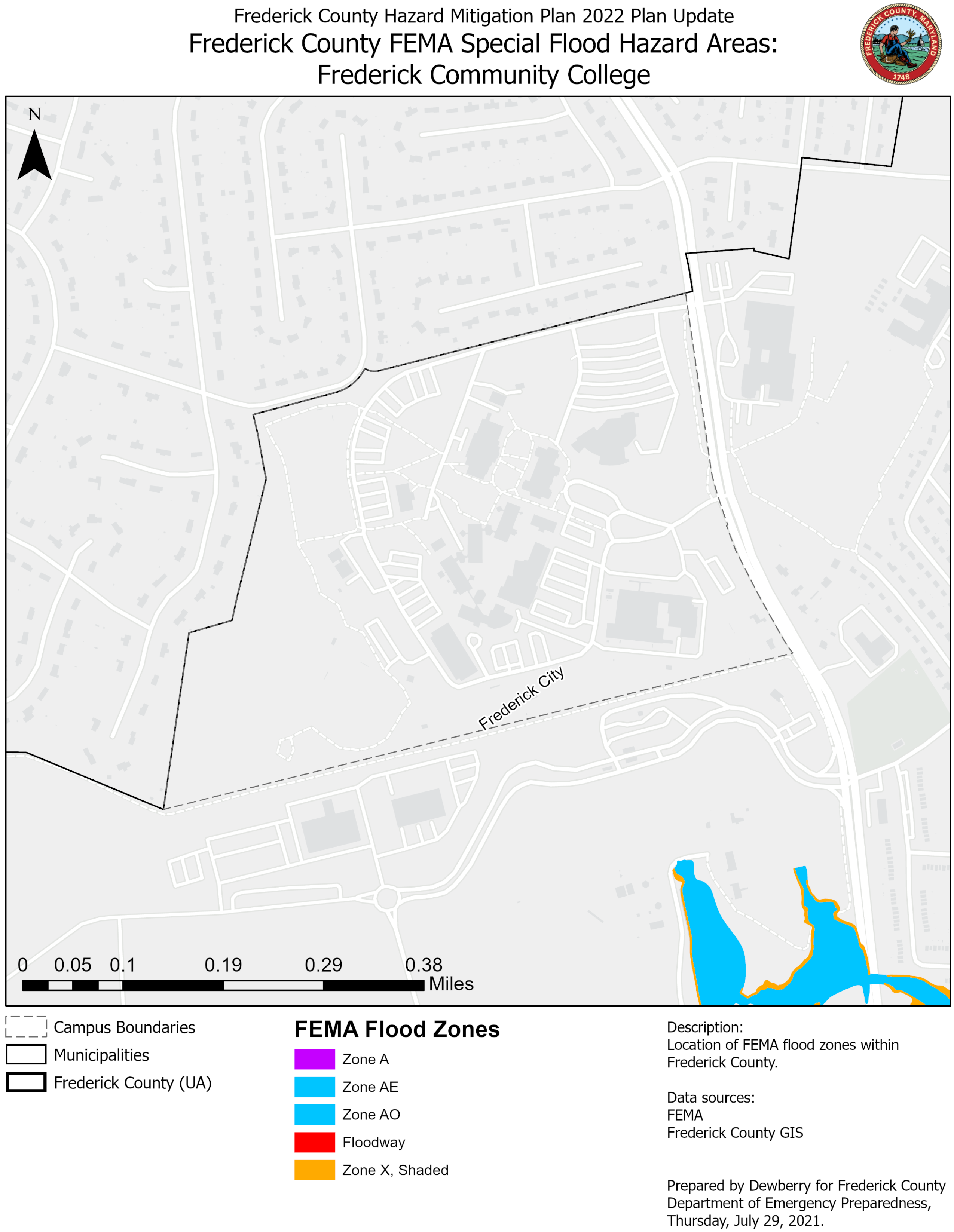
SFHAs in the county are delineated on a Flood Insurance Rate Map (FIRM) produced as part of a Flood Insurance Study (FIS). Major watercourses in Frederick County typically have SFHAs mapped as Zone AE while smaller tributary streams are mapped as Zone A. Other small streams have shading as Zone X, and other classifications are also possible. Table 3.8. Description of FEMA Flood Zones presents the various flood hazard zones (including coastal zones which will be discussed in the subsequent section) mapped on FIRM panels in Frederick County.

Table 3.8. Description of FEMA Flood Zones

Zone	Description
A	An area with a 1% chance of flooding in any given year for which no base flood elevations (BFEs) have been determined.
AE	An area with a 1% chance of flooding in any given year for which base flood elevations have been determined. This area may include a mapped floodway.
AO	An area with a 1% chance of flooding in any given year where average depths of flooding are between one and three feet.

Zone	Description
X (Shaded)	An area with a 0.2% chance of flooding in any given year for which no base flood elevations have been determined.
X (Unshaded)	An area that is determined to be outside of the 1% and 0.2%-annual-chance floodplains.

Figure 3.1. FEMA Flood Zones near Frederick Community College Campus



Extent

A number of factors contribute to the extent of a flood and the relative vulnerabilities of certain areas in the floodplain. Development, or the presence of people and property in the hazardous areas, is a critical factor in determining vulnerability to flooding. Additional factors that contribute to flood extent and vulnerability include:

- **Flood depth**: The greater the depth of flooding, the higher the potential for significant damages.
- **Flood duration**: The longer duration of time that floodwaters are in contact with building components, such as structural members, interior finishes, and mechanical equipment, the greater the potential for damage. Floodwaters may linger because of the low relief of the area, but the degree varies.
- **Velocity**: Flowing water exerts force on the structural members of a building, increasing the likelihood of significant damage. A one-foot depth of water, flowing at a velocity of five feet per second or greater, can knock an adult over and cause significant scour around structures and roadways.
- **Elevation**: The lowest possible point where floodwaters may enter a structure is the most significant factor contributing to its vulnerability to damage due to flooding. Data on the specific elevations of structures in Frederick County has not been compiled for use in this analysis.
- **Construction type**: Certain types of construction are more resistant to the effects of floodwaters than others. Masonry buildings, constructed of brick or concrete blocks, are typically the most resistant to flood damages simply because masonry materials can be in contact with limited depths of water without sustaining significant damage. Wood frame structures are more susceptible to flood damage because the construction materials used are easily damaged when inundated with water. The type of construction throughout Frederick County varies.

The strength or magnitude of a flood hazard is dependent on the factors above. For example, during a riverine flood, water slowly climbs over the edges of a stream or riverbed and spreads to the surrounding area. Observing the slow rise of water along with an area-wide flood warning usually gives adequate time to evacuate; however, because the rainfall associated with flash flooding is so intense and fast moving, it is not as easy to predict when a flash flood will occur. Specific extent of flash flooding is difficult to determine in advance because local terrain, soil conditions, and construction play a role in how much stormwater can percolate into the soil, be accommodated by waterways, or cause flash flooding.

Previous Occurrences

According to the NCEI, 18 flood events were reported in the City of Frederick, where the College is located, between 1996 to March 2021. Of these, nine events were classified as flash floods. These events have resulted in $133,576 of property damages, but no crop damages. A record of events by jurisdiction is in Table 3.9. All values have been adjusted for inflation to reflect 2021 values.

Table 3.9. NCEI Record of City of Frederick Flooding Events

Jurisdiction	Events	Property Damage (2021$)	Crop Damage (2021$)	Total Damage (2021$)
City of Frederick	18	$133,576	$0	$133,576
Frederick County (Total)	**230**	**$36,819,292**	**$67,228**	**$36,886,520**

Probability and Severity of Future Occurrences

FCC is located outside of the 1%-annual-chance and the 0.2% -annual-chance flood zones. As a result, the College has a very low chance to suffer from riverine flooding. However, there is always a risk for flash floods, poor drainage and low-lying floods, along with other riverine and stream flooding. While climate change impacts are expected to impact precipitation patterns, the probability of future floods can be discussed in relation to the benchmark flood, or the "1%-annual-chance" flood.

In addition to this statistical probability, there is also an increased chance of flooding in communities that are not maintaining natural floodplains and infrastructure. Urban flooding can often be minimized or avoided with consistent drainage system maintenance. In addition, by working to maintain clean floodways, natural floodplains will be allowed to flood normally, minimizing adjacent property damage. Table 3.10. shows the flood probability for the region.

Table 3.10. Flood Probabilities for the Region

Recurrence interval (years)	Probability of occurrence in any given year	Chance of occurrence in any given year
500	1 in 500	0.2%
100	1 in 100	1%
50	1 in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%

It is important to note that although a recurrence interval is given for a storm of a certain magnitude, that does not mean this size storm only occurs once in a certain number of years. For example, a 1%-annual-chance flood, or 100-year flood, has a 1% chance of occurring each year. There is always a chance that a storm of the same magnitude can occur in the same year.

Based on NCEI data, the City of Frederick, which encompasses FCC, experienced 18 flood events that recorded $133,576 in damages within a 25-year period between 1996 and 2021. Based on these occurrences, FCC can expect to witness 9.2 flood events and endure $1,475,461 in property and crop damages in any given year.

For a record of events for all jurisdictions, refer to the flood section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Table 3.11. Annualized NCEI Flood Events for City of Frederick

Jurisdiction	Events	Annualized Events	Total Damage (2021$)	Annualized Damages (2021$)
City of Frederick	18	0.72	$133,576	$5,343

Frederick County (Total)	**230**	**9.2**	**$36,886,520**	**$1,475,461**

National Flood Insurance Program (NFIP)

The National Flood Insurance Program (NFIP) is a federal program that enables property owners in participating communities to purchase insurance for flood losses. Floodplain management begins at the community level with operation of a community program of corrective and preventative measures for reducing flood damage. For a community to participate in the NFIP they must adopt FEMA's flood risk maps and the Flood Insurance Study as well as floodplain management regulations that reduce future flood damages. For more information on the NFIP, refer to the flood section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Table 3.12 summarizes community participation in the NFIP for the City of Frederick, which encompasses FCC. The current effective maps for FCC are from September 2007, with preliminary products issued December 2, 2020. As of August 2021, there were 229 flood insurance policies in effect throughout the City, with total annual premiums of $230,940 covering more than $71 million in property. The loss statistics from FEMA's Community Information System (CIS) database for the City of Frederick indicate that there have been 60 flood insurance claims processed by the NFIP since 1978. These statistics are summarized in Table 3.13.

Table 3.12. Community Participation in the National Flood Program (as of August 2021)

Community Name	Initial FHBM Identified	Initial FIRM Identified	Current Effective Map Date	Date of NFIP Entry
Frederick, City of	10/18/74	06/15/78	09/19/07	06/15/78

Table 3.13. Flood Insurance Policy Statistics and Claims (as of August 2021)

Community Name	No. of Policies	Total Premium	Total Coverage	Total Claims since 1978	Total Payments
Frederick, City of	229	$230,940	$71,531,400	60	$319,906

Flood insurance is available to anyone in Frederick County, including structures outside of the mapped SFHA, provided they are located in an NFIP-participating community. In some cases, therefore, the number of policies includes policies for structures that are outside the mapped SFHA. FCC is located within a participating community and does possess a flood insurance policy.

Impact Summary

Primary Impacts

Flood damage to property and populations can be devastating, both emotionally and financially. Flood damage to employment centers, like institutions of higher education, could result in loss of income, wages, and tax revenues. Buildings are susceptible to damage and sometimes collapse as a result of a severe flood.

Floodwaters can also block roadways and evacuation routes, as well as damage vehicles, if drainage in parking lots or along roadways is insufficient.

Secondary Impacts

Flooding can disrupt utilities and result in the accumulation of debris and garbage. Gas and electrical services may be interrupted, either because the lines got damaged by the floodwaters itself or suspended items like rocks or trees.

Vulnerability Assessment

Structures in the affected areas are more likely to experience the greatest effects of flooding. Flooding directly affects FCC's ability to function by damaging facilities and blocking roadways, preventing people from traveling to or from the campus. FCC facilities that are flooded may sustain damage to the structure and its contents that disrupt research or related activities, risking loss of existing or future grant funding.

Primary Climate Change Interaction: Extreme Weather

The frequency, severity, and magnitude of the hazards in the following section – winter storms and thunderstorms – are all affected by climate change. In Frederick County, average air temperatures and annual precipitation amounts are both projected to rise in the coming decades. As temperatures rise, certain atmospheric conditions that are ideal for extreme weather events to form may become more frequent, while others, like winter storms, may become rarer.

Winter Storm

Hazard Identification

Hazard Description

Winter storms can vary in size and strength and include heavy snowstorms, blizzards, freezing rain, sleet, ice storms, and blowing and drifting snow conditions. Extremely cold temperatures accompanied by strong winds can result in wind chills that cause bodily injury, such as frostbite and death. A variety of weather phenomena and conditions can occur during winter storms. For clarification, the following are National Weather Service-approved descriptions of winter storm elements:

- **Heavy snowfall** - the accumulation of six or more inches of snow in a 12-hour period or eight or more inches in a 24-hour period.
- **Blizzard** - the occurrence of sustained windspeeds over 35 mph accompanied by heavy snowfall or large amounts of blowing or drifting snow for more than three hours.
- **Freezing drizzle/freezing rain** - precipitation that falls as liquid, but freezes on contact with roads, trees, power lines and other surface structures that are below 32 degrees F, forming a dangerous glaze of ice.
- **Ice storm** - a type of winter storm characterized by freezing rain which results in a dangerous coating of ice on trees, power lines, and road surfaces.
- **Sleet** - solid grains or pellets of ice formed by the freezing of raindrops or the refreezing of largely melted snowflakes. Sleet does not cling to surfaces.
- **Wind chill** – a calculated temperature index that describes the combined effect of wind and low air temperatures on exposed skin.

For more details on this hazard, refer to the winter storm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Location

Winter weather affects the entirety of Frederick County, including FCC campus. While the probability of a winter storm occurring is roughly the same in all parts of the region, the risk of damage will vary depending on the density of infrastructure and development. There is a high probability for traffic accidents and traffic jams during heavy snow and light icing events. Roads may become impassable, inhibiting the ability of emergency equipment to reach trouble spots and the accessibility of medical and shelter facilities.

Extent

The severity of a winter storm is often relative to the conditions that the area of focus is accustomed to. There are some standardized tools that can be used to provide estimates on expected storm impacts, such as the National Weather Service's Winter Storm Severity Index (WSSI). This index is outlined in the winter storm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Previous Occurrences

There have been seven federal disaster declarations since 1993 related to severe snowfall and winter storms in Frederick County (Table 3.15). There was a total of 265 winter related events in Frederick County between 1996 and 2021 Table 3.14. According to the NCEI, there were 65 major winter storms, 1 major blizzard, 7 heavy snow events, and 7 ice storms. The remaining 184 events were classified as general winter weather events. These events have resulted in $406,988 of property damages and $208,282 in crop damages. For more details on these events, refer to the winter storm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Table 3.14. NCEI Historical Severe Winter Storm Events in Frederick County

Hazard Events	# of Events	Deaths	Injuries	Property Damage	Crop Damage	Total Damage
Blizzard	1	0	0	$33,614	$0	$33,614
Cold/Wind Chill	9	0	0	$0	$0	$0
Extreme Cold/Wind Chill	6	0	0	$0	$0	$0
Frost/Freeze	46	0	0	$0	$184,015	$184,015
Heavy Snow	7	0	0	$0	$0	$0
Ice Storm	7	0	0	$74,023	$24,267	$98,290
Winter Storm	65	1	0	$299,351	$0	$299,351
Winter Weather	124	0	0	$0	$0	$0
Grand Total	265	1	0	$406,988	$208,282	$615,270

Table 3.15. Presidentially Declared Disasters for Frederick County since 1993[11]

Disaster Number	Incident Type	Incident Date	Programs Declared			
			IH	IA	PA	HM
EM-3100	Severe Snowfall & Winter Storm	3/13/1993			✓	✓
DR-1016	Severe Winter Weather & Ice Storm	2/8/1994			✓	✓
DR-1081	Severe Snowstorm (Blizzard of '96)	1/6/1996			✓	✓
DR-1324	Severe Winter Storm	1/25/2000			✓	✓

[11] FEMA Declared Disasters (as of August 2021).

EM-3179	Severe Snowstorm	2/14/2003			✓	✓
DR-1910	Severe winter storms and snowstorms	2/5/2010			✓	✓
DR-4261	Severe winter storms and snowstorms	1/22/2016			✓	✓
IH=Individual Housing IA=Individual Assistance		PA=Public Assistance HM=Hazard Mitigation				

Four federally declared disasters have data related to Public Assistance grants. Table 3.16 lists some of the statistics for each disaster. There was a total of 96 projects for these 4 declarations. These projects had six different project types between them: debris removal, protective measures, roads and bridges, public buildings, public utilities, and recreational or other.

Table 3.16. Declared Disaster Public Assistance Statistics for Frederick County

Disaster Number	Incident Type	Incident Date	Number of Projects	Total Project Amount	Total Federal Amount
DR-1324	Severe Winter Storm	1/25/2000	14	$449,779	$337,334
DR-1910	Severe winter storms and snowstorms	2/5/2010	38	$1,373,538	$1,030,153
EM-3179	Severe Snowstorm	2/14/2003	16	$517,226	$387,919
DR-4261	Severe winter storms and snowstorms	1/22/2016	28	$2,217,175	$1,662,723
Totals			**96**	**$4,557,717**	**$3,418,130**

Frederick County typically experiences 10 to 11 severe winter events each year, this is up from 6 to 7 events as reported in the 2016 Hazard Mitigation Plan. Two such events since 2015 are described below. Events before 2015 are included in Appendix A.

- On January 22 to 23, 2016, coastal low pressure in the Mid-Atlantic paired with high pressure from the North resulted in blizzard conditions throughout the County. Heavy snowfall was reported in several communities: New Market reported 35in., Myersville reported 32in., and Thurmont reported 26in. On March 4, 2016, the event received a Federal Disaster Declaration (referenced in Table 3.16).
- Higher than average amounts of ice were reported between December 16 to 17, 2019, particularly over the Catoctin Mountains. Sabillasville and Thurmont received 0.45-0.50in. of coverage; Other areas only received up to 0.1in. of coverage.

For the college, winter storms have caused classes to be cancelled and campus to be shut down, resulting in loss of instructional time. No insurance claims have been filed due to winter related events and damages. Table 3.17 includes information on specific events that significantly affected FCC, its facilities, and operations.

Table 3.17. Damage History Due to Severe Winter Weather

Loss Date	Description	Damage Amount
February 5-6, 2010	"Snowmageddon"	
January 22, 2016	Snowstorm - Ice damaged gutters on Buildings L, H, E, and C.	Estimated repair cost $7,700.

Probability and Severity of Future Events

The FCC campus is vulnerable to winter storms. With many winter storms occurring during the past, the probability of winter storms occurring in the future is probable, and the effects of the storm may impact the College.

Based on the NCEI database, Frederick County has a high probability of experiencing severe winter storm events. NCEI-recorded winter weather events happen about five times a year, winter storms about two to three every year, an ice storm and a heavy snow event every three years, and some sort of cold/wind chill every one to two years. This information is summarized in Table 3.18.

Table 3.18. NCEI Probability of Severe Winter Storm Events in Frederick County

Hazard Events	# of Events	Annualized Events
Blizzard	1	0.04
Cold/Wind Chill	9	0.36
Extreme Cold/Wind Chill	6	0.24
Frost/Freeze	46	1.84
Heavy Snow	7	0.28
Ice Storm	7	0.28
Winter Storm	65	2.6
Winter Weather	124	4.96
Frederick County Total	**265**	**10.6**

Impact Summary

Primary Impacts

The primary impact of excessive cold is increased risk for frostbite, and potentially death as a result of over-exposure to extreme cold. If power outages occur and there is a lack of readily available heat sources, these impacts can become more widespread. Transportation delays and disruptions to power distribution networks can make getting aid to those affected more difficult, which can further place lives at risk. The impacts of winter storms are usually minimal in terms of property damage and long-term effects.

Secondary Impacts

Winter weather has the capacity to immobilize a region, cut communities off from emergency management personnel, and make travel impossible. When winter weather is paired with freezing rain and ice storms, utilities including water, gas, and electric can be compromised. Health threats can become severe when frozen precipitation makes roadways and walkways very slippery, when prolonged power outages occur, and when fuel supplies are jeopardized.

Vulnerability Assessment

Vulnerability to the effects of winter storms on buildings depends on the age of the building (and the building codes in effect at the time of construction), type of construction, and condition of the structure (i.e., how well it has been maintained, materials used, etc.).

Severe winter storms result in the loss of utilities, increases in traffic accidents, impassable roads, and lost income since normal commuting can be hindered. Snow and ice can be extremely hazardous because visibility is reduced, and surface accumulation reduces traction and strains power lines, roofs, and other structures.

All campus buildings are vulnerable to the effects of severe winter storms due to the potential disruption of services and transportation systems as well as possible structure failure due to heavy snow loads. Additional impacts, as noted previously by the College, include the following:

- Sidewalks retain water/puddles that freeze;
- Snow and ice buildup on parking garage top levels freeze, then melt, and re-freeze on parking deck ramps. No chloride products are used due concrete construction. Area quarantined to allow sun to melt and dry off;
- During and following blizzards, there is no place to pile snow without losing limited parking areas;
- Parking lot drains need to be plowed open to ensure drainage from parking lots;
- Fire hydrants are not marked and no visible posts to avoid covering with snow; and
- Flat roofs allow for snow/ice/water building up.

Thunderstorm

For the purposes of this hazard mitigation plan update, thunderstorm includes non-hurricanic and non-tornadic wind, lightning, and hail. Wind associated with hurricanes, wind associated with tornados, flooding, and winter storm are evaluated in their own sections.

Hazard Identification

Hazard Description

A thunderstorm is a convective rain or snow shower accompanied by lightning and thunder.[12] The National Weather Service (NWS) defines a thunderstorm as a localized storm produced by a cumulonimbus cloud and accompanied by lightning and thunder. Thunderstorms are typically the result of warm, moist air that is pushed upwards into the atmosphere where it cools and forms into cumulonimbus clouds. As the air continues to cool, it starts to form water droplets or ice. As these droplets or ice start to fall, they may collide and combine many times into larger forms before reaching the Earth's surface. Instability can be caused by surface heating or

[12] Nese, Jon M. and Grenci, Lee M. Kendall/Hunt. *A World of Weather, Third Edition.* Penn State Meteorology.

upper tropospheric (approximately 50,000 feet) divergence of air (rising air parcels can also result from airflows over mountainous areas).

Thunderstorms can form in any geographic region and are sometimes the cause of other natural phenomena such as downburst winds, heavy rain, flash floods, large hailstones, lightning, tornadoes, and waterspouts. While many thunderstorms produce relatively little damage, stronger "supercell" thunderstorms can produce heavy winds, hail, significant damaging lightning strikes, and even tornadoes. Such storms have historically caused significant damage, injury, and even death through the destruction of trees; damage to buildings, vehicles, and power lines; and direct lightning strikes.

This hazard also includes non-hurricanic and non-tornadic wind (straight-line and downburst winds), lightning, and hail, which are described in the following sections. For more details on these types of events, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Straight-Line Winds

Extreme wind events occur when there is a large difference in atmospheric pressure over a short distance, called a pressure gradient. High winds may occur during severe thunderstorms, in mountainous regions (wind flow down mountains), and in strong weather systems. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. The larger the pressure gradient over a certain area, the stronger the winds will generally be. Strong cold fronts and low-pressure systems separating two distinctly different air masses lead to strong winds. Typically, non-thunderstorm strong wind events occur most often in autumn, winter, and spring when the temperature difference between air masses is the greatest.

For more details on these types of winds and NWS classifications, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Downburst Winds

“Downbursts” cause the high winds in a thunderstorm. A downburst is a severe localized wind blasting down from a thunderstorm. Downburst activity is sometimes mistaken for tornado activity. Both storms have very damaging winds (downburst wind speeds can exceed 165 mph) and are very loud. These "straight line" winds are distinguishable from tornadic activity by the pattern of destruction and debris such that the best way to determine the damage source is to fly over the area. They are more common than tornadoes in Maryland. Downburst winds result from the sudden descent of cool or cold air toward the ground. As the air hits the ground, it spreads outward, creating high winds. Unlike tornadoes, downburst winds move in a straight line, without rotation. Depending on the size and location of downburst events, the destruction to property may be significant. Downbursts fall into two categories:

- **Microbursts** affect an area less than 2.5 miles in diameter, last 5 to 15 minutes, and can cause damaging winds up to 168 mph.
- **Macrobursts** affect an area at least 2.5 miles in diameter, last 5 to 30 minutes, and can cause damaging winds up to 134 mph.

Another widespread thunderstorm wind event is known as a derecho. Derechos are associated with lines (squall lines) of fast-moving thunderstorms that might vary in length and have the potential to travel hundreds of miles. Winds in these types of events can rival those of “weaker” tornadoes with gusts of 80 to 100 mph covering a wide area.

Lightning

Lightning is defined by the NWS as a visible electrical discharge (i.e. lightning bolt) produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground or between the ground and a cloud. According to NOAA, the creation of lightning during a storm is a complicated process that is not fully understood. In the initial stages of development, air acts as an insulator between the positive and negative charges. However, when the potential between the positive and negative charges becomes too great, a discharge of electricity (lightning) occurs. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes, but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder.

In-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom. Cloud-to-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom of a second cloud. Cloud-to-ground lightning is the most dangerous. In summertime, most cloud-to-ground lightning occurs between the negative charges near the bottom of the cloud and positive charges on the ground.

Hail

Hail is precipitation in the form of ice pellets larger than five mm that forms in thunderstorms between currents of rising air (updrafts) and currents of descending air (downdrafts). Hailstorms are violent and spectacular phenomena of atmospheric convection, always associated with heavy rain, gusty winds, thunderstorms, and lightning. Hail is a product of strong convection and occurs only in connection with a thunderstorm where the high velocity updrafts carry large raindrops into the upper atmosphere (where the temperature is well below the freezing point of water). For more details on hail, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Location

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. All areas of Frederick County are susceptible to thunderstorms and severe weather events. Fortunately, in Maryland, injury and death due to these events is relatively uncommon. Since 1996, only 4 deaths and 15 injuries were reported to NCEI. Although thunderstorm damage is expected each year, most events do not cause significantly reported or measured damage.

Most thunderstorm damage is associated with downbursts, which typically have a greater effect on elevated areas such as hilltops, ridges, and "wind corridors" within communities. Areas with more trees in proximity to power lines and structures are more vulnerable to the effects of thunderstorm damage than more urban areas.

Hailstorms occur more frequently in the late spring and early summer and are more common in the Midwest. The land area affected by individual hailstorms is not much smaller than that of a parent thunderstorm, an average of 15 miles in diameter around the center of a storm.

Extent

The strength of a thunderstorm is typically measured in terms of its effects, namely the speed of the wind, the presence of significant lightning, and the size of hail. In general, thunderstorm winds are less than tropical cyclone speeds, but strong winds associated with downbursts can be extremely hazardous and reach speeds up to 168 mph.

The NWS issues alerts for both thunderstorms and wind events. NWS Storm Prediction Center (SPC) issues Day 1, Day 2, and Day 3 Convective Outlooks that depict non-severe thunderstorm areas and severe thunderstorm threats across the contiguous United States. The categorical forecast specifies the level of the overall severe weather threat via numbers (e.g., 5), descriptive labeling (e.g., HIGH), and colors (e.g., magenta). The probabilistic forecast directly expresses the best estimate of a severe weather event occurring within 25 miles of a given point. The text narrative begins with a listing of severe thunderstorm risk areas by state and/or geographic region. This is followed by a concise, plain-language summary of the type(s) of threat along with timing that is focused on the highest-risk areas.

For more detail on the NWS classification system, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Wind

The NWS issues the following wind alerts:

- **Wind Advisory**—when sustained non-thunderstorm winds range from 25 mph to 39 mph and/or gusts to 57 mph.
- **High Wind Watch**—when there is the potential for non-thunderstorm high wind speeds to develop and pose a hazard, or otherwise be life-threatening.
- **High Wind Warning**—when non-thunderstorm high wind speeds are occurring and may pose a hazard or are life-threatening. For a High Wind Warning to be issued, non-thunderstorm winds either must be sustained at 40 mph or greater for one hour or longer, or 58 mph or greater than 58 mph for any duration.

Lightning

While there is no established index for lightning, a lightning strike is of minimum severity when it has limited impacts on the natural and built environment (ex. tree limbs and buildings) and major severity when it causes extensive damage (ex. loss of life, fire, structural damage). The potential damages resulting from lightning strikes are primarily injury, loss of life, power outages, business interruption, fire and minor structural damage. A false sense of security often leads people to believe that they are safe from a lightning strike because it may not appear to be near their location. However, lightning can strike 10 miles away from a rain column, which puts people who are still in clear weather at risk.

Hail

The severity of hail is measured by duration, hail size, and geographic extent. All of these factors are directly related to thunderstorms, which creates hail. There is wide potential variation in these severity components. Using the NWS definition for a severe thunderstorm, dime-sized hail is considered a minimum hazard and quarter-sized hail is considered a major hazard. Quarter-sized hail can cause significant damage to agricultural crops and livestock, as well as property such as automobiles, aircraft, and roofs. Although rare, large hailstones may even cause injury or death. The amount of cover obtained during a hailstorm can greatly reduce the risk to human health during these events. The size of hailstones is a direct function of the severity and size of the storm.

Previous Occurrences

There have been 6 federal disaster declarations related to severe storms in Frederick County. A summary of notable (e.g., damages greater than $10,000) of severe weather events can be found in the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Table 3.19 lists the number of severe weather events recorded in the City of Frederick, along with injuries, deaths, and damages. There have been 62 reports of thunderstorms since 1955, when the NOAA began keeping track of these occurrences in the NCEI Storm Events Database. Cumulatively, these events incurred more than $1.5 million in damages.

Table 3.19. NCEI Total Thunderstorm and Severe Weather Events (1955 - March 2021) for City of Frederick

Jurisdiction	Events	Injuries	Deaths	Total Damages (2021$)
City of Frederick	62	2	3	$1,516,025
Frederick County (All Jurisdictions)	**652**	**15**	**4**	**$6,831,131**

Probability and Severity of Future Events

Thunderstorms are a common occurrence in Maryland and occur on approximately 27 to 36 days each year. Lightning strikes are relatively infrequent in Maryland but can occur on any day, even if a thunderstorm is not happening. Windstorms, as mentioned previously, may occur as part of thunderstorms or independently. The predicted wind speed given in wind warnings issued by the NWS is for a one-minute average; gusts may be 25 to 30% higher. Hail does not occur with every thunderstorm. Although, it causes nearly $2 billion in crop and property damages, on average, each year in the United States.

This section summarizes the potential recurrence intervals for all of Frederick County based on recorded events and losses in the NCEI Storm Events database. In order to determine the average annualized number of hazard events, the total number of recorded events in the NCEI Storm Events Database were divided by the number of years the hazards were recorded. Table 3.20 shows the total period of record for each hazard event in this section. It is important to note that not all damages are captured in the NCEI data, so the number of events and dollar figures are likely higher than shown. All values were adjusted to 2021 dollars using CPI calculations to account for inflation.

Table 3.20. NCEI Record Periods (Severe Weather Events)

Hazard Type	NCEI Record Period	Years Recorded
Thunderstorm	1953-2021	68
Lightning	1996-2021	25
Extreme Wind	1996-2021	25

As summarized in Table 3.21, the City of Frederick can expect to experience thunderstorms or severe weather about twice a year. Thunderstorms and severe weather can be expected to incur nearly $50,000 every year. Because of how the hazard events were recorded, hail events were annualized separately, then added to the total, as hail has been recorded by NOAA since 1955 and the other events since 1996. For maps depicting probabilistic extreme wind events, refer to Figures 27 through 33 in Appendix E: Maps.

Table 3.21. NCEI Probability of Thunderstorms and Severe Weather Events in City of Frederick

Jurisdiction	Events	Annualized Events	Total Damage (2021$)	Annualized Damages (2021$)
City of Frederick	62	2.01	$1,516,025	$49,097
Frederick County (Total)	652	24.14	$6,831,131	$252,939

The formation of thunderstorms is linked to climate factors, but currently, the understanding of how climate change will affect the future frequency and severity of thunderstorms is still in development. Some studies show that climate change may lead to more frequent and intense severe thunderstorms, but to what extent this will affect Frederick County is unclear.[13] For more detail on the probability and severity of future events for Frederick County and all jurisdictions, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Impact Summary

Primary Impacts

The primary hazard caused by thunderstorm winds is the transport of debris, which can cause casualties and property damage. Immobility and damage to utilities are common impacts. Roads may become impassable due to flooding, downed trees, or a landslide, preventing students, staff, and faculty from accessing FCC's facilities. High winds may also cause damage to poles and lines carrying electric, telephone, and cable television service.

Lightning is responsible for many fires around the world each year and can injure or kill people as well as damage buildings not properly grounded. Hail up to the size of softballs damages cars, windows and structures, and kills livestock caught out in the open.

Strong (up to more than 120 mph) straight-line winds associated with thunderstorms knock down trees, power lines and mobile homes.[14] Extreme wind events pose a danger to Frederick County because they can result in localized or widespread power outages, property damage, and falling trees. Injury or death to people can result from falling objects or flying debris. For more details on estimating damages from wind, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Secondary Impacts

The most significant secondary hazard of windstorms is utility failure resulting from downed power lines and tree branches. As noted, high windstorms can cause localized or regional power outages, thus leading to exposure extreme temperatures for vulnerable populations. An example was the widespread power outages following Superstorm Sandy and the exceptionally cold temperatures which led counties to open additional shelters for displaced residents. An additional secondary hazard is traffic accidents that may occur when power to traffic control devices is disrupted.

Hailstorms, like many of the other hazards discussed, are often accompanied by other severe weather. One secondary effect of hailstorms is the damage to critical infrastructure which in turn may lead to utility failure. Additionally, extreme hailstorms impact traffic routes and may lead to transportation accidents.

Flash flooding, particularly in low lying areas, is a secondary effect of thunderstorms as intense rain often accompanies thunderstorms.

Vulnerability Assessment

Older facilities are more vulnerable to wind damage due to the age of construction and potential poor condition due to lack of maintenance. Evaluation criteria include the age of the building (and what building codes may

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[13] The Fourth National Climate Assessment. Volume II, Impacts, Risks, and Adaptation in the United States. U.S. Global Change Research Program, 2018.; Revised February 2020. https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf.
[14] NOAA. "Severe Weather 101: Thunderstorms." Retrieved from https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

have been in effect at the time of construction), type of construction, and condition of the structure (i.e., how well the structure has been maintained).

Human-Caused Hazards

Non-Climate-Influenced Hazards

Workplace or School Violence

Hazard Identification

Hazard Description

Workplace or school violence is violence or the threat of violence against workers/students. It includes any act or threat of physical violence, harassment, intimidation, or other threatening disruptive behavior that occurs at the worksite.[15] These incidents can be caused by fellow employees, by employers, students, administrators or by members of the general public. Acts of workplace or school violence could be a one-time incident or could occur repetitively over time, lasting weeks to years. Workplace or school violence can occur at or outside the workplace/school.

An example of workplace or school violence would be an active shooter, who is an individual actively engaged in killing or attempting to kill people in a confined and other populated area. In most cases, active shooters use firearms and there is not a pattern or method to their selection of victims. Active shooter situations are unpredictable and evolve quickly. The shooter in an active shooter scenario may be a sniper. A sniper is a concealed, usually skilled shooter who fires at exposed persons, typically using powerful high-energy, military-style assault rifles.

Location

Workplace or school violence can occur at or outside the workplace/school and can range from threats and verbal abuse to physical assaults and homicide. It can affect and involve employees, students, clients, customers, and visitors. Workplace or school violence includes locations such as churches, malls, etc. and may be the result of a person acting alone. [16]

Extent

Active shooter and workplace or school violence events can last minutes, hours, or days. Depending on the intent of the perpetrator, damages can be limited or extensive and can involve small firearms or large “stand-off” weapons (for example rocket propelled grenades).[17] In most cases in the United States, armed attacks involve small firearms and typically are a short duration (e.g., less than a few hours). Aggressors may target a specific person or group of people; they may also seek to make a political or social statement.

Previous Occurrences

FCC has not experienced workplace or school violence on campus. Table 3.7 provides a list of some of the deadliest school shootings in US history.[18, 19,20]

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[15] US Department of Labor, Occupational Safety and Health Act, www.OSHA.gov
[16] US Department of Labor, Occupational Safety and Health Act, www.OSHA.gov
[17] Reference Manual to Mitigate Potential Terrorist Attacks against Buildings. FEMA Publication 426. December 2003
[18] Workplace Shootings. http://www.emergency-management.net/workplace_shoot.htm
[19] “A Timeline of Recent Worldwide Shootings.” http://www.infoplease.com/ipa/A0777958.html
[20] “Deadliest U.S. mass shootings | 1984-2015” Los Angeles Times. Retrieved from http://timelines.latimes.com/deadliest-shooting-rampages/ on December 4, 2015.

Table 3.22. Deadliest US School Shootings

Date	Location	Description
October 1, 2015	Roseburg, OR	Christopher Sean Harper-Mercer shot and killed eight fellow students and a teacher at Umpqua Community College.
December 14, 2012	Newtown, CT	Adam Lanza, a 20-year old armed with an assault rifle, and two semi-automatic pistols entered Sandy Hook Elementary School and killed 20 children under the age of 7, and six employees. Prior to driving to the school, the gunman killed his mother in their Newtown home.
April 3, 2012	Oakland, CA	Former student One Goh killed seven people and injured three more at Oikos College.
April 16, 2007	Blacksburg, VA	A 23-year-old Virginia Tech student, Cho Seung-Hui, killed two in a dorm, and then killed 30 more two hours later in a classroom building. His suicide brought the death toll to 33, making the shooting rampage the deadliest in U.S. history. Fifteen others were wounded.
March 21, 2005	Red Lake, MN	After killing his grandfather and grandfather's companion, Jeff Weise, 16, opened fire at his school where he killed a teacher, a security guard, 5 students, and finally himself, leaving a total of 10 dead.
April 20, 1999	Littleton, CO	Eric Harris, 18, and Dylan Klebold, 17, opened fire at Columbine High School, killing 12 students and teachers and wounding 23 others before shooting themselves. The shooters had plotted to kill at least 500 and blow up the school for a year.
June 12, 1976	Fullerton, CA	Edward Allaway, a disgruntled janitor, shot and killed 7 and California State University at Fullerton.[21]
August 1, 1966	Austin, TX	Charles Whitman, 25 years old and a former engineering student, at the University of Texas, killed his wife and mother before he opened fire on the school from the school's tower. He killed 16 and injured 31.[22]

Probability and Severity of Future Events

Since there are no recorded incidents of workplace or school violence at Frederick Community College, using the typical approach of the hazard history to estimate future vulnerability would result in a 0% probability. A

[21] Pfeifer, Stuart. "Mass Killer Says He's No Longer Mentally Ill." Los Angeles Times, 5 June 2001. http://articles.latimes.com/2001/jun/05/local/me-6582
[22] "University of Texas Shooting Remembered." NPR. http://www.npr.org/templates/story/story.php?storyId=9619382

2014 study of active shooter incidents found an increasing trend in the number of events between 2000 and 2010 nationwide, which makes a zero percent probability seem unrealistic.[23]

Impact Summary

Primary Impacts

If an active shooter scenario were to occur, Frederick County's hospital could become overtaxed as the number of hazard-related trauma injuries increases. Victims may require differing levels of trauma care and will rely on hospitals from neighboring jurisdictions for support.

Secondary Impacts

Following an active shooter situation, those involved will need mental health screening and support. Additionally, some students, staff, and faculty may decide not to return to the College following an event, resulting in a drop in enrollment and employees.

Vulnerability Assessment

All schools and workplaces are vulnerable to this type of event, and the occurrences in cities throughout the country underscore the susceptibility of all areas to general domestic violence.

Localized Infectious Disease Outbreak

Hazard Identification

Hazard Description

A localized infectious disease outbreak is a sudden rise in the occurrence of a disease. Some outbreaks are expected each year, like influenza, or other respiratory or gastrointestinal diseases. Such infectious disease outbreaks can be foodborne, waterborne, vector-borne, environmental, or transmitted person-to-person.[24]

The following list summarizes potential disease outbreaks that could affect FCC and its campus:

- **Middle East Respiratory Syndrome** (MERS) is viral respiratory illness first reported in Saudi Arabia in 2012. It is caused by a coronavirus called MERS-CoV. Most people who have been confirmed to have MERS-CoV infection developed severe acute respiratory illness. They had fever, cough, and shortness of breath. About 30% of these people died. All the cases have been linked to 6 countries in or near the Arabian Peninsula. CDC continues to closely monitor the MERS-CoV situation globally and work with partners to better understand the risks of this virus, including the source, how it spreads, and how infections might be prevented. The risk to the general public is low.
- The **H5N1 or avian influenza**, was first detected in Guangdong, China in 1996 and has since been found in birds in numerous countries throughout Africa, Asia, and Europe.25 Asian H5N1 was first detected in humans in 1997 during a poultry outbreak in Hong Kong and has since been detected in poultry and wild birds in more than 50 countries in Africa, Asia, Europe, and the Middle East. Six countries are considered

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[23] Federal Bureau of Investigations, Law Enforcement Bulletin, January 2014. https://leb.fbi.gov/2014/january/active-shooter-events-from-2000-to-2012

[24] Monterey Bay Flu Watch. http://cns.miis.edu/flu_watch/history.htm

[25] The Prioritization of Critical Infrastructure for a Pandemic Outbreak in the United States Working Group Final Report. National Infrastructure Advisory Council. 16 January 2007. www.dhs.gov/xlibrary/assets/niac/niac-pandemic-wg_v8-011707.pdf

endemic for Asian H5V1 (Bangladesh, China, Egypt, India, Indonesia, and Vietnam. H5N1 is the most likely cause of a pandemic, though it is not the only possible cause.[26]

- **Foot and Mouth Disease** (FMD) is a severe, highly contagious viral disease of cattle and swine. It also affects sheep, goats, deer, and other cloven-hooved ruminants. It can be spread, unintentionally through contact with people wearing contaminated clothes/shoes. FMD causes production losses and hardships for farmers. As shown in the Agro Terrorism section, hoofed animals and products are a mainstay for farmers in Frederick. If an FMD outbreak occurs in the US, the disease could spread rapidly to all regions of the country through routine livestock movements.

Location

Disease outbreaks are more likely to occur in areas where individuals are traveling from other places and in close contact with one another, making it possible for a disease to spread.

Extent

The severity and duration of a disease outbreak will depend on the disease's specific characteristics, such as how it is transmitted, and the available countermeasures, such as treatments or medications.

Previous Occurrences

Frederick Community College has not experienced events or damages related to localized infectious disease outbreaks. The following list summarizes non-major animal or plant disease historical incidents:

- The 2014 Ebola Virus Disease outbreak primarily affected countries in western Africa, though Ebola cases were diagnosed in the United States and other countries. The Frederick County Health Department monitored the situation and worked closely with community and state partners in preparing for and responding to situations that might be related to Ebola. Although there were no cases of Ebola Virus Disease in Maryland, the Maryland State Department of Health and Mental Hygiene monitored hundreds of travelers returning from affected countries. The Frederick County Health Department was involved in monitoring those returning travelers categorized at a higher risk level. The county health department continues to work to improve its capabilities to handle patients with Ebola or other highly communicable diseases.
- A strain of bird flu, scientifically known as Highly Pathogenic Avian Influenza (HPAI), entered the Pacific Northwest in December 2014 by migratory waterfowl. As of July 2015, the virus has infected more than 48 million birds in 15 states. As of August 2015, no detections had been reported in Maryland.[27] The virus is not known to threaten human health but can wipe out flocks of poultry within days. In Frederick County, several birds tested positive, but through a site inspection and additional testing, it was determined that the virus was not HPAI.
- There have been 24 confirmed cases of bovine spongiform encephalopathy (BSE) ("mad cow disease") in North America from 1993 through February 2015.[28] Twenty of the cases were in Canada and four in the US. Between 1996 and 2014, there have been four US cases of Variant Creutzfeldt-Jakob Disease (vCJD).[29] Millions of cattle have been destroyed on suspicion of contracting mad cow disease, costing billions of dollars. National milk producers have worked on plans for mitigating milk movement.

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[26] CDC Highly Pathogenic Asian Avian Influenza. August 2015.

[27] USDA Animal and Plant Health Inspection Services. http://www.aphis.usda.gov August 2015

[28] Centers for Disease Control and Prevention. BSE in North America. http://www.cdc.gov/prions/bse/bse-north-america.html August 2015.

[29] Centers for Disease Control and Prevention. Variant Creutzfedt-Jakob Disease. http://www.cdc.gov/prions/vcjd/index.html August 2015.

- In 1996, a small outbreak of a fungus disease called Karnal blunt occurred in wheat seeds in Arizona. As a result, more than 50 countries restricted trade with the U.S. The total cost of clean-up was around $45 million, and the reduction in exports cost $250 million.[30] In 1983, highly pathogenic avian influenza struck Pennsylvania. About 17 million chickens were disposed of, costing $86 million. The price of poultry increased, costing consumers $548 million, and an additional $7 million in wages were lost.
- Between 1970 and the present, several versions of leaf blight have destroyed over 10 million acres and $1 billion of crops.

Probability and Severity of Future Events

College campuses, due to their relatively high density of population and residential nature, are susceptible to disease outbreak. Given the data available, a potential recurrence interval or probability is not able to be calculated.

Impact Summary

Primary Impacts

The primary impacts of a disease outbreak will be felt by those who contract the disease, but specific effects will depend on the disease characteristics. If the disease prevents infected individuals from attending work or school, then FCC may witness lowered class attendance or even understaffing of facilities. The risk of property and infrastructure damage is low or even nonexistent.

Secondary Impacts

Depending on the disease characteristics, localized outbreaks could result in cancelled classes or events to prevent additional transmission or due to low student attendance and available staff.

Vulnerability Assessment

All college campuses are vulnerable to localized disease outbreaks due to their relatively higher density of people working and interacting with another for extended periods of time.

Pandemic

Hazard Identification

Hazard Description

A pandemic refers to an infectious disease outbreak that spreads across countries or continents.[31] This type of hazard affects more people than a localized outbreak or epidemic.

At the time of this plan update, the novel coronavirus (COVID-19) pandemic continues to affect Frederick County and has disrupted lives and economic activities worldwide since its first appearance in late 2019. Since early 2020, COVID-19 has infected more than 310 million people and resulted in roughly 5.5 million deaths.[32] In Frederick County alone, there have been more than 37,000 cases and nearly 425 recorded deaths due to COVID-19 as of mid-January 2022.[33]

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[30] Kohnen, Anne. Responding to the Threat of Agro terrorism: Specific Recommendations for the United States Department of Agriculture. October 2000. http://ianrhome.unl.edu/c/document_library/get_file?folderId=3562&name=DLFE-282.pdf p. 4-5

[31] State of Maryland. 2021. *2021 State of Maryland Hazard Mitigation Plan.* Retrieved from https://aecomviz.com/MEMA-Maryland-360/Doc/MEMA%20HazMitPlan.pdf#page=156

[32] The New York Times. 2022. "Coronavirus World Map: Tracking the Global Outbreak." Retrieved from https://www.nytimes.com/interactive/2021/world/covid-cases.html.

[33] Frederick County. 2022. "COVID-19 in Frederick County." Retrieved from https://frederickcountymd.gov/8094/COVID-19-in-Frederick-County

Location

By definition, pandemics are infectious diseases that affect large geographic areas, such as entire countries or event worldwide. The locations that are affected by pandemics will depend on how the disease is transmitted, such as whether it is transmitted from animals to humans or human to human.

Areas that are more densely population are more likely to experience a higher transmission rate. However, some rural areas tend to have higher shares of people that have pre-existing conditions or limited access to healthcare that make them more susceptible to infection or severe illness.

Extent

The severity of a pandemic depends on the disease's specific characteristics, such as how it is transmitted, the availability of countermeasures and treatments, its mortality rate, and to what extent the population has pre-existing immunity to the disease.

Previous Occurrences

At the time of this plan update, the COVID-19 pandemic is still active, with new cases recorded daily in Frederick County. Prior to 2020, there were no recorded occurrences of pandemics affecting FCC. The following list summarizes major pandemics that have affected the county:

- The **1918 Spanish Flu Pandemic** was caused by an H1N1 virus with genes of avian origin, but unknown geographic origin. The Spanish Flu spread globally between 1918 and 1919, infecting 500 million – a third of the world's population – and killing at least 50 million globally, including 675,000 in the United States.[34] In Maryland specifically, the first cases were recorded at Camp Meade in September 1918, and by the next year, tens of thousands of cases were reported in Baltimore.[35]
- The **2009 H1N1 "Swine" Flu Pandemic** was first detected in the United States and quickly spread throughout the country, resulting in the Maryland Governor declaring a State of Emergency and the closure of many Maryland schools. By April 2010, more than 1,700 cases of the swine flu had been recorded in Maryland, resulting in at least 45 deaths.[36] In 2010, the widespread deployment of the Swine Flu vaccine ended the pandemic.
- The **2020 COVID-19 Pandemic** is a respiratory virus that first appeared in Wuhan, China in late 2019. In Maryland, the first recorded cases were identified on March 3, 2020, at which points the Governor declared a State of Emergency. Throughout March 2020, the COVID-19 cases rose globally and in Maryland, resulting in the closure of schools, private businesses, and government buildings. By March 26, 2020, FEMA issued a Major Disaster Declaration for Maryland for the COVID-19 pandemic. At the time of this plan update, Maryland has had more than 850,000 reported cases of COVID-19 and more than 12,000 deaths.[37]

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[34] Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases (NCIRD). 2019. *1918 Pandemic (H1N1 virus).* Retrieved from https://www.cdc.gov/flu/pandemic-resources/1918-pandemic-h1n1.html

[35] State of Maryland. 2021. *2021 State of Maryland Hazard Mitigation Plan.* Retrieved from https://aecomviz.com/MEMA-Maryland-360/Doc/MEMA%20HazMitPlan.pdf#page=158

[36] State of Maryland. 2021. *2021 State of Maryland Hazard Mitigation Plan.* Retrieved from https://aecomviz.com/MEMA-Maryland-360/Doc/MEMA%20HazMitPlan.pdf#page=159

[37] The New York Times. 2022. "Tracking Coronavirus in Maryland: Latest Map and Case Count" https://www.nytimes.com/interactive/2021/us/maryland-covid-cases.html

Probability and Severity of Future Events

College campuses, due to their relatively high density of population and residential nature, are susceptible to the quick spread of pandemics. Given the data available, a potential recurrence interval or probability is not able to be calculated.

Impact Summary

Primary Impacts

The primary impacts of a pandemic will be felt by those who contract the disease, but specific effects will depend on the disease characteristics. If the disease prevents infected individuals from attending work or school, then FCC may witness lowered class attendance or even understaffing of facilities. The risk of property and infrastructure damage is low or even nonexistent.

Secondary Impacts

As witnessed with COVID-19, pandemics can result in the disruption of economic and everyday activities. To prevent further spread of pandemic, some activities may be canceled or transitioned to a virtual environment. For example, FCC transitioned to virtual learning to accommodate students during the COVID-19 pandemic. The inability to conduct research work or other economic activity could result in loss of income for FCC and businesses in the area.

Vulnerability Assessment

All college campuses are vulnerable to pandemics due to their relatively higher density of people working and interacting with another for extended periods of time.

CHAPTER 4.CAPABILITY ASSESSMENT

A capability assessment evaluates the existing programs and resources in order to determine the extent of mitigation activities that are already in place and helps to emphasize the potential for new strategies. Through a thorough review of Frederick Community College's financial resources, personnel expertise, and existing mitigation activities, planners can reach a better understanding of factors that may influence the College's ability to implement mitigation actions that address the effects of the hazards identified in Chapter 3. This assessment includes a comprehensive assessment of:

- Administrative Capabilities
- Plan and Program Capabilities
- Fiscal Capabilities
- Regulatory Environment
- Community Interaction

Administrative Capabilities

Faculty, administrative offices, staff, academic departments and students contain a wealth of physical and metaphysical resources that contribute to the overall functioning, safety, and security of the College. This section attempts to identify those pre-existing resources that may assist in bettering the mitigation strategy.

Administrative Organization

The staff/technical capabilities have been identified as part of the FCC CPT capability assessment questionnaire. Personnel capabilities include:

- Emergency management
- Engineers or professionals trained in construction practices related to buildings and/or
- Infrastructure
- Planners with an understanding of natural and/or human-caused hazards
- Resource development staff or grant writers
- Risk Management and Public Service: Prepared Emergency Response Guidebook
- Crisis Management Team (CMT)

The CMT advises the President on all issues related to prepare for, mitigate, respond to, and recover from an emergency. The FCC COOP integrates the daily organizational structure and functions of the college during the short- and long-term recovery efforts. The CMT guides all college efforts related to emergency drills and exercises, and improvement actions and subsequent changes in the COOP.

Police Department

FCC places a high priority on maintaining a safe environment for all students, staff, faculty, and guests. Security staff routinely patrol our campus and provide services including evening accompaniment to vehicles, assistance to ill or injured persons, and help with lost property. FCC security works closely with local first responders to respond to emergencies and manage criminal incidents.

The security staff does not have arrest powers but works cooperatively with the Frederick City Police Department through a Memorandum of Understanding (MOU). These local authorities investigate and prosecute violations of traffic and criminal laws on campus.[38]

Academic Organization

FCC administers over 80 different degree and continuing education programs. With more than 104 full-time faculty and 286 part-time faculty within the FCC community command expertise in subject matters that may hold potential in assisting the development and implementation of a Hazard Mitigation Plan. [39] FCC is the only college in the country contracted with FEMA's Emergency Management Institute (EMI) to provide college credit for the Emergency Management Independent Study Program.[40] In Table 4.1 below, departments have been selected as potential resources.

Table 4.1. Academic Programs with Potential for Hazard Subject Matter Expertise

Academic Programs	
Fire Science	Emergency Management
Communications	Computer Science and Computer Aided Design
Building Trade Technologies	Geographic Information Systems
Construction Management and Supervision	Government and Politics
Information Technology Specialist	Police Science

Plan and Program Capability

The College has invested significantly in its emergency planning and preparedness programs. These programs have contributed to the wellbeing of community residents, employees and visitors, as well as enhancing the ability of the College to respond to major events.

College Plans and Programs

FCC is in the process of updating its Facilities Master Plan to determine future changes in buildings and other facilities. The College has also identified the need to upgrade its stormwater management program, which has not been updated in the last five years. Several college-wide, board approved policies address hazard mitigation, including: Alcohol, Tobacco, Opioid, and Other Drug Use Awareness, Behavioral Evaluation and Response Team, Weapons, and Use of Facilities.

Tables 4.2 and 4.3 describe the various plans that the College and local community have in place and provide recommendations, where appropriate, for integration with the hazard mitigation plan.

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[38] http://www.frederick.edu/faculty-staff/campus-security.aspx
[39] Frederick Community College. 2017. *Frederick Community College Facilities Master Plan 2012-2022: Five Year Update – 2017-2022.* Retrieved from https://apps.frederick.edu/Flipbook/FacilitiesMasterPlan/files/assets/common/downloads/FacilitiesMasterPlan.pdf
[40] Emergency Management. Frederick.edu. Frederick Community College. 4 April 2014.

Table 4.2. FCC Planning Capabilities

Plan Name	Description	Integration Options
Facilities Master Plan 2017 - 2022	Includes a narrative highlighting any facility deficiencies or needs, the responsibilities of the college, background data on campus facilities, facility user data, an evaluation of existing facilities, a description of programs and services at the college and any changes to these programs, an evaluation of the adequacy of the facilities to meet current and projected needs, proposals to address the assessed needs and a prioritized list of recommended projects based on the assessed needs. This process will lead to the development of sound capital planning to guide the physical development of the college's facilities.	Recommendations: Ensure Master Plan and HMP recommendations are integrated.
Continuity of Operations 2018	Created through a collaborative effort with Risk Management/Public Services and College Administration, the Continuity of Operations Plan (COOP). A COOP event is defined as a weather, geological, or human-caused event that has the potential to keep students, faculty, staff, contractors, and visitors away from the main campus or Monroe Center for an extended period of time. The data contained in the COOP will support the Crisis Management Team (CMT) in decision-making during emergencies by providing a framework for deliberate and informed steps to be taken that will guide the College towards recovery.	Recommendations: Ensure COOP, CMT, and HMP recommendations are integrated. Use results of HIRA to inform update/review/exercise.
Technology Strategic Plan 2015 - 2020	Provides a unified and inclusive strategic framework for the funding, planning and implementation of near and long-term technology needs of the College. The plan addresses many factors, most prominent of which are the interdependencies of technology areas that have traditionally been distinct but have evolved over time to have convergent dependencies.	Information only
Approved Operating Budget FY 2021	Includes FCC operating budget, capital budgets, auxiliary budgets, and compensation scales.	Information only
FCC Forward: Strategic Plan 2020 - 2025	Outlines the mission, values, vision and goals for Frederick Community College.	Recommendations: Align strategic goals with hazard mitigation goals and objectives.
Annual Information	Update yearly and addresses actions needed to maintain integrity of the system.	Information only

Technology Security Plan		
Emergency Response Guidebook Rev. 2019	Supply readily accessible information for use in emergency situations ranging from high risk emergencies resulting from natural disaster or an intruder, to everyday accidents, injuries or property crimes. The guide provides "best practice" responses to situations that may be encountered by members of the campus community.	Information only
Weapons Policy and Procedures Rev. 2021	Defines policies and procedures regarding weapons and exceptions to the policy.	Information only

Table 4.3. Local Plans and Programs

Plan Name	Description	Integration Options
Frederick County Hazard Mitigation and Climate Adaptation Plan 2022	The Frederick County Hazard Mitigation and Climate Adaptation Plan identifies goals and measures for hazard mitigation and risk reduction to better ensure that the participating communities are disaster resistant. The plan not only addresses current concerns but has also been developed to help guide and coordinate mitigation activities and local policy decisions for future land use. This plan follows FEMA's planning requirements and associated guidance for developing Local Hazard Mitigation Plans.	Recommendations: Continue coordination between college and county.
Frederick County Emergency Operations Plan	The basic plan describes the concept of emergency operations and assigns duties and responsibilities to agency heads or organizations which are either part of, or will serve in support of, local government in time of emergency. It becomes the organizational and legal basis for emergency operations. Functional annexes and hazard-specific appendices to the basic plan provide additional guidance and set forth detailed procedures as needed to assure an appropriate level of emergency preparedness.	Recommendations: Ensure the College participates in next update of the EOP.
Mid-Atlantic Center for Emergency Management & Public Safety (MACEM&PS)	FCC operates the MACEM&PS, an instructional program in preparedness and response, including emergency management, fire, police, criminal justice, and GIS.	Information only.

Fiscal Capability

FCC's FY21 approved budget was $63,781,689; the FY21 budget included a 29.8% increase from FY16, and a 0.96% increase from FY20. Table 4.4 summarizes the budget by college function. Instruction accounts for 39.8% of FCC revenue, followed by 20.1% other revenue (includes Auxiliary Services, Direct Program Services, Student Support, Scholarships and Student Aid), 16.6% in instructional support, 11% in Plant Operations, 10.5% in Student Services, and 1.8% in Academic Support. The college's main source of revenue come from Tuition and Fees (24%), State appropriations (17%), County appropriations (32%), and Grants (8%).

Table 4.4. FCC Fiscal Years 2020 and 2021 Approved Budgets by Function

Function	FY 2020 Approved	FY 2021 Approved
Instruction	$25,830,429	$25,408,980
Academic Support	$1,201,017	$1,168,427
Student Services	$7,898,436	$6,722,481
Plant Operations	$7,019,766	$7,031,292
Instructional Support	$9,457,472	$10,615,657
Other*	$11,766,214	$12,834,852
Total	**$63,173,334**	**$63,781,689**

*Other Revenue = Auxiliary Services + Direct Program Services + Student Support + Scholarships + Student Aid

Maryland State Policies and Plans

Maryland State Hazard Mitigation Plan

Maryland State's most recent Standard Hazard Mitigation Plan was approved by FEMA in August 2016. Sections 1-5 and 1-6 outline the process to engage Maryland's 23 counties and 139 municipalities in hazard mitigation planning.

The Mitigation Strategy (Section 5) describes the process to create, and refine the state's mitigation goals, objectives, and actions. Table 4.5 outlines the goals and objectives within the plan relevant to FCC's mitigation plan.

Table 4.5. 2016 Maryland State Mitigation Goal and Objectives

Goal	To protect life, property, and the environment from hazard events through:
Objectives	Increased public awareness of hazards, mitigation, preparedness, and resiliency.
	Enhanced coordination with local jurisdictions and linkages between state and local mitigation and resiliency efforts.

	Protection of State assets, infrastructure, and critical facilities
	Promote actions that protect natural resources, while enhancing hazard mitigation and community resiliency.
	Efficient use of State resources

Actions were developed by five subcommittees which formed during topical break-out sessions during the meeting:

1. Programs, Policy, Planning and Funding
2. Mitigation of High Hazard Structures
3. Local Planning Interface
4. 2014 Vulnerability Analysis
5. Education and Outreach

Maryland's 2016 Standard Hazard Mitigation Plan further identifies the criteria used in prioritizing mitigation actions. The FCC mitigation strategy development process will take these criteria – as well as the State's goals and objectives – under consideration when identifying its own goals, objectives and strategies for FCC.

State of Maryland Response Operations Plan (SROP) - March 2015

The Maryland State Response Operations Plan (SROP) describes the roles and responsibilities of entities within Maryland during incident response operations. Response operations focuses on ensuring that the State is able to effectively respond to any threat or hazard, including those with cascading effects, in order to save and sustain lives, protect property and the environment, stabilize the incident, rapidly meet basic human needs, and restore essential community services and functionality.[41]

The objectives of the SROP include:

- Maintain 24/7 situational awareness across the State of Maryland, the nation, and around the world.
- Coordinate the activities of State, local, Federal agencies, nonprofit organizations, and private-sector partners in support of incident response.
- Facilitate the transition from incident response to disaster recovery.

The SROP addresses the risks identified in the State's annual Threat and Hazard Identification and Risk Assessment (THIRA), and triennial Hazard Identification and Risk Assessment (HIRA).

Regulatory Environment

State

Uniform Statewide Building Code

Maryland's law related to building codes is called the Maryland Building Performance Standards (MBPS). It requires each jurisdiction in Maryland to use the same edition of the same building codes that are the

[41] Maryland State Response Operations Plan (SROP). Retrieved from https://mdem.maryland.gov/Documents/SROP_V3_03_MAR-15.pdf

International Building Code (IBC), the International Residential Code (IRC), and the International Energy Conservation Code (IECC). The State has modified the IBC and the IRC to coincide with other Maryland laws. The International Building Code (IBC), the International Residential Code (IRC), and the International Energy Conservation Code (IECC), with modifications by the State constitute the Maryland Building Performance Standards (MBPS).

Each local jurisdiction in Maryland may modify these codes to suite local conditions with exception to the 2021 International Energy Conservation Code (IECC - The Energy Code) and Maryland Accessibility Code (MAC - The Accessibility Code). The Energy Code and the Accessibility Code can be made more stringent but not less by the local jurisdictions.

Maryland building performance standards are based on the 2021 I-codes. Effective May 2011, Maryland became the first state to legislatively adopt ICC.[42] This includes:

- 2021 International Building Code
- 2021 International Energy Conservation Code
- 2018 International Green Construction Code
- 2021 International Mechanical Code
- 2018 International Plumbing Code
- 2018 International Residential Code

In addition, Frederick County has jurisdictionally adopted:

- 2021 International Building Code
- 2021 International Energy Conservation Code
- 2021 International Fuel Gas Code
- 2021 International Mechanical Code
- 2018 International Plumbing Code
- 2021 International Residential Code

Establishing Preparedness Initiatives in State Government

Governor Martin O'Malley issued Executive Order 01.01.2013.06 on October 29, 2013 to adopt the Maryland's Emergency Preparedness Program (MEPP) [43]. The order outlines the roles and responsibilities related to the four mission areas used for measuring preparedness — prevention and protection, hazard mitigation, incident response and disaster recovery. Maryland Emergency Management Agency (MEMA), Maryland State Police, and other state agencies are charged with fulfilling the activities that support those four core mission areas. The executive order requires that state agencies develop or maintain documents necessary to support MEPP, at a minimum Continuity of Operations Plans that are updated bi-annually.

[42] International Code Council. State Adoptions. http://www.iccsafe.org/about-icc/government-relations/map/maryland/

[43] Maryland State Executive Order 01.01.2013.06 http://mema.maryland.gov/Documents/MEPP_01.01.2013.06eo.pdf

CHAPTER 5. MITIGATION AND ADAPTATION STRATEGY

This chapter presents a series of goals and objectives to help Frederick Community College identify and select mitigation and adaptation actions to address its vulnerabilities, as discussed in Chapter 3. The selected mitigation actions will help the college avoid, prevent, or otherwise reduce damages from hazards.

Mitigation Goals and Objectives

Definitions

Goals: general guidelines that explain what you want to achieve; usually broad, long-term policy statements representing global visions.

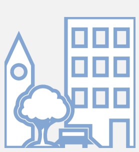
Objectives: define strategies or implementation steps to attain the identified goals; specific and measurable.

Frederick County's HMPC, which included FCC representation, met October 14, 2021 to discuss goals and objectives for the mitigation plan. At this meeting, members discussed the results of the Hazard Identification and Risk Assessment, which identified vulnerabilities in the context of the capability assessment, prior to establishing the revised mitigation goals.

The FCC CPT reviewed the mitigation goals from the main Frederick County Hazard Mitigation and Climate Adaptation Plan and adapted them to better align with FCC's specific needs and vision. The adapted goals and objectives for FCC are outlined in Table 5.1.

Table 5.1. Goals and Objectives

Mitigation Category	Goal	Objective
Physical Projects 	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
		Objective 2: Increase the percentage of critical equipment and property that is protected from hazards (e.g., data storage, paperwork, lab equipment, hazardous materials).

Mitigation Category	Goal	Objective
Capability and Capacity Building 	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.	Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards.
		Objective 4: Advance hazard mitigation and climate adaptation-related training and development.
		Objective 5: Ensure students, faculty, staff, and visitors can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Awareness and Education 	Goal C: Improve the community's awareness of potential hazards, education on resilience planning, and methods to reduce risk.	Objective 6: Use public information and education programs to support community members' decision-making on how to protect themselves from hazard events.
		Objective 7: Increase the public's awareness of their natural hazard risks.
Forward-Looking Policy and Planning 	Goal D: Adapt to climate change and natural hazards through forward-looking policies and plans.	Objective 8: Integrate hazard mitigation, climate adaptation, and resilience planning into other college planning efforts.
		Objective 9: Implement plans and policies that encourage future—or significantly renovated—infrastructure to be made resilient to future climate impacts.

Identification of Mitigation Actions

At the November 30, 2021 meeting, the FCC CPT was provided with an overview of the types of mitigation actions that could be undertaken. The committee then was provided a range of potential mitigation actions specific to the FCC's vulnerabilities and capabilities which included the mitigation projects previously proposed by FCC. Information from the FCC Continuity of Operations Plan and the FCC Master Plan was also used to inform the discussion. The committee reviewed the list and refined it further based on their knowledge of the college. Carry-over actions were included in the list, which the CPT had already evaluated and provided updates for at the first local planning team meeting.

Prioritizing Actions

The FCC CPT used the STAPLE/E (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) criteria to select and prioritize the most appropriate mitigation and adaptation alternatives (see Table 5.2). This methodology requires that social, technical, administrative, political, legal, economic, and environmental considerations be taken into account when reviewing potential actions for the College to undertake. This process was used to help ensure that the most equitable and feasible actions would be undertaken based on the College's capabilities.

Table 5.2. STAPLE/E Selection and Prioritization Criteria for Alternatives

STAPLE/E	Considerations
Social	• Is the proposed action socially acceptable to the college? • Are there equity issues involved that would mean that one segment of the community is treated unfairly? • Will the action cause social disruption?
Technical	• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of the college's other goals?
Administrative	• Can the college implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
Political	• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
Legal	• Is the college authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? • Are there legal side effects? Could the activity be construed as a taking? • Will the college be liable for action or lack of action? • Will the activity be challenged?
Economic	• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account?

STAPLE/E	Considerations
	• Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the college? • What are the budget and revenue effects of this activity? • Does the action contribute to other college goals? • What benefits will the action provide?
Environmental	• How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and state regulatory requirements? • Are endangered or threatened species likely to be affected?

A priority level of high, medium, or low was assigned to each action based on the STAPLE/E assessment. This prioritization method was selected because the HMPC and FCC CPT believed it would foster a realistic expectation of what could be accomplished in the next five years. The prioritization process has been significantly enhanced compared to the 2016 method which mainly focused on funding availability to assign priority rankings.

2022 Mitigation Action Plans

The following tables detail the in progress and ongoing mitigation actions selected by the college, as well as the new mitigation actions included in the 2022 Plan. Only the actions with a HMCAP priority of "high" have been developed into full action plans.

Key for Action Header Colors:

Action Carried Over from 2016 Plan	Action Added During 2022 Plan Update	Action Added During 2022 Plan Update & Significantly Supports Climate Adaptation*

*As there is a strong connection between traditional hazard mitigation actions and climate adaptation actions, there is considerable overlap between the two action categories (i.e., many of the actions support both). However, for the purpose of easy identification, the actions that *significantly* support climate adaptation are highlighted.

Action FCC-1	
Description of Action	Include factors that address risks to natural hazards (e.g., terrain, elevation) in site selection/acquisition criteria.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.

Action FCC-1	
Applicable Objective(s)	Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm
HMCAP Priority	Low
Responsible Party	Facilities and Planning
Timeline for Implementation	1 year
Status since 2016	Site analysis will be evaluated in current 10-year Facilities Master Plan

Action FCC-2	
Description of Action	Finalize the sheltering memorandum of understanding with Frederick County Public Schools. Update the sheltering memorandum of understanding with the American Red Cross.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 5: Ensure students, faculty, staff, and visitors can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm, Pandemic
HMCAP Priority	High
Responsible Party	Director of Public Safety and Security
Estimated Cost	Staff time
Possible Funding Source(s)	Operating budget
Timeline for Implementation	1 year
Status since 2016	Under review for update

Action FCC-3	
Description of Action	Evaluate Building G to remove existing air conditioning system (ceiling units) and replace with modernized equipment. Retrofit rooms to further protect equipment.
Applicable Goal(s)	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 2: Increase the percentage of critical equipment and property that is protected from hazards (e.g., data storage, paperwork, lab equipment, hazardous materials).
Relevant Hazard(s)	Flood, Thunderstorm
HMCAP Priority	High
Responsible Party	Capital Planning, Operations
Estimated Cost	$17,000
Possible Funding Source(s)	Capital projects budget
Timeline for Implementation	2-3 years
Status since 2016	Completed the upgrade for Building L where the new data center is located

Action FCC-4	
Description of Action	Begin developing a campus beautification plan that includes standards for low impact development (to reduce flood risk) and use of resilient tree species (to reduce debris risk).
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm
HMCAP Priority	Low
Responsible Party	Facilities and Planning

Action FCC-4	
Timeline for Implementation	3 years
Status since 2016	Facilities Master Plan Updated; Capital project budgets to include "pocket park" development

Action FCC-5	
Description of Action	Create a monitoring plan for flat roofs that experience stress under snow and shovel as necessary.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies and plans.
Applicable Objective(s)	Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards. Objective 9: Implement plans and policies that encourage future—or significantly renovated—infrastructure to be made resilient to future climate impacts.
Relevant Hazard(s)	Winter Storm
HMCAP Priority	High
Responsible Party	Plant Operations
Estimated Cost	Staff time
Possible Funding Source(s)	Operating budget
Timeline for Implementation	1 year
Status since 2016	Ongoing effort

Action FCC-6	
Description of Action	Update the Continuity of Operations Plan to incorporate information and recommendations (as appropriate) from the HMCAP.

Action FCC-6	
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies and plans.
Applicable Objective(s)	Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards. Objective 8: Integrate hazard mitigation, climate adaptation, and resilience planning into other college planning efforts.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm, Workplace or School Violence, Localized Infectious Disease Outbreak, Pandemic
HMCAP Priority	High
Responsible Party	Director of Public Safety and Security
Estimated Cost	Staff time
Possible Funding Source(s)	Operating budget
Timeline for Implementation	1 year
Status since 2016	Ongoing effort

Action FCC-7	
Description of Action	Assess the Emergency Operations Center site (Boardroom [A-201] - Administrative Building) to determine if it has adequate emergency power. Ensure there is a backup EOC location (potentially A-204G) for redundancy.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm, Workplace or School Violence, Localized Infectious Disease Outbreak, Pandemic
HMCAP Priority	Medium

Action FCC-7	
Responsible Party	Operations
Timeline for Implementation	1 – 2 years
Status since 2016	Safes updated and initial site chosen.

Action FCC-8	
Description of Action	Develop and implement a mitigation project to address the stormwater flooding in the parking lot east of Building G.
Applicable Goal(s)	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard(s)	Flood
HMCAP Priority	Medium
Responsible Party	Facilities and Planning
Timeline for Implementation	2-3 years

Action FCC-9	
Description of Action	Acquire and install portable generators at all critical locations.
Applicable Goal(s)	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 2: Increase the percentage of critical equipment and property that is protected from hazards (e.g., data storage, paperwork, lab equipment, hazardous materials).

Action FCC-9	
	Objective 5: Ensure students, faculty, staff, and visitors can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm
HMCAP Priority	High
Responsible Party	Operations, Facilities and Planning
Estimated Cost	$300,000 (variable depending on locations chosen)
Possible Funding Source(s)	HMGP
Timeline for Implementation	2-3 years

Action FCC-10	
Description of Action	Identify, scope, and price alternative power supplies on campus, including the potential for micro-grids. Install alternative energy solutions.
Applicable Goal(s)	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies and plans.
Applicable Objective(s)	Objective 2: Increase the percentage of critical equipment and property that is protected from hazards (e.g., data storage, paperwork, lab equipment, hazardous materials). Objective 5: Ensure students, faculty, staff, and visitors can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts. Objective 9: Implement plans and policies that encourage future—or significantly renovated—infrastructure to be made resilient to future climate impacts.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm

Action FCC-10	
HMCAP Priority	Medium
Responsible Party	Operations, Facilities and Planning
Timeline for Implementation	2-5 years

Action FCC-11	
Description of Action	Study the campus to develop a detailed map of stormwater flood hazard areas using the pluvial flood analysis in the main HMCAP as a foundation. Mitigate these areas.
Applicable Goal(s)	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal D: Adapt to climate change and natural hazards through forward-looking policies and plans.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards. Objective 9: Implement plans and policies that encourage future—or significantly renovated—infrastructure to be made resilient to future climate impacts.
Relevant Hazard(s)	Flood
HMCAP Priority	Medium
Responsible Party	Facilities and Planning, GIS, Plant Operations
Timeline for Implementation	3-4 years

Action FCC-12	
Description of Action	Create a public/student education program on the impacts of hazards. Make it available to instructors for inclusion in classroom training and post it on the college's website and social media platforms.
Applicable Goal(s)	Goal C: Improve the community's awareness of potential hazards, education on resilience planning, and methods to reduce risk.
Applicable Objective(s)	Objective 6: Use public information and education programs to support community members' decision-making on how to protect themselves from hazard events. Objective 7: Increase the public's awareness of their natural hazard risks.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm, Workplace or School Violence, Localized Infectious Disease Outbreak, Pandemic
HMCAP Priority	Low
Responsible Party	Director of Public Safety and Security
Timeline for Implementation	1-2 years

Action FCC-13	
Description of Action	Establish a central location for all Geographic Information System (GIS) files to be stored. Prioritize GIS data to be acquired, and a system for keeping that data up to date. Digitize and organize all maps of campus and historic building plans and specifications.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm
HMCAP Priority	Medium
Responsible Party	Facilities and Planning
Timeline for Implementation	1-2 years

Action FCC-14	
Description of Action	Conduct annual evaluation of trees on campus to ensure they are not at risk due to a hazard event. Implement trimming as needed.
Applicable Goal(s)	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm
HMCAP Priority	Medium
Responsible Party	Plant Operations
Timeline for Implementation	1 year

Action FCC-15	
Description of Action	Develop an active shooter policy, conduct awareness training for staff and students, and conduct a tabletop exercise at least annually.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the community's awareness of potential hazards, education on resilience planning, and methods to reduce risk.
Applicable Objective(s)	Objective 4: Advance hazard mitigation and climate adaptation-related training and development. Objective 5: Ensure students, faculty, staff, and visitors can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts. Objective 6: Use public information and education programs to support community members' decision-making on how to protect themselves from hazard events.
Relevant Hazard(s)	Workplace or School Violence
HMCAP Priority	Medium

Action FCC-15	
Responsible Party	Director of Public Safety and Security
Timeline for Implementation	1 year

Action FCC-16	
Description of Action	Monitor local infection rates and support campus outreach and education campaigns to encourage annual vaccinations.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects. Goal C: Improve the community's awareness of potential hazards, education on resilience planning, and methods to reduce risk.
Applicable Objective(s)	Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards. Objective 7: Increase the public's awareness of their natural hazard risks.
Relevant Hazard(s)	Localized Infectious Disease Outbreak, Pandemic
HMCAP Priority	High
Responsible Party	Director of Public Safety and Security
Estimated Cost	Staff time
Possible Funding Source(s)	Operating Budget
Timeline for Implementation	6 months

Action FCC-17	
Description of Action	Identify potential locations for rain gardens or permeable pavement projects to reduce the risk of flash flooding on campus roads and pathways.
Applicable Goal(s)	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.

Action FCC-17	
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
Relevant Hazard(s)	Flood
HMCAP Priority	Medium
Responsible Party	Facilities and Planning
Timeline for Implementation	1-2 years

Action FCC-18	
Description of Action	Use the college's website to disseminate information on hazards, mitigation actions, and emergency evacuation and sheltering. Include other public resources, plans, and links to Frederick County resources.
Applicable Goal(s)	Goal C: Improve the community's awareness of potential hazards, education on resilience planning, and methods to reduce risk.
Applicable Objective(s)	Objective 6: Use public information and education programs to support community members' decision-making on how to protect themselves from hazard events. Objective 7: Increase the public's awareness of their natural hazard risks.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm, Workplace or School Violence, Localized Infectious Disease Outbreak, Pandemic
HMCAP Priority	Low
Responsible Party	Director of Public Safety and Security, Marketing
Timeline for Implementation	6 months - 1 year

Action FCC-19	
Description of Action	Work with Frederick County to establish the athletic center as a robust shelter site for the county.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Frederick Community College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.

Action FCC-19	
Applicable Objective(s)	Objective 5: Ensure students, faculty, staff, and visitors can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard(s)	Flood, Winter Storm, Thunderstorm, Workplace or School Violence, Pandemic
HMCAP Priority	Medium
Responsible Party	Director of Public Safety and Security, Facilities and Planning
Timeline for Implementation	2-5 years

CHAPTER 6.IMPLEMENTATION AND MAINTENANCE

The long-term success of the Frederick Community College's Hazard Mitigation Plan Annex depends on its success in implementing the plan and in establishing a process to ensure that the plan is current and continues to provide value to the college.

The Frederick County Hazard Mitigation and Climate Adaptation Plan is intended to serve as Frederick County's road map for evaluating hazards, identifying resources and capabilities, selecting appropriate actions, and developing and implementing mitigation measures to eliminate or reduce future damage from those hazards in order to protect the health, safety, and welfare of the residents in the community. This annex identifies procedures for keeping this annex current and updated at least once every five years, as prescribed by the DMA2K.

Plan Implementation

Responsibility for the overall implementation and maintenance of the College hazard mitigation plan rests primarily with the members of the CPT. The Frederick County Director of Emergency Preparedness will work with the committee to ensure the implementation and maintenance of the plan.

For all mitigation actions, an appropriate College department(s) has been identified that will have primary responsibility for implementation of that particular action. The CPT, in concert with the primary responsible department, has established measures of success and potential funding sources for each high priority hazard mitigation action. The measures of success will be used to gauge how well the plan is being implemented and whether the actions are achieving their intended purpose; while the other criteria create a level of responsibility and accountability for each of the mitigation actions.

Beyond these initial measures of success, additional implementation needs and measures will be the responsibility of the primary responsible department, the FCC Director of Public Safety and Security and ultimately the members of the CPT. This may include any meetings with local officials, integration measures with other planning documents, identifying additional funding sources, etc.

Just as important as the mitigation actions themselves, is the development of a risk averse culture. The members of the CPT will continue to ensure that the goals and strategies of new and updated planning documents are consistent with the goals and actions of this plan, and that new projects throughout the College consider potential risks and are designed in such a way as to avoid them. Risk reduction principles identified in this plan should be carefully considered when developing new goals and actions of other College planning documents and projects.

Monitoring, Evaluating, and Updating the Plan

Plan maintenance requires an ongoing effort to monitor and evaluate the implementation of the plan, and to update the plan as progress, roadblocks, or changing circumstances are recognized. The FCC CPT will be responsible for monitoring and updating the plan and the HMPC will play an advisory role available for oversight. The team should accomplish the following:

- Annual progress reports from departments designated as "Primary Department" in the mitigation action plan,
- An annual review of these progress reports and the overall plan by the CPT, and sending a report to the County Director of Emergency Preparedness, and
- A 5-year written update to be submitted to the state and FEMA Region III, unless a disaster or other circumstances (e.g., change in regulations) leads to a different time frame.

The timing of the yearly reviews should coincide with either the anniversary of the approval date of this plan or another date chosen by the committee. Re-prioritization of projects may be needed as high priority mitigation actions are completed.

As described above, the FCC CPT and primary responsible departments for each project will be responsible for evaluating progress in implementing mitigation projects. The FCC CPT, along with the Department of Emergency Preparedness, during its annual review, also may identify corrective actions for projects. In addition, the FCC CPT should review its organizational composition annually and adjust membership, if needed.

The FCC CPT, in conjunction with the Department of Emergency Preparedness will determine at its annual meeting if a formal update of the plan is required. At a minimum, the plan will be updated every five years. Factors to consider when determining if an update is necessary include:

- Decreased vulnerability as a result of implementing recommended actions;
- Increased vulnerability as a result of failed or ineffective mitigation actions;
- Increased vulnerability as a result of new development;
- New state/federal laws, policies, or programs;
- Changes in resource availability; and/or
- Applicability of goals/objectives/strategies.

A major event, such as a presidentially declared disaster, may trigger a need to review the plan. If such an event affects Frederick County, the Department of Emergency Preparedness, and the FCC CPT will coordinate to determine how best to review and update the plan. Major changes to the plan will be submitted to the state and to FEMA Region III.

Public Involvement

Public notice of the annual review will be given, and public participation will be invited. At a minimum, notification will be through web postings and press releases to local media outlets, primarily newspapers. In addition, an annual event will be held to publicize progress on implementing the mitigation plan. This event could be timed to coincide with the anniversary of a significant event or annual awareness event (e.g., Hurricane Preparedness Week). The county will also post a link to the mitigation plan on the Department of Emergency Preparedness's website. It is recommended that the College's website serve as a means of communication by providing information about mitigation initiatives and updates to the projects and the plan itself. The CPT also should provide an annual update to the College's Board of Trustees to keep them informed about plan implementation.

APPENDICES

Appendix A: 2016 Mitigation Action Plans

The following tables detail the mitigation actions selected by the college in 2016 and their status as of 2022. The content of the tables appears exactly as it was in the 2016 plan, so referenced goals and objectives refer to the 2016 plan's goals and objectives.

Action	FCC-1
Description of Action	Utilize Frederick Community College's emergency management program to develop a 15- to 20-minute briefing for instructors to deliver to students at the beginning of every semester on emergency preparedness.
Applicable Goal	A
Objective	Use public information and education programs to advise students on how to protect themselves from hazard events.
Priority:	High
Responsible Organizations	Director of Public Safety and Security
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	Summer 2016 – FY 17
Status since 2016:	Complete—this is ongoing and is now a capability of FCC.

Action	FCC-2
Description of Action	Develop and/or disseminate awareness information on natural hazards preparedness and mitigation for students, employees and their families. Reinforce need to review and update annually personal emergency evacuation plans.
Applicable Goal	A
Objective	Use public information and education programs to advise students on how to protect themselves from hazard events.
Priority:	High

Responsible Organizations	Director of Public Safety and Security
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	FY 17
Status since 2016:	Complete—this is now a capability. The evacuation plan has been updated, updated evacuation maps are in every room, emergency trainings are offered monthly, and ongoing preparedness messaging is sent out. More hazard mitigation aspects will be added to all messaging.

Action	**FCC-3**
Description of Action	Purchase radios to enable better, more reliable communications among college departments and with county/city emergency services.
Applicable Goal	I
Objective	Increase college's ability to quickly respond, recover and mitigate against hazard events.
Priority:	Medium
Responsible Organizations	Director of Public Safety and Security
Estimated Costs	$35,000
Possible Funding Sources	Operations Budget
Timeline for implementation	FY 17
Status since 2016:	Complete—a new 2-way radio system was purchased from ProComm in 2017.

Action	**FCC-4**
Description of Action	Convert lockdown presentation to web-based product for broad dissemination
Applicable Goal	A

Objective	Use public information and education programs to advise students on how to protect themselves from hazard events
Priority:	High
Responsible Organizations	Director of Public Safety and Security
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	Summer 16 - FY 17
Status since 2016:	Complete—YouTube video link is available on the FCC website.

Action	**FCC-8**
Description of Action	Cap existing wet fire suppression system in Primary Server Room (G) and maintain dry fire suppression system
Applicable Goal	J
Objective	Ensure continuity of information technology systems
Priority:	High
Responsible Organizations	Director of Network Services
Estimated Costs	$15,000
Possible Funding Sources	Capital Projects
Timeline for implementation	FY 17
Status since 2016:	Not complete—it was determined that the Fire Marshall does not allow dry systems.

Action	**FCC-9**
Description of Action	Cap existing wet fire suppression system in Primary Hub Room (L-207) and install dry fire suppression system
Applicable Goal	J

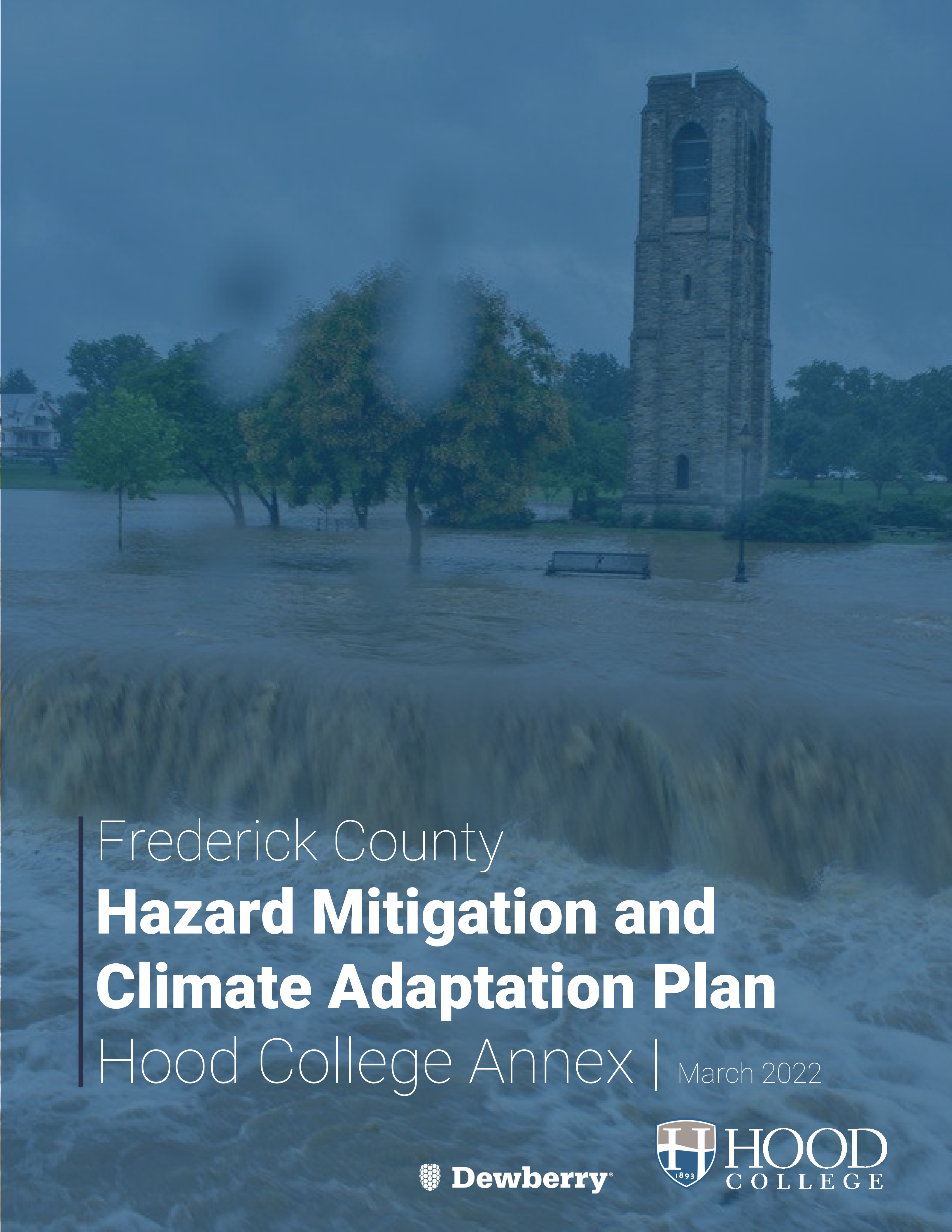
Objective	Ensure continuity of information technology systems
Priority:	High
Responsible Organizations	Director of Network Services
Estimated Costs	$15,000
Possible Funding Sources	Capital Projects
Timeline for implementation	FY 17
Status since 2016:	Not complete—it was determined that the Fire Marshall does not allow dry systems.

Action	**FCC-11**
Description of Action	Evaluate options to improve drainage (i.e., install French drains, retrofit entrances to improve waterproofing) for minor flood issue affecting Knuckle A/B
Applicable Goal	J
Objective	Minimize flood hazard
Priority:	Medium
Responsible Organizations	Director of Facilities and Planning
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	FY 17
Status since 2016:	Complete—a new threshold was installed and additional sealing was put on the base of storefronts.

Action	**FCC-13**
Description of Action	Purchase materials to flag fire hydrants in case of snow events. Assign responsible party to do the flagging
Applicable Goal	J

Objective	Enhance the college's resilience to future hazard events
Priority:	High
Responsible Organizations	Plant Operations
Estimated Costs	Approximately $10 for each flag/Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	FY 17
Status since 2016:	Complete

Action	**FCC-17**
Description of Action	Conduct a structural inspection (10-year cycle) of the older buildings on campus
Applicable Goal	J
Objective	Enhance the college's resilience to future hazard events
Priority:	Low
Responsible Organizations	Facilities and Planning
Estimated Costs	Staff time
Possible Funding Sources	Existing budget
Timeline for implementation	FY 2021
Status since 2016:	Complete—this was completed with the creation of the Facilities Master Plan.



Frederick County

Hazard Mitigation and Climate Adaptation Plan

Hood College Annex | March 2022

Dewberry

HOOD COLLEGE

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CHAPTER 1. INTRODUCTION

Plan Purpose

This annex supplements the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan (HMCAP) by focusing on Hood College, which is located next to Frederick Health Hospital in Frederick County, MD. The annex focuses on identifying potential hazards and assessing the vulnerability of the campus to these hazards. This plan also assesses the college's existing capabilities to implement the variety of mitigation strategies. This plan concludes with implementation and maintenance procedures.

Natural and human-caused hazards can affect higher education institutions through structural damage to buildings and infrastructure or interruptions to daily operations that can last days, weeks, or months at a time. Disruptions to research activities can even threaten a loss of funding or future opportunities. If severe enough, disasters may result in faculty or student departures, causing a loss of educational continuity for students. Institutions may face future financial duress due to rising insurance premiums or costs of necessary repairs and reconstruction in the aftermath of a disaster.

This annex represents one step in a series of proactive actions taken by Hood College to reduce the adverse impacts of disasters and to avoid future losses and disruption. This plan focuses on hazard mitigation, but also addresses some aspects of disaster preparedness, response and recovery, which can enhance or hinder this plan's ultimate success. This plan also serves to guide Hood College's decision-making regarding land use and development of new buildings, facilities and utilities, and in the renovation of existing structures.

Planning Process

Frederick County included Hood College in its mitigation planning process for the 2022 plan update to improve the region's overall resilience to future hazards. This effort resulted in the following annex that specifically addresses the College's unique vulnerabilities and mitigation efforts. Hood College conducted a mitigation planning process modeled after Frederick County's strategy and FEMA's *Building a Disaster-Resistant University*, a guide that closely follows state and local requirements outlined in the Disaster Mitigation Act of 2000 (DMA2K).[1]

Hood College participated in the Frederick County Hazard Mitigation and Climate Adaptation Planning Committee (Hazard Mitigation and Climate Adaptation Planning Committee) and College Planning Teams (College Planning Team) to support the County's plan update and the development of this annex plan. The College participated in College Planning Team meetings with Frederick County and the contracted consultant, Dewberry, to help gather the information needed for the plan update. Table 1.1 lists the members of the Hood College Planning Team, as well as a brief description of their participation.

[1] FEMA. 2003. *Building a Disaster-Resistant University*. Retrieved from https://mitigation.eeri.org/files/FMEA443.disaster.resist.univ.pdf

Table 1.1. Hood College Planning Team Members

Name	Department	Planning Participation
Thurmond Maynard, II	Director and Chief of Campus Safety	• Hazard Mitigation and Climate Adaptation Planning Committee Member • Coordinated input from Hood College • Attended meetings to develop plan and plan annex • Contributed to survey and provided other information as requested
Rowela Lascolette	Risk Manager	• Hazard Mitigation and Climate Adaptation Planning Committee Member • Attended meetings to develop plan annex • Provided other information as requested
Craig Zeigler	Director of Facilities	• Attended meetings to develop plan annex • Provided other information as requested

Guided by the County, the Hood College Planning Team participated in the hazard mitigation plan development process by attending meetings, communicating with the contracted consultant via phone and e-mail, and reviewing and commenting on draft documents. Between meetings, Hood College participated in informal conversations and communication via telephone and e-mail to ensure constant and consistent communication between stakeholders. The Hazard Mitigation and Climate Adaptation Planning Committee and Hood College Planning Team met several times throughout the hazard mitigation planning, outlined in Table 1.2.

Table 1.2. Meetings Throughout the Hazard Mitigation and Climate Adaptation Planning Process

Meeting	Date	Purpose	# of Attendees
College Planning Team Kick-Off	June 23, 2021	Coordinate on hazard mitigation planning process	8
Hazard Mitigation and Climate Adaptation Planning Committee Kick-Off	July 13, 2021	Review the hazard mitigation planning process and discuss new hazard issues/mitigation needs	31

Meeting	Date	Purpose	# of Attendees
Local/College Planning Team Update Workshops	August 25 – September 16, 2021	Collect updates on hazard mitigation needs, completed projects, 2016 strategy progress, capability assessment, etc. since the 2016 plan	1-17 (varied on specific meeting)
Hazard Identification and Risk Assessment (HIRA) Workshop	October 14, 2021	Review findings from the risk assessment and discuss new goals/objectives	31
Public Meeting #1	October 28, 2021	Provide an overview of the hazard mitigation planning process, solicit input through the Story Map and Survey, review high-level findings from the risk assessment	11
Resilience Strategy Coordination Meeting #1	November 9, 2021	Discuss opportunities for information sharing between the hazard mitigation plan update and the upcoming operations resilience plan	10
Local/College Planning Team Strategy Workshops	November 30 – December 2, 2021	Provide final feedback on the goals/objectives and make decisions on mitigation and adaptation actions for each town, city, college, university, and county	34 (total)
Community Rating System (CRS) Workshop	December 8, 2021	Complete a CRS toolkit activity and discuss current potential standing and path forward for the county	10
Public Meeting #2	December 9, 2021	Review hazard mitigation planning process until this point, review goals/objectives/actions highlights, review public feedback received, review risk assessment highlights, provide information on the upcoming plan review period	Aired on TV
Resilience Strategy Coordination Meeting #2	December 14, 2021	Discuss feedback on the climate impacts section, HIRA, new goals/objectives, and mitigation and adaptation actions	9
Hazard Mitigation and Climate Adaptation Planning Committee Plan Review Workshop	January 26, 2022	Reviewed the draft plan, discussed major changes, and provided further feedback on final changes	24

The Hood College Planning Team workshop was held on August 25, 2021 to establish a project timeline, identify priorities, establish relationships, and to request assistance with data collection. The strategy workshop was held on November 30, 2021 to determine progress on previous mitigation strategies and to identify new strategies to include in the plan annex. The College provided its completed hazard survey in September 2021 and its completed capability assessment in November 2021. In March 2022, the college provided additional information.

Using the results of the HIRA to guide their decision-making process, the College developed a list of comprehensive mitigation strategies. In the weeks that followed, Hood College prioritized these strategies and developed a mitigation action plan. The plan identifies the departments responsible for implementation of the strategies and potential funding sources. For more information on this process and the actual Mitigation Action Plan, please refer to Chapter 5.

In January 2022, the final draft plan was provided to Hood College Planning Team for a final review. The College Planning Team vetted and confirmed the contents with minor changes. The draft plan was shared with the appropriate stakeholder groups.

Existing Studies and Plans Reviewed

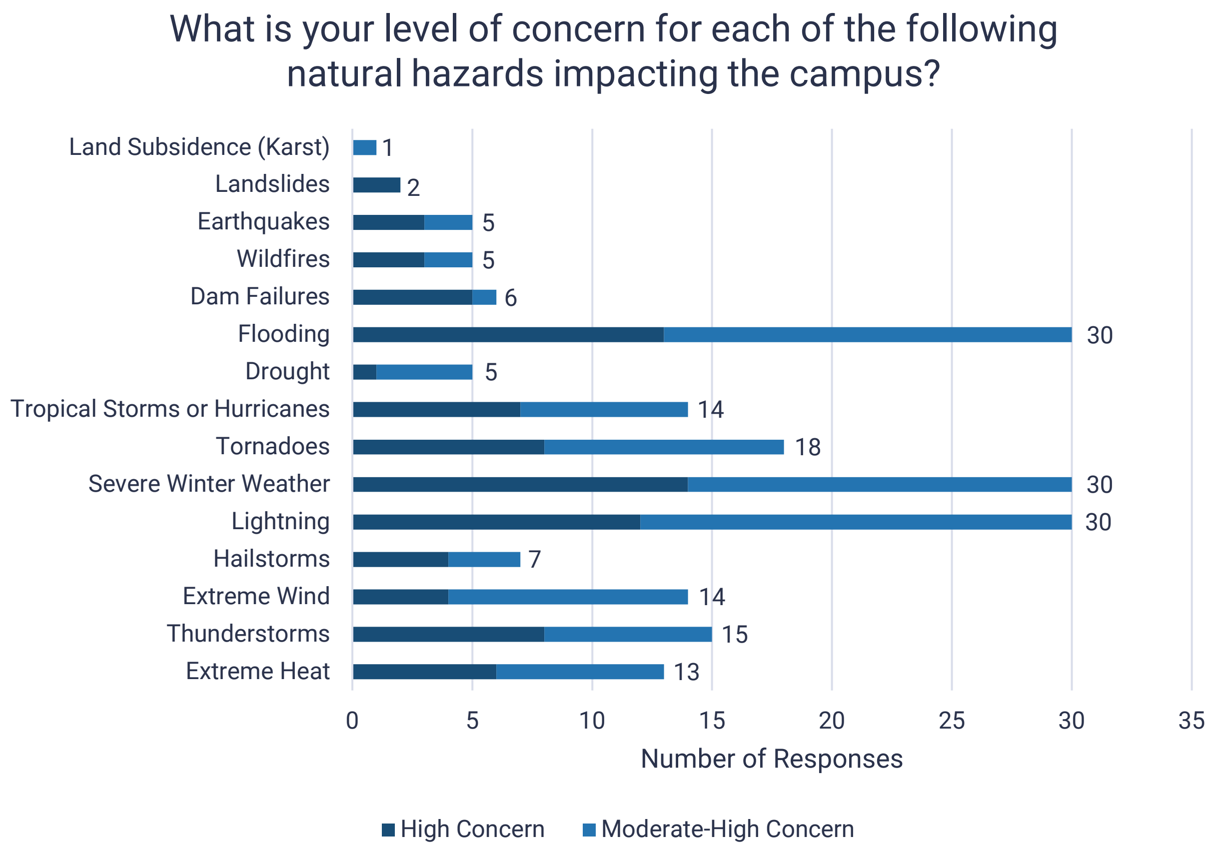
Planning documents, studies, guides, regulations, ordinances, and policies were reviewed and incorporated during the initial plan and each following update. These plans included FEMA documents, emergency services documents, county and local general plans, community plans, local codes and ordinances, and other similar documents, including the following:

- Hood College Campus Master Plan: Executive Summary 2015
- 2022-2025 Strategic Plan
- Building a Disaster-Resistant University
- FEMA CRS-DMA2K Mitigation Planning Requirements
- 2016 Maryland Department of Emergency Management and FEMA Crosswalk Comments for Frederick County

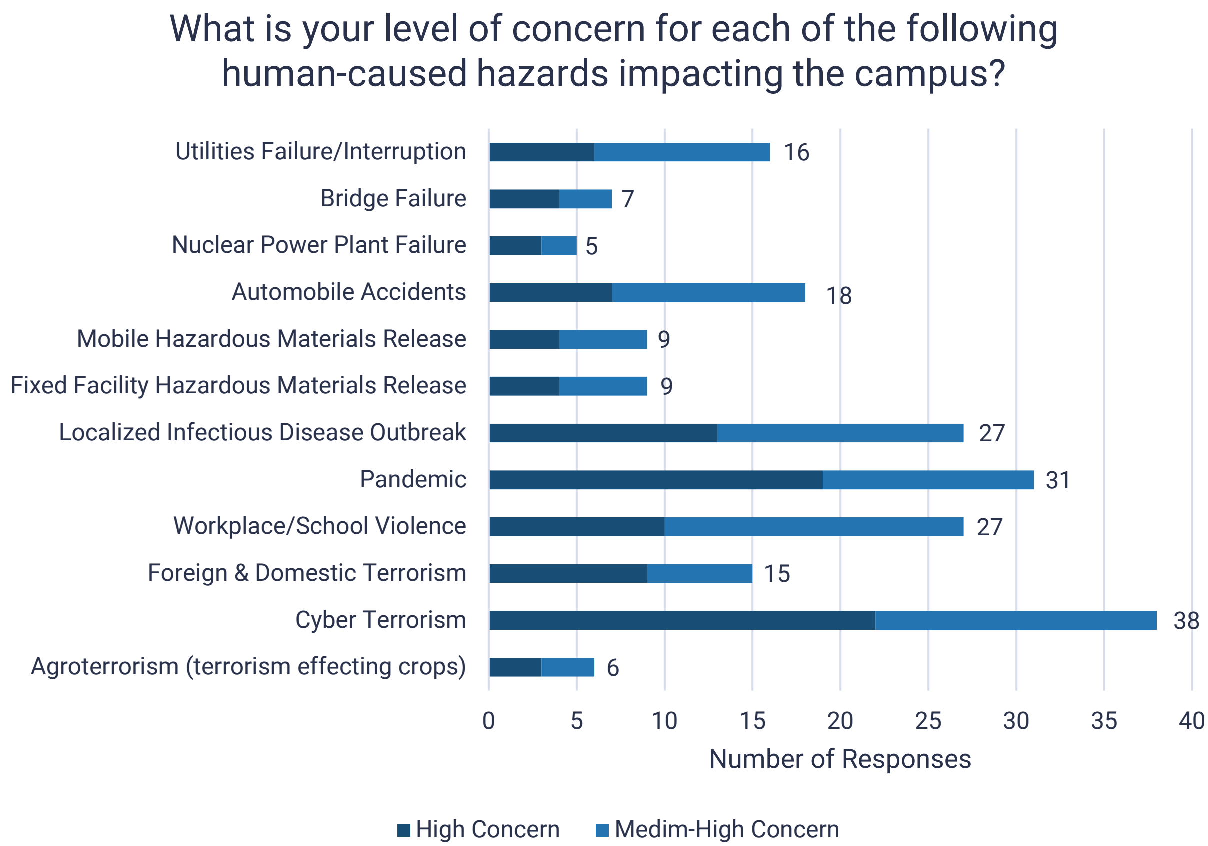
College Survey Results

Of the 684 responses to the Frederick County public survey, 74 participants identified themselves as a student, faculty, or staff member of Hood College. Because this is Hood College's first hazard mitigation plan, respondents were not asked about their awareness of the College's previous plans or mitigation efforts.

Hood College survey participants were asked to identify their level of concern for each of the following natural hazards impacting campus: severe winter weather, flooding, lightning, thunderstorms, tornadoes, tropical storms or hurricanes, extreme heat, dam failures, extreme wind, hailstorms, wildfires, earthquakes, landslides, drought and land subsidence (karst). Respondents most reported moderate-high to high concerns about flooding, severe winter weather, and lightning affecting Hood College campus as shown on the graph below. This is consistent with the National Centers for Environmental Information (NCEI) Storm Events data in Table 3.5. Furthermore, the campus has experienced localized flooding on campus in the past due to the backup of the city's storm drainage system, which speaks to some of the concerns.



Students, faculty, and staff were also asked to identify their levels of concern for human-caused hazards. The options provided were cyber terrorism, pandemic, localized infectious disease outbreak, workplace/school violence, foreign & domestic terrorism, automobile accidents, utilities failure/interruption, fixed facility hazardous materials release, mobile hazardous materials release, bridge failure, agroterrorism (terrorism effecting crops), and nuclear power plant failure. Respondents most frequently cited medium-high to high concerns about cyber terrorism, pandemics, workplace or school violence, and localized infectious disease outbreaks affecting Hood College's campus as shown on the graph below. Heightened media coverage regarding cyber threats, the ongoing pandemic and shootings nationwide may have contributed to these responses. Regarding cyber threats, the campus experienced two cyber incidents in 2019. Because the survey does not provide option to select a localized cyber incident, respondents selected cyber terrorism as a threat.



Forty-seven people answered the question of whether any recent hazard events made them more aware of the dangers of hazards on campus. Majority of respondents (91% or 43 respondents) said recent hazard made them more aware of the dangers that hazards pose to their campus. Sixty-four percent of respondents specifically cited the lightning strike that caused a fire at Brodbeck Hall in September 2021. Among other specifically cited events, respondents also reported that the COVID-19 pandemic (10 people or 21%) and recent flooding due to hurricanes (8 people or 17%) raised their awareness of hazards.

Students, faculty, and staff were asked to rate on a scale from 0 to 100 how safe from hazards they feel on campus. Sixty-five people answered the question. On average, respondents rated their feelings of safety a 71 out of 100, but responses ranged from a low of zero (1 respondent) to a high of 100 (1 respondent). The modal rating was 85 and the median rating was 79. Respondents were also asked to identify areas on campus that are vulnerable to hazards (Figure 1.1). Thirty-six people responded to the question. Respondents cited specific parking lots on the eastern side of campus and Brodbeck Music Hall as areas of concern. It should be noted that a new storm water management system was designed in 2019 to support Blazer Hall and address the flooding issues in the eastern parking lots identified by respondents. Additionally, concerns regarding Brodbeck Music Hall was tied to the September 2021 lightning strike.

Figure 1.1. Hood College Map of Problem Areas as Submitted by Survey Respondents

Respondents were asked about important actions the College can take to mitigate hazards and become more resilient. Three-fourths of respondents identified improvements to cyber security defenses as a key mitigation action. Other frequently cited important actions include outreach and education to students, faculty, and staff, and installation or improvements to backup systems, like generators or computer databases. When asked to identify one mitigation action the College could take, many respondents provided open-ended answers related to increased cyber security, education and awareness initiatives, and flood prevention measures.

CHAPTER 2. PLANNING CONTEXT

Hood College

History

Hood College's roots reach back to 1893, when the Potomac Synod of the Reformed Church of the United States – now the United Church of Christ – established the Woman's College of Frederick, which moved from the Potomac Synod's Mercersburg College in Mercersburg, Pennsylvania. In 1897, the College was officially chartered with the purpose of creating a college for the promotion and advancement of women and the cultivation and diffusion of literature, science and art. Located in Winchester Hall on East Church Street in Downtown Frederick, the College opened its first semester with a student body of 83 and a faculty of eight. That same year, the College acquired land on the northwestern edge of Frederick through a gift from Margaret Scholl Hood, for whom the College was renamed. Today more than 30 academic, residential and administrative buildings are on Hood's 50-acre campus. In 2003, the College made the transformation to a fully coeducational institution, although males had been enrolled as commuters or in the graduate programs since 1970.

Hood College offers more than 33 bachelor's degrees, four pre-professional programs, 19 master's degrees, two doctorates and 12 post-baccalaureate certificates. With small class sizes, Hood students receive individual attention from supportive faculty. Located on a picturesque campus within walking distance of historic Frederick, Maryland, the College's proximity to the hub of national research labs, Washington, D.C., Baltimore and the I-270 technology corridor provides students countless internship and research opportunities. Currently the College enrolls nearly 1,200 undergraduates and 900 graduate students, who are served by 98 full-time faculty members, 97 percent of whom hold a doctorate or the terminal degree in their field Our stellar and supportive faculty and staff provide a quality education for both undergraduate and graduate students.

Hood offers a strong foundation in the liberal arts, emphasizing critical thinking, communication and collaborative skills, which prepares students for their first jobs, their careers and active citizenship. In addition, accredited professional programs and majors, applied learning opportunities and a variety of extra-curricular activities provide a well-rounded and integrated education. Student clubs, organizations and Division III athletics create an active, vibrant and highly collegial campus environment. Hood's graduate program is the regional leader in meeting the workforce development needs of Frederick and the surrounding regions by providing cutting-edge content in business, STEM, the humanities and education. The College consistently receives rave reviews from all who come in contact with its beloved community and is a treasure to its more than 21,000 current alumni.

Location

Hood College is located in the City of Frederick in Frederick County, Maryland. The College maintains more than 30 buildings on 52 acres, providing services to roughly 850,000 square feet of space. These facilities are summarized in Table 2.1 and shown on the campus in Figure 2.1.

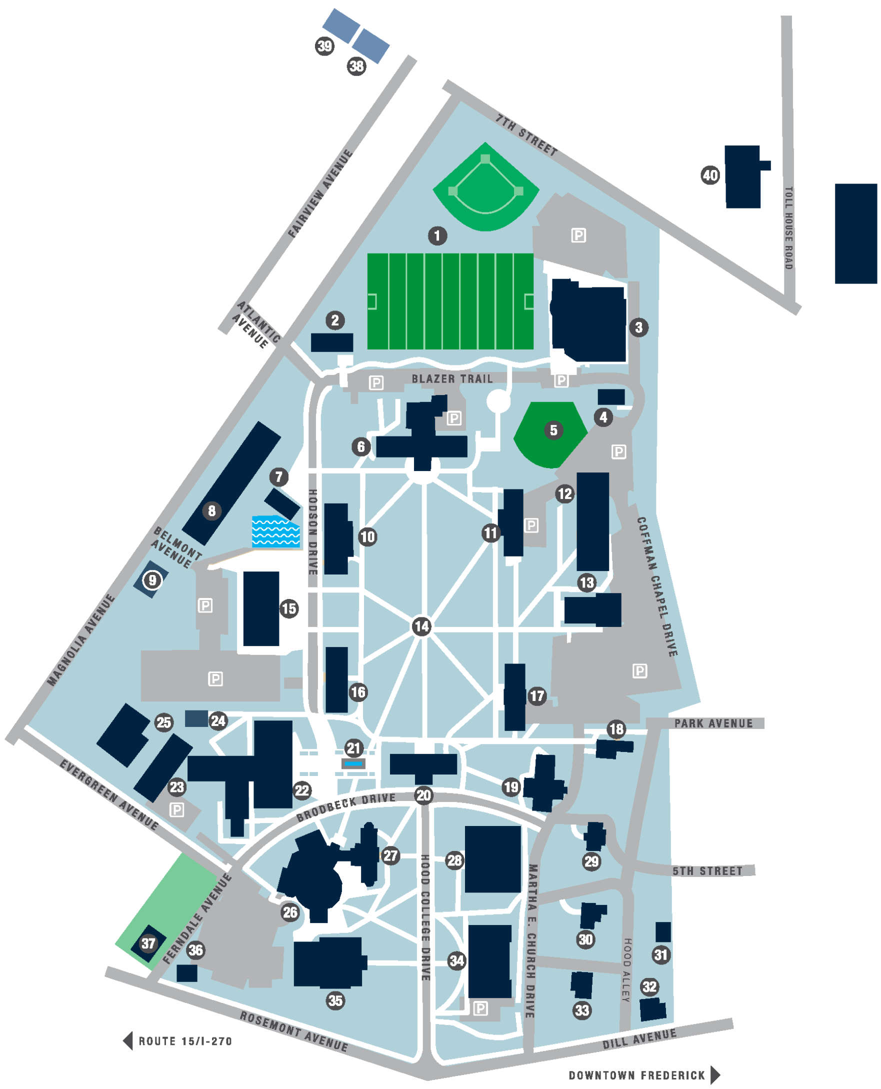
Table 2.1. Hood College Campus Facilities[2]

Facility Name	
Academic and Administrative	
Admission House	Alumnae Hall
Alumnae House	Joseph Henry Apple Academic Resource Center
Beneficial-Hodson Library and Learning Commons	Brodbeck Music Hall
Coffman Chapel	Gambrill Gymnasium
Hodson Science and Technology Center	Georgetown Hill at Hood College Lab School
Rosenstock Hall	Strawn Cottage
Tatem Arts Center	Kiln Pavilion
Williams Observatory	Carson Cottage
Hodson Annex	
Residence Halls	
Blazer Hall	Coblentz Hall
Coblentz Memorial Hall	Meyran Hall
Shriner Hall	Smith Hall
7 Street Duplexes	
Student Life	
Whitaker Campus Center	Ronald J. Volpe Athletic Center
Huntsinger Aquatic Center	Nicodemus Athletic Complex
Tennis Complex	Thomas Athletic Field
Other College Facilities	
East Cottage	East Cottage
Joseph Pastore Facilities Center	Joseph Pastore Facilities Center

[2] Hood College. *2020-2021 Catalog: Facilities.* Retrieved from http://hood.smartcatalogiq.com/en/2020-2021/Catalog/Facilities

Facility Name	
College House (5)	

HOOD COLLEGE CAMPUS MAP



1 Thomas Athletic Field
2 Nicodemus Athletic Complex
3 Ronald J. Volpe Athletic Center
4 Williams Observatory
5 Hodson Outdoor Theater
6 Coblentz Hall
7 Huntsinger Aquatic Center
8 Tennis Complex
9 College House
10 Meyran Hall
11 Coblentz Memorial Hall
12 New Residence Hall
13 Coffman Chapel
14 Truxal Pergola
15 Gambrill Gymnasium
16 Shriner Hall
17 Smith Hall
18 Carson Cottage
19 Brodbeck Music Hall
20 Alumnae Hall
21 The Jeanne Zimmerman Gearey '52 Alumni Plaza and Blazer Brick Promenade
22 Hodson Science and Technology Center
23 Hodson Annex
24 Kiln Pavilion
25 Joseph Pastore Facilities Center
26 Whitaker Campus Center
27 Joseph Henry Apple Academic Resource Center
28 Tatem Arts Center
29 Strawn Cottage
30 Admission House
31 Georgetown Hill Lab School
32 East Cottage - President's House
33 Alumnae House
34 Beneficial-Hodson Library and Information Technology Center
35 Rosenstock Hall
36 College House
37 College House
38 French House
39 Spanish and German House
40 Health Center

Figure 2.1. Hood College Campus Map

Regional Context

Hood College is located in the City of Frederick in Frederick County. Founded in 1748, Frederick County, Maryland is about an hour northwest of Washington, D.C. and an hour west of Baltimore. Its area encompasses a total of 662.7 square miles[3] and contains approximately 391.7 persons per square mile. Based on the most recent data available from the U.S. Census Bureau, the estimated population in 2019 was 259,547, an 11.2% increase since 2010.[4] Table 2.2 indicates recent and projected change in Frederick County population from 2020 to 2045.

In the County, the City of Frederick is the second largest in Maryland and has a 50-block historic district with many buildings dating back to the 18th and 19th centuries. Frederick has a variety of attractions, including Civil War sites, museums, parks, recreational facilities, wineries, antique shops, restaurants, and entertainment venues.

Table 2.2. Population Projections in Frederick County[5]

Year	Household	Population	Employment
2020	98,400	263,900	117,300
2025	106,300	284,300	123,200
2030	115,400	304,500	128,600
2035	122,400	320,000	135,300
2040	128,100	334,600	141,100
2045	132,100	346,600	145,500

Table 2.3 shows the 2019 U.S. Census population estimates and the 2021 Frederick County Planning estimates for Frederick County municipalities.

Table 2.3. 2019 and 2021 Population Estimates in Frederick County

Municipalities	2019 U.S. Census Population Estimates	2021 Frederick County Population Estimates
Brunswick	6,491	7,826
Burkittsville	165	151
Emmitsburg	3,198	2,866

[3] Maryland Department of Commerce. 2021. "Brief Economic Facts: Frederick County, Maryland." Retrieved from https://commerce.maryland.gov/Documents/ResearchDocument/FrederickBef.pdf
[4] U.S. Census Bureau. 2021. "Quickfacts: Frederick County, Maryland Population Estimates." Retrieved from https://www.census.gov/quickfacts/frederickcountymaryland
[5] Frederick County Planning Department, 2021.

Municipalities	**2019 U.S. Census Population Estimates**	**2021 Frederick County Population Estimates**
Frederick City	72,244	72,097
Middletown	4,792	4,516
Mount Airy	9,458	3,785*
Myersville	1,838	1,713
New Market	738	1,241
Rosemont	322	296
Thurmont	6,895	6,286
Woodsboro	1,269	1,161
Walkersville	6,415	6,182
Unincorporated County	145,722	86,191
		77,189**
Total	**259,547**	**271,500**

*Portion within Frederick County

** "Other Small Areas"

Land Use and Development Trends

In its 2015 Campus Master Plan, Hood College identifies new opportunities and establishes a framework for using the existing campus to meet future strategic goals. This plan aims to shape the College's future in three phases: address current needs and prepare for expansion; plan for and implement expansion; and shape the Hood College of the future. The College utilizes the Campus Master Plan to guide its capital projects. Consistent with the plan, in January 2020 the College transformed its library into a modern learning commons that offers a collaborative space to support learning, research and student projects. Also in-line with the plan, the College completed the construction of Blazer Hall in August 2020.

Asset Inventory

FEMA guidelines emphasize the use of "best available" data for hazard mitigation plans. The following sections provide information on the data collected and data gaps that currently exist. These gaps may be considered as mitigation strategies in future planning cycles.

General Building and Facility Information

Hood College maintains more than 30 buildings on its 52-acre campus. These buildings occupy a total of 850,000 square feet of space.[6]

Daily Occupancy/Hours of Use

In fall 2021, Hood College enrollment was around 2,100 students, of which 1,200 were undergraduates and nearly 900 were graduate students, seeking master's degrees, certificates, or certifications. More than half of undergraduate students live on campus. The College has 98 full-time professors, 134 part-time faculty, and more than 160 staff.

Total Replacement Value

The total replacement value for the buildings (buildings and contents) included in this plan is estimated at over $180,400,000.

Utilities

Hood College uses the City of Frederick's utilities and has its own campus security team. The College is located directly next to Frederick Health Hospital, and is less than two miles from the Frederick City Police Department and one mile from the nearest fire department.

[6] Hood College. *Campus Facilities*. Retrieved from https://www.hood.edu/offices-services/campus-facilities

CHAPTER 3. HAZARD IDENTIFICATION AND RISK ASSESSMENT

The purpose of the Hazard Identification and Risk Assessment (HIRA) is to identify the hazards that could affect Hood College and assess what unique risk the campus may have to those hazards. Hazards were identified as part of the Frederick County Hazard Mitigation and Climate Adaptation Plan Update and were validated and prioritized for the campus by the Hood College Steering Committee in November 2015. Profiles of each of the identified hazards and the risk assessment for the high and medium-high priority hazards are presented in this section of the plan.

The following chapter profiles and assesses risk for hazards identified high or medium-high priorities by the Hood College Planning Team. These sections include an abbreviated profile of the hazard that is fully described in the main Frederick County Hazard Mitigation and Climate Adaptation Plan, with specific focus on the Hood College campus and the City of Frederick, where the main campus is located. The 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan should be referenced for a complete hazard review.

Hazard Identification

Hood College Planning Team members were asked to identify major concerns with respect to the campus and hazards that were likely to impact the College. Frederick County assessed natural hazards for the 2022 plan update and previously, examined human-caused hazards. The County decided not to assess human-caused hazards during this planning process.

In alignment with the County's plan update, the risk assessment is organized by the primary climate change interaction each hazard faces. The 2016 Plan was organized by hazard type (i.e., atmospheric, hydrologic, wildfire, geologic), but setting each hazard in the context of climate change will allow for a better understanding of how risk from each hazard may change in the future. The primary climate change interactions included are:

- Changes in precipitation,
- Rising temperatures, and
- Extreme weather.

Earthquake and human-caused hazards are organized under a "non-climate-influenced" hazard category.

The hazards are given priority levels as a part of the hazard profiling process. They are determined based on Hood College Planning Team input as well as the five criteria summarized below to assign a quantitative ranking. Each criterion identifies and categorizes the comparative probability and potential vulnerability for the identified hazards. The framing criteria/questions are shown in the list below and Table 3.1 provides the thresholds for each of the risk levels.

The five main parameters include:

1. **Probability/History**: Has the hazard occurred in the area before, and if so, how often based on the historical record? Weighting Factor: 0.25

2. **Vulnerability**: If the expected event does occur, how many people might be killed, injured, or contaminated, and how much property might be damaged or destroyed (e.g., the percent of people or property vulnerable to the hazard)? Weighting Factor: 0.20
3. **Maximum Threat**: What is the worst-case scenario of the hazard and how bad can it get? What will the loss of life and property damage be if the worst-case scenario occurs (e.g., the percent of the campus impacted by the hazard)? Weighting Factor: 0.10
4. **Warning Time**: How much time is the campus given to prepare for an event? Weighting Factor: 0.10
5. **Ranking in Previous Plan**: The ranking from the 2011 Hazard Mitigation and Climate Adaptation Plan (Significant, Moderate, Limited) was factored in the 2016 ranking. Weighting Factor: 0.35

Table 3.1. Hazard Priority Ranking Criteria

Probability / History	Vulnerability	Maximum Threat (Geographic Area Affected)	Warning Time	2016 Ranking
Weighting Factor: 0.25	*Weighting Factor: 0.20*	*Weighting Factor: 0.10*	*Weighting Factor: 0.10*	*Weighting Factor: 0.35*
Unlikely No documented occurrence with annual probability <0.01	**Negligible** 1 to 10% of people or property	**Isolated** < 5% of community impacted	**Extended** More than 3 days	**Low**
Somewhat Unlikely Infrequent occurrence with at least one documented event and annual probability between 0.5 and 0.01	**Slight** 10% to 20% of people or property	**Minor** 5 to 15% of community impacted	**Slight** 3 days	**Medium-Low**
Somewhat Likely Moderate occurrence with at least two documented events and annual probability between 0.5 and 0.01	**Limited** 20 to 30% of people or property	**Small** 15 to 25% of community impacted	**Limited** 2 days	**Medium**
Likely Frequent occurrence with at least three documented events and annual probability between 1 and 0.5	**Critical** 25 to 50% of people or property	**Medium** 25 to 50% of community impacted	**Minimal** 1 day	**Medium-High**
Highly Likely Common events with annual probability >1	**Catastrophic**	**Large** > 50% of community impacted	**No Notice** < 24 hours	**High**

Probability / History	Vulnerability	Maximum Threat (Geographic Area Affected)	Warning Time	2016 Ranking
	> 50% of people or property			

Table 3.2 and Table 3.3 summarize the Frederick County and Hood College assigned priority levels. For natural hazards, the Hood College Planning Team identified floods as a medium-high priority. For human-caused hazards, Hood College assigned medium-high priority to cybercrime. In the 2021 college survey, the Hood College Planning Team cited winter storms, floods, pandemics, and utilities failure or interruption as hazard events more likely to occur and impact the College. The College Planning Team also identified several noteworthy hazard events, including the ongoing COVID-19 pandemic, which resulted in campus closures; annual snow that causes delays or closures; annual flooding that moves vehicles; and utility failures, affecting electricity, water, and gas services.

Table 3.2. Natural Hazard Priority Level Comparison

Natural Hazards Type	2022 Priority Level	
	Frederick County	Hood College
Primary Climate Change Interaction: Changes in Precipitation		
Flood	High	Medium-High
Dam and Levee Failure	Low	Low
Karst and Land Subsidence	Medium-High	Low
Drought	Medium	Low
Landslide	Medium-Low	Low
Wildfire	Medium	Low
Primary Climate Change Interaction: Rising Temperatures		
Extreme Heat	Medium	Low
Primary Climate Change Interaction: Extreme Weather		
Winter Storm	High	Medium
Thunderstorm	Medium-High	Medium-Low
Tornado	Medium-High	Medium-Low
Tropical Cyclone	Medium	Medium-Low

Natural Hazards Type	2022 Priority Level	
	Frederick County	Hood College
Non-Climate-Influenced Hazards		
Earthquake	Medium-Low	Low

Table 3.3. Human-Caused Hazard Priority Level

Human-Caused Hazards Type	Hood College 2022 Priority Level
Non-Climate-Influenced Hazards	
Agroterrorism	Low
Cybercrime	Medium-High
Foreign and Domestic Terrorism	Medium-Low
Civil Disobedience	Low
Workplace or School Violence	Medium
Pandemic	Medium
Localized Infectious Disease Outbreak	Low
Fixed Facility Hazardous Materials Release	Low
Mobile Hazardous Materials Release	Low
Automobile Accidents	Low
Rail Accidents	Low
Air Accidents	Low
Nuclear Power Plant Failure	Low
Bridge Failure	Low
Utilities Failure or Interruption	Medium-Low

Areas of Concern

As part of the campus survey, Hood College Planning Team members provided additional areas of impact and vulnerability. Vulnerable areas and reoccurring problems were taken into consideration during the analysis phase. Questions posed to committee members included the following:

- What are your major concerns with respect to the campus and the hazards identified?
- Have there been noteworthy events in the past? Were there major consequences?
- What events do you think are likely to occur?
- What specific vulnerabilities exist on the campus?

In general, areas of concern related mostly to aging infrastructure and buildings. These areas are described in Table 3.4. These areas should be considered as potential mitigation strategies to reduce future risk and injury. It should be noted that this list only indicates concerns held by members of the Hood College Planning Team; it is not comprehensive, nor does it completely describe the vulnerabilities of the college.

Table 3.4. Institutional Knowledge of Building Vulnerabilities and Areas of Concern

Areas of Concern	Summary of Vulnerability
2022 Plan Update	
Carson Cottage	Building is aged and has been affected by significant water damage over the years.
Brodbeck Hall	Building was recently struck by lightning and fire ensued. The building is currently off-limits and has very old infrastructure which will need to be updated in order to reopen.

Damage History

The data collection effort utilized meetings with Hood College Planning Team members and other officials, existing reports and studies, state and national data sets, and other sources, such as newspaper archives. Hazard data collected at the state or national level, such as the National Centers for Environmental Information's (NCEI) Storm Event Database, is aggregated at a county level and does not provide site-specific information. To the greatest extent possible, information specific to the College was included.

The historical hazard data was used to identify hazard events most likely to occur and to quantify the impacts each type of event had on the College. In each hazard profile, when applicable, damage history claims by hazard type have been summarized in a table. Information regarding insurance claims was provided by the Office of the Vice President for Finance.

National Centers for Environmental Information (NCEI) Storm Events

NCEI storm events data is published by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The storm events database contains information on storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce from 1950 to March 2021. Records for the majority of weather events were reported starting in 1996, with the exception of tornadoes, thunderstorms, and hail.

Table 3.5 summarizes the natural hazards profiled for the Frederick County 2022 plan update. Because this data is provided at a county-level, these events occurred throughout the County, and not all may have affected the College. The information summarized in Table 3.5 supports the hazard identification completed by the Hood College Planning Team. Detailed hazard event information is presented in the Frederick County 2022 Hazard Mitigation and Climate Adaptation Plan and the hazard-specific sections in this annex.

There has been a total of 1,248 events for the hazards profiled in this report. Total property damages from these events exceed $96 million (adjusted for inflation). These estimates may underrepresent the actual losses experienced due to both hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCEI database; this is especially true with crop damages.

As shown in the Table 3.5, several of the hazards are not collected in the NCEI storm events database. Each of the individual hazard sections use the best available national and local data. In most cases, Frederick County departments have provided supplemental data for past events and damages.

Table 3.5. NCEI Storm Events for Frederick County, MD

Hazard Type	Period of Record	Total Events	Property Damage (2021$)	Crop Damage (2021$)	Injuries	Deaths
Primary Climate Change Interaction: Changes in Precipitation						
Flood	1996 - 2021	237	$83,237,213	$67,228	1	6
Dam and Levee Failure	*Data not collected by NCEI. Analysis source to be used: USACE National Inventory of Dams and Levees.*					
Karst and Land Subsidence	*Data not collected by NCEI. Analysis source to be used: USGS Engineering Aspects of Karst data and County historical data.*					
Drought	1996 - 2021	12	$0	$40,277,677**	0	0
Landslide	*Data not collected by NCEI. Analysis source to be used: USGS Landslide susceptibility data.*					
Wildfire	*Data not collected by NCEI. Analysis source to be used: AMS fire database.*					
Primary Climate Change Interaction: Rising Temperatures						
Extreme Heat	1996 - 2021	44	$0	$0	6	2
Primary Climate Change Interaction: Extreme Weather						
Winter Storm	1996 - 2021	265	$406,988	$208,282	0	1
Thunderstorm***	1955 - 2021	496	$2,578,924	$115,983	7	2
Extreme Wind***	1996 - 2021	57	$2,174,353	$145,543	2	1
Hailstorms***	1955 - 2021	79	$6,124	$21,438	0	0

Hazard Type	Period of Record	Total Events	Property Damage (2021$)	Crop Damage (2021$)	Injuries	Deaths
Lightning* **	1996 - 2021	22	$1,788,766	$0	5	1
Tornado	1950 - 2021	36	$6,067,480	$84,034	1	0
Tropical Cyclone	1996 - 2021	2*	$5,863	$0	0	0
Non-Climate-Influenced Hazards						
Earthquake	*Data not collected by NCEI. Analysis source to be used: USGS Earthquake Hazards Program data.*					
Total		**1,248**	**$96,265,711**	**$40,920,185**	**22**	**12**

***There are tropical storm/hurricane events were categorized as floods or not recorded in the NCEI database, due to the kind of damage and if damages were recorded.**

**** Zonal damages for three regional droughts spanning 1997 – 1999.**

*****Thunderstorms, extreme wind, hailstorms, and lightning are presented collectively under the Thunderstorm hazard profile. Previous plans, including the 2016 plan update, presented these hazards separately.**

Federal Declared Disasters

Presidential disaster declarations are issued for counties, independent cities, and towns when an event has been determined to be beyond the capabilities of state and local governments to respond. An emergency declaration is more limited in scope and does not provide the same long-term federal recovery programs as a presidential disaster declaration.

Two important sources for identifying hazards that can affect a locality are the record of federal disaster declarations and historic storm data. According to FEMA, since 1962, there have been 25 major disaster declarations for Maryland, of which 13 have been declared for Frederick County. Nine of the declarations were for flooding/severe storm and four were for winter weather. In addition, there have been five emergency declarations in Maryland; Frederick County was included in all five declarations. Table 3.6 presents the declared disasters in Frederick County and available FEMA recovery programs since 1962. While these events affected Frederick County, not all may have affected Hood College's campus and facilities.

Table 3.6. Presidentially Declared Disaster for Frederick County

Disaster Number	Incident Type	Incident Date	Programs Declared			
			IH	IA	PA	HM
DR-309	Flooding, Severe Storm	8/17/1971		✓	✓	✓
DR-341	Flooding, Heavy Rains (Tropical Storm Agnes)	6/23/1972		✓	✓	✓
DR-489	Flooding, Heavy Rains	10/4/1975		✓	✓	✓

Disaster Number	Incident Type	Incident Date	Programs Declared			
			IH	IA	PA	HM
DR-522	Severe Storms, Flooding	10/14/1976		✓	✓	✓
DR-601	Severe Storms, Tornadoes & Flooding	9/14/1979		✓	✓	✓
EM-3100	Severe Snowfall & Winter Storm	3/13/1993			✓	✓
DR-1016	Severe Winter Weather & Ice Storm	2/8/1994			✓	✓
DR-1081	Severe Snowstorm (Blizzard of '96)	1/6/1996			✓	✓
DR-1094	Severe Storms, Flooding	1/19/1996		✓	✓	✓
DR-1139	Severe Storms, Flooding (Tropical Storm Fran)	9/6/1996		✓		✓
DR-1324	Severe Winter Storm	1/25/2000			✓	✓
EM-3179	Severe Snowstorm	2/14/2003			✓	✓
DR-1492	Flooding, Severe Storms, Wind (Hurricane Isabel)	9/18/2003	✓	✓	✓	✓
EM-3251	Sheltering, Evacuation (Hurricane Katrina)	8/29/2005			✓	
DR-1910	Severe winter storms and snowstorms	2/5/2010			✓	✓
EM-3335	Hurricane (Irene)	8/26/2011			✓	
EM-3349	Hurricane (Sandy)	10/26/2012			✓	
DR-4091	Hurricane (Sandy)	10/26/2012	✓		✓	✓
DR-4261	Severe winter storms and snowstorms	1/22/2016			✓	✓
DR-4374	Severe Storms, Flooding	5/15/2018			✓	
EM-3430	COVID-19	1/20/2020			✓	
DR-4491	COVID-19 Pandemic	1/20/2020		✓		

IH = Individual Housing PA = Public Assistance

IA = Individual Assistance HM = Hazard Mitigation

Source: FEMA Declared Disasters (as of August 2021).

Insurance Claims and Institutional Knowledge

Insurance claims were provided by the Office of the Vice President for Finance. Information includes when the loss/event occurred, type of hazard event, and the number of claims for the specific event. Table 3 6 summarizes the most recent historical events impacting the College as the result of various types of natural events and human-caused hazards based on insurance claims and also institutional knowledge.

Table 3.7. Historical Events Impacting Hood College

Date	Event	Buildings Impacted
May 2018	Severe Weather	Severe weather resulted in flooding Rosenstock Hall and Alumnae Hall.
March 2018	Severe Wind	Severe wind resulted in damage to Alumnae Hall Roof.
January 2018	Frozen Pipes	Frozen sprinkler pipe in Coblentz Hall ruptured and caused damages to the dry storage area. Loss is limited to food.
March 2019	Transformer Fire in Downtown Frederick	Transformer fire in downtown Frederick resulted in power outage on campus. The surge from the outage damaged some HVAC electronics.
October/December 2019	Ransomware/Phishing	
September 2021	Thunderstorm/Lighting	Lightning caused fire to Brodbeck Music Hall. The same thunderstorm caused flooding in Carson Cottage.

Natural Hazards

Primary Climate Change Interaction: Changes in Precipitation

The frequency, severity, and magnitude of floods are affected by the amount of precipitation received in a region. As precipitation patterns change, so too does Frederick County's vulnerability to certain hazards. By the end of this century, Frederick County is projected to receive more than 46 inches of precipitation every year, an increase of roughly 16% compared to historical averages.[7] The region is also expected to experience more frequent and intense severe rainfall events. Given these projections, Frederick County's vulnerability to the following hazard may intensify in the coming decades.

Flood

Hazard Identification

Hazard Description

Flooding is the most frequent and costly natural hazard in the United States. A majority of presidential disaster declarations result from weather events where flooding was a major component. Flooding, as defined by the National Flood Insurance Program for insurance purposes, is "a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from: overflow of inland or tidal waters, unusual and rapid accumulation or runoff of surface waters from any source, or a mudflow."

A flood occurs when an area that is normally dry becomes inundated with water. Flooding can occur at any time of the year, with peak volume in the late winter and early spring. Snowmelt and ice jam breakaway contribute to winter flooding, while seasonal rain patterns contribute to spring flooding. Torrential rains from hurricanes and tropical systems are more likely in late summer. Development of flood-prone areas tends to increase the frequency and degree of flooding.

According to FEMA, there are several different types of inland flooding:

- **Riverine Flooding**: Also known as overbank flooding, it occurs when channels receive more rain or snowmelt from their watershed than normal, or the channel becomes blocked by an ice jam or debris. Excess water spills out of the channel and into the channel's floodplain area.
- **Flash Flooding**: A rapid rise of water along a water channel or low-lying urban area, usually a result of an unusually large amount of rain and/or high velocity of water flow (particularly in hilly areas) within a very short period of time. Flash floods can occur with limited warning.
- **Shallow Flooding**: Occurs in flat areas where a lack of a water channel results in water being unable to drain away easily. The three types of shallow flooding include:
    - **Sheet Flow**: Water spreads over a large area at uniform depth.
    - **Ponding**: Runoff collects in depressions with no drainage ability.
    - **Urban Flooding**: Occurs when man-made drainage systems are overloaded by a larger. amount of water than the system was designed to accommodate.

Frederick County largely suffers from riverine and flash flooding. Flash flooding (stormwater or pluvial flooding) as the name suggests, occurs suddenly after an intense but brief downpour, generally less than 6 hours. They move fast and terminate quickly. Although the duration of these events is usually brief, the damages can be

[7] NOAA. National Weather Service: Climate Prediction Center. 2021. Retrieved from https://www.cpc.ncep.noaa.gov/

quite severe. Flash floods also result as a secondary effect from other types of disasters, including dam breaks and denuded ground from large wildfires. Wildfires remove vegetative cover and alter soil characteristics, increasing the quantity and velocity of storm water runoff, and dam breaks release large quantities of water into receiving drainage ways in a very short timeframe. Flash floods can also deposit large quantities of sediments on floodplains and can be destructive of vegetation cover not adapted to frequent flood conditions. For more details on pluvial flood hazards, refer to Appendix A of the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Riverine (or fluvial) flooding occurs when a channel, such as a stream or river, receives more water than it can hold, and the excess water overflows the channel banks, flooding the surrounding area. Heavy rain and large amounts of snow melt can cause riverine flooding. Riverine flooding is a longer-term event than flash flooding, maybe lasting days or weeks. Riverine floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies use historical records to determine the probability of occurrence for different extents of flooding. The probability of occurrence is expressed as the percentage chance that a flood of a specific extent will occur in any given year. On the other hand, flash floods are more difficult to predict accurately and happen whenever there are heavy storms. For more details on flood hazards, refer to the flood section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Location

According to FEMA, most municipalities in the United States have at least one clearly recognizable area at risk of flooding around a river, stream, or large body of water. In support of the National Flood Insurance Program (NFIP), FEMA identifies and maps areas of flood risk (floodplains). The floods are often described in terms of annual percentage chance of occurrence. Floodplains have been delineated by FEMA to reflect the 1% and 0.2% annual flood events previously known as 100-year and 500-year floods, respectively. The area that has a 1% - annual-chance to flood each year is delineated as a Special Flood Hazard Area (SFHA) for the purposes of the NFIP. This flood is often referred to as the “base flood” or “100-year flood.” The 0.2%-annual-chance floodplain indicates areas of moderate flood hazard.

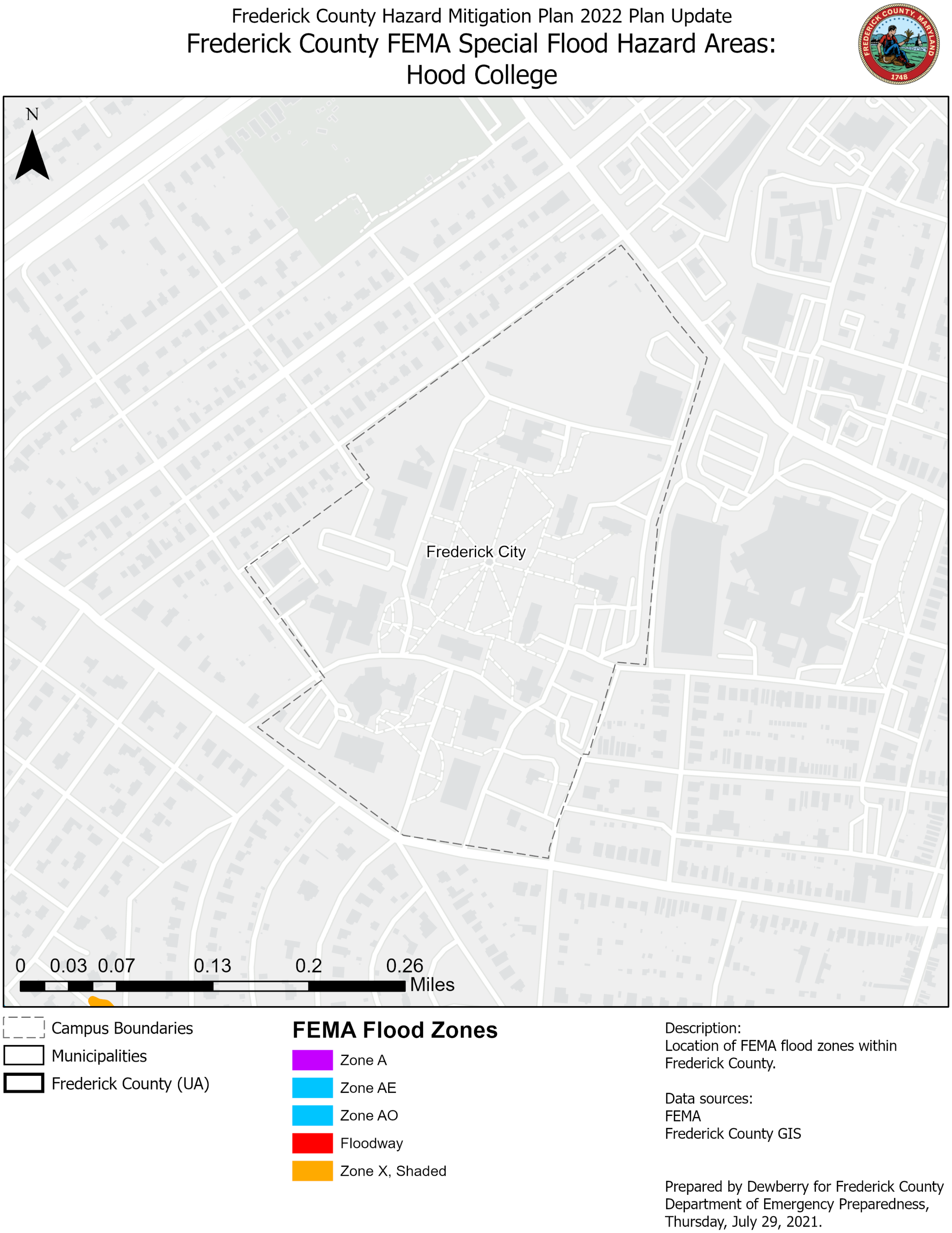
SFHAs in the county are delineated on a Flood Insurance Rate Map (FIRM) produced as part of a Flood Insurance Study. Major watercourses in Frederick County typically have SFHAs mapped as Zone AE while smaller tributary streams are mapped as Zone A. Other small streams have shading as Zone X, and other classifications are also possible. Table 3.8. Description of FEMA Flood Zones presents the various flood hazard zones (including coastal zones which will be discussed in the subsequent section) mapped on FIRM panels in Frederick County.

Table 3.8. Description of FEMA Flood Zones

Zone	Description
A	An area with a 1% chance of flooding in any given year for which no base flood elevations (BFEs) have been determined.
AE	An area with a 1% chance of flooding in any given year for which base flood elevations have been determined. This area may include a mapped floodway.
AO	An area with a 1% chance of flooding in any given year where average depths of flooding are between one and three feet.

Zone	Description
X (Shaded)	An area with a 0.2% chance of flooding in any given year for which no base flood elevations have been determined.
X (Unshaded)	An area that is determined to be outside of the 1% and 0.2%-annual-chance floodplains.

Figure 3.1. FEMA Flood Zones near Hood College Campus



Extent

A number of factors contribute to the extent of a flood and the relative vulnerabilities of certain areas in the floodplain. Development, or the presence of people and property in the hazardous areas, is a critical factor in determining vulnerability to flooding. Additional factors that contribute to flood extent and vulnerability include:

- **Flood depth**: The greater the depth of flooding, the higher the potential for significant damages.
- **Flood duration**: The longer duration of time that floodwaters are in contact with building components, such as structural members, interior finishes, and mechanical equipment, the greater the potential for damage. Floodwaters may linger because of the low relief of the area, but the degree varies.
- **Velocity**: Flowing water exerts force on the structural members of a building, increasing the likelihood of significant damage. A one-foot depth of water, flowing at a velocity of five feet per second or greater, can knock an adult over and cause significant scour around structures and roadways.
- **Elevation**: The lowest possible point where floodwaters may enter a structure is the most significant factor contributing to its vulnerability to damage due to flooding. Data on the specific elevations of structures in Frederick County has not been compiled for use in this analysis.
- **Construction type**: Certain types of construction are more resistant to the effects of floodwaters than others. Masonry buildings, constructed of brick or concrete blocks, are typically the most resistant to flood damages simply because masonry materials can be in contact with limited depths of water without sustaining significant damage. Wood frame structures are more susceptible to flood damage because the construction materials used are easily damaged when inundated with water. The type of construction throughout Frederick County varies.

The strength or magnitude of a flood hazard is dependent on the factors above. For example, during a riverine flood, water slowly climbs over the edges of a stream or riverbed and spreads to the surrounding area. Observing the slow rise of water along with an area-wide flood warning usually gives adequate time to evacuate; however, because the rainfall associated with flash flooding is so intense and fast moving, it is not as easy to predict when a flash flood will occur. Specific extent of flash flooding is difficult to determine in advance because local terrain, soil conditions, and construction play a role in how much stormwater can percolate into the soil, be accommodated by waterways, or cause flash flooding.

Previous Occurrences

According to the NCEI, 18 flood events were reported in the City of Frederick, where the College is located, between 1996 to March 2021. Of these, nine events were classified as flash floods. These events have resulted in $133,576 of property damages, but no crop damages. A record of events by jurisdiction is in Table 3.9. All values have been adjusted for inflation to reflect 2021 values.

Table 3.9. NCEI Record of City of Frederick Flooding Events

Jurisdiction	Events	Property Damage (2021$)	Crop Damage (2021$)	Total Damage (2021$)
City of Frederick	18	$133,576	$0	$133,576
Frederick County (Total)	**230**	**$36,819,292**	**$67,228**	**$36,886,520**

Probability and Severity of Future Occurrences

Hood College is located outside of the 1%-annual-chance and the 0.2% -annual-chance flood zones. As a result, the College has a very low chance to suffer from riverine flooding. However, there is always a risk for flash floods, poor drainage and low-lying floods, along with other riverine and stream flooding. While climate change impacts are expected to impact precipitation patterns, the probability of future floods can be discussed in relation to the benchmark flood, or the “1%-annual-chance” flood.

In addition to this statistical probability, there is also an increased chance of flooding in communities that are not maintaining natural floodplains and infrastructure. Urban flooding can often be minimized or avoided with consistent drainage system maintenance. In addition, by working to maintain clean floodways, natural floodplains will be allowed to flood normally, minimizing adjacent property damage. Table 3.10. shows the flood probability for the region.

Table 3.10. Flood Probabilities for the Region

Recurrence interval (years)	Probability of occurrence in any given year	Chance of occurrence in any given year
500	1 in 500	0.2%
100	1 in 100	1%
50	1 in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%

It is important to note that although a recurrence interval is given for a storm of a certain magnitude, that does not mean this size storm only occurs once in a certain number of years. For example, a 1%-annual-chance flood, or 100-year flood, has a 1% chance of occurring each year. There is always a chance that a storm of the same magnitude can occur in the same year.

Based on NCEI data, the City of Frederick, which encompasses Hood College, experienced 18 flood events that recorded $133,576 in damages within a 25-year period between 1996 and 2021. Based on these occurrences, Hood College can expect to witness 9.2 flood events and endure $1,475,461 in property and crop damages in any given year.

For a record of events for all jurisdictions, refer to the flood section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Table 3.11. Annualized NCEI Flood Events for City of Frederick

Jurisdiction	Events	Annualized Events	Total Damage (2021$)	Annualized Damages (2021$)
City of Frederick	18	0.72	$133,576	$5,343
Frederick County (Total)	**230**	**9.2**	**$36,886,520**	**$1,475,461**

National Flood Insurance Program (NFIP)

The National Flood Insurance Program (NFIP) is a federal program that enables property owners in participating communities to purchase insurance for flood losses. Floodplain management begins at the community level with operation of a community program of corrective and preventative measures for reducing flood damage. For a community to participate in the NFIP they must adopt FEMA's flood risk maps and the Flood Insurance Study as well as floodplain management regulations that reduce future flood damages. For more information on the NFIP, refer to the flood section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Table 3.12 summarizes community participation in the NFIP for the City of Frederick, which encompasses Hood College. The current effective maps for Hood College are from September 2007, with preliminary products issued December 2, 2020. As of August 2021, there were 229 flood insurance policies in effect throughout the City, with total annual premiums of $230,940 covering more than $71 million in property. The loss statistics from FEMA's Community Information System database for the City of Frederick indicate that there have been 60 flood insurance claims processed by the NFIP since 1978. These statistics are summarized in Table 3.13.

Table 3.12. Community Participation in the National Flood Program (as of August 2021)

Community Name	Initial Flood Hazard Boundary Map Identified	Initial FIRM Identified	Current Effective Map Date	Date of NFIP Entry
Frederick, City of	10/18/74	06/15/78	09/19/07	06/15/78

Table 3.13. Flood Insurance Policy Statistics and Claims (as of August 2021)

Community Name	No. of Policies	Total Premium	Total Coverage	Total Claims since 1978	Total Payments
Frederick, City of	229	$230,940	$71,531,400	60	$319,906

Flood insurance is available to anyone in Frederick County, including structures outside of the mapped SFHA, provided they are located in an NFIP-participating community. In some cases, therefore, the number of policies includes policies for structures that are outside the mapped SFHA. Hood College has flood coverage endorsement under its insurance policy.

Impact Summary

Primary Impacts

Flood damage to property and populations can be devastating, both emotionally and financially. Flood damage to employment centers, like institutions of higher education, could result in loss of income, wages, and tax revenues. Buildings are susceptible to damage and sometimes collapse as a result of a severe flood. Floodwaters can also block roadways and evacuation routes, as well as damage vehicles, if drainage in parking lots or along roadways is insufficient.

Secondary Impacts

Flooding can disrupt utilities and result in the accumulation of debris and garbage. Gas and electrical services may be interrupted, either because the lines got damaged by the floodwaters itself or suspended items like rocks or trees.

Vulnerability Assessment

Structures in the affected areas are more likely to experience the greatest effects of flooding. Flooding directly affects Hood College's ability to function by damaging facilities and blocking roadways, preventing people from traveling to or from the campus. College facilities that are flooded may sustain damage to the structure and its contents that disrupt research or related activities, risking loss of existing or future grant funding.

Human-Caused Hazards

Non-Climate-Influenced Hazards

Cybercrime

Hazard Identification

Hazard Description

Cybercrime refers to criminal activity involving a computer, networked device, or the internet. Cybercrime incidents often involve pre-meditated attacks against information, computer systems, computer programs and data, and infrastructure which results in disruption or violence. Examples include business email compromises, ransomware, spoofing and phishing, and other various types of fraud.

Location

According to Microsoft Global Threat Activity models, education is the most affected sector for malware attacks when compared to other industries. The models suggest that, in addition to businesses and professional services, colleges and universities are prime targets for ransomware attacks. In October 2021, educational organizations were found to be the target of approximately 5.5 million malware attacks (within the previous 30-days).[8]

Extent

The threat of ransomware in higher education is increasing as cyberattacks surge in frequency and effect. In March 2021, the FBI Cyber Division alerted the public to increasing cyber threats through a ransomware called PYSA in which attackers were found to be targeting educational institutions. PYSA is a malware that has the capability to exfiltrate data and encrypt users' critical data and files stored on their systems. The FBI noted that "the unidentified cyber actors have specifically targeted higher education, K-12 schools, and seminaries," and have used PYSA to "exfiltrate data from victims prior to encrypting victims' systems to use as leverage in eliciting ransom payments."[9] Recommended mitigations for such attacks include regularly backing up data, implementing network segmentation and recovery plans, installing updates and patch operating systems, regularly changing passwords, auditing users, installing anti-virus and anti-malware software, disabling hyperlinks in emails, and focusing on awareness and raining for system users.

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[8] Microsoft Security Intelligence. *Cyberthreats, Viruses, and Malware*. Retrieved from https://www.microsoft.com/en-us/wdsi/threats
[9] Department of Justice, Federal Bureau of Investigation. 2021. *Increase in PYSA Ransomware Targeting Education Institutions*. Retrieved from https://www.ic3.gov/Media/News/2021/210316.pdf

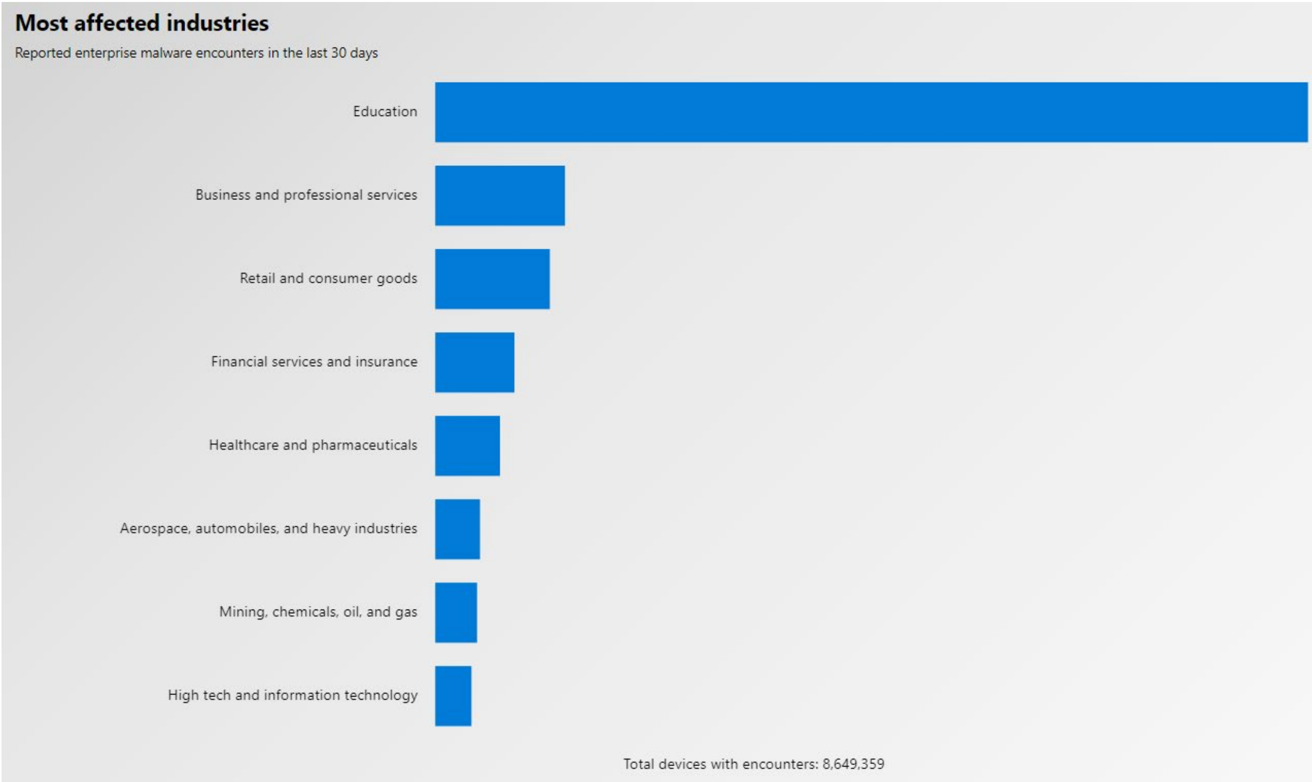

Figure 3.2. Microsoft Global threat Activity: Most Affected Industries (October 2021)

Today, governments and industries rely on technology for everyday operations. In almost every sector, organizations take advantage of processing, communications, and other complex technologies to ensure smooth, efficient operations. A cyber terrorist can infiltrate many institutions including banking, medical, education, government, military, and communication and infrastructure systems. The majority of effective malicious cyber activity has become web based. Recent trends indicate that hackers are targeting users to steal personal information and moving away from targeting computers by causing system failure. [10]

The duration of a cyberattack is dependent on the complexity of the attack, how widespread it is, how quickly the attack is detected, and the resources available to aid in restoring the system. Common types of cyberattacks are summarized in Table 3.14. One of the difficulties of malicious cyber activity is that its origin could be virtually anyone, virtually anywhere. Table 3.15 summarizes common sources of cybersecurity threats.[11]

Table 3.14. Common Types of Cybercrimes

Type of Attack	Description
Botnet	A collection of compromised machines (bots) under (unified) control of an attacker (botmaster).
Denial of service	A method of attack from a single source that denies system access to legitimate users by overwhelming the target computer with messages and blocking legitimate traffic. It

[10] Symantec, "Internet Security Threat Report" Volume 17 (2011), www.symantec.com/threatreport
[11] United States Government Accountability Office, "Critical Infrastructure Protection: Department of Homeland Security Faces Challenges in Fulfilling Cybersecurity Responsibilities", Report #GAO-05-434 (May 2005), www.gao.gov/new.items/d05434.pdf

Type of Attack	Description
	can prevent a system from being able to exchange data with other systems or use the internet.
Distributed denial of service	A variant of the denial-of-service attack that uses a coordinated attack from a distributed system of computers rather than from a single source. It often makes use of worms to spread to multiple computers that can then attack the target.
Exploit tools	Publicly available and sophisticated tools that intruders of various skill levels can use to determine vulnerabilities and gain entry into targeted systems.
Logic bombs	A form of sabotage in which a programmer inserts code that causes the program to perform a destructive action when some triggering event occurs, such as terminating the programmer's employment.
Phishing	The creation and use of e-mails and websites—designed to look like those of well-known legitimate businesses, financial institutions, and government agencies—in order to deceive Internet users into disclosing their personal data, such as bank and financial account information and passwords. The phishers then take that information and use it for criminal purposes, such as identity theft and fraud.
Sniffer	Synonymous with packet sniffer. A program that intercepts routed data and examines each packet in search of specified information, such as passwords transmitted in clear text.
Trojan horse	A computer program that conceals harmful code. A Trojan horse usually masquerades as a useful program that a user would wish to execute.
Virus	A program that infects computer files, usually executable programs, by inserting a copy of itself into the file. These copies are usually executed when the infected file is loaded into memory, allowing the virus to infect other files. Unlike the computer worm, a virus requires human involvement (usually unwitting) to propagate.
War dialing	Simple programs that dial consecutive telephone numbers looking for modems.
War driving	A method of gaining entry into wireless computer networks using a laptop, antennas, and a wireless network adaptor that involves patrolling locations to gain unauthorized access.
Worm	An independent computer program that reproduces by copying itself from one system to another across a network. Unlike computer viruses, worms do not require human involvement to propagate.

Table 3.15. Common Sources of Cybersecurity Threats

Threat	Description
Bot-network operators	Bot-network operators are hackers; however, instead of breaking into systems for the challenge or bragging rights, they take over multiple systems in order to coordinate attacks and to distribute phishing schemes, spam, and malware attacks. The services of these networks are sometimes made available on underground markets (e.g., purchasing a denial-of-service attack, servers to relay spam or phishing attacks, etc.).
Criminal groups	Criminal groups seek to attack systems for monetary gain. Specifically, organized crime groups are using spam, phishing, and spyware/malware to commit identity theft and online fraud. International corporate spies and organized crime organizations also pose a threat to the United States through their ability to conduct industrial espionage and large-scale monetary theft and to hire or develop hacker talent.
Foreign intelligence services	Foreign intelligence services use cyber tools as part of their information-gathering and espionage activities. In addition, several nations are aggressively working to develop information warfare doctrine, programs, and capabilities. Such capabilities enable a single entity to have a significant and serious impact by disrupting the supply, communications, and economic infrastructures that support military power—impacts that could affect the daily lives of U.S. citizens across the country.
Hackers	Hackers break into networks for the thrill of the challenge or for bragging rights in the hacker community. While remote cracking once required a fair amount of skill or computer knowledge, hackers can now download attack scripts and protocols from the Internet and launch them against victim sites. Thus, while attack tools have become more sophisticated, they have also become easier to use. According to the Central Intelligence Agency, the large majority of hackers do not have the requisite expertise to threaten difficult targets such as critical U.S. networks. Nevertheless, the worldwide population of hackers poses a relatively high threat of an isolated or brief disruption causing serious damage.
Insiders	The disgruntled organization insider is a principal source of computer crime. Insiders may not need a great deal of knowledge about computer intrusions because their knowledge of a target system often allows them to gain unrestricted access to cause damage to the system or to steal system data. The insider threat also includes outsourcing vendors as well as employees who accidentally introduce malware into systems.
Phishers	Individuals, or small groups, that execute phishing schemes in an attempt to steal identities or information for monetary gain. Phishers may also use spam and spyware/malware to accomplish their objectives.
Spammers	Individuals or organizations that distribute unsolicited e-mail with hidden or false information in order to sell products, conduct phishing schemes, distribute spyware/malware, or attack organizations (i.e., denial of service).

Threat	Description
Spyware/malware authors	Individuals or organizations with malicious intent carry out attacks against users by producing and distributing spyware and malware. Several destructive computer viruses and worms have harmed files and hard drives, including the Melissa Macro Virus, the Explore.Zip worm, the CIH (Chernobyl) Virus, Nimda, Code Red, Slammer, and Blaster.
Cyber terrorists	Cyber terrorists seek to destroy, incapacitate, or exploit critical infrastructures in order to threaten national security; cause mass casualties, weaken economies or target businesses; and damage public morale and confidence. Cyber terrorists may use phishing schemes or spyware/malware in order to generate funds or gather sensitive information.

Previous Occurrences

There are no recorded cybercrime events for Hood College. However, the Hood College Planning Team listed cybercrime as a major concern and vulnerability for the institution as part of the 2022 plan update.

Probability and Severity of Future Events

Ransomware attacks against colleges and universities more than doubled in 2021 since the onset of the COVID-19 pandemic where the nation saw an enormous shift towards remote learning.[12] However, given the data available, a potential recurrence interval or probability is not able to be calculated.

Impact Summary

Primary Impacts

A cybercrime incident typically targets traffic pipelines or powerful servers of an information technology (IT) system. Attackers may seek to compromise their target through service disruption or manipulation. Attacks could utilize destructive worms and viruses, Denial of Service exploits, and intrusions to disrupt targeted networks.

Secondary Impacts

Attacks geared toward critical infrastructure and hospitals can result in the loss of life and the loss of basic needs, such as power and water, to the general public. Cybercrime incidents can also lead to the loss of operational capacity.

Vulnerability Assessment

A cybercrime attack (cyberattack) could be geared toward one organization, one type of infrastructure and/or a specific geographical area. The affected area could range from small to large scale. Cyberattacks generated toward large corporations can negatively affect the economy. The Congressional Research Service study found the economic impact of cyberattacks on businesses has grown to over $226 billion annually.[13]

Humans are the weakest link in a chain of cyber security. It remains difficult to continuously monitor and manage human/operator vulnerability. Actors either inside or outside of the asset's organization could carry out acts of sabotage. Attractive targets include government websites and high value networks.

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[12] The Daily Swig: Cybersecurity News and Views. 2021. *Ransomware attacks more than doubled last year as cybercrime operations scale up during coronavirus pandemic*. https://portswigger.net/daily-swig/ransomware-attacks-more-than-doubled-last-year-as-cybercrime-operations-scale-up-during-coronavirus-pandemic
[13] Defense Tech. http://defensetech.org/2008/10/20/the-cyber-attack-danger/

CHAPTER 4. CAPABILITY ASSESSMENT

A capability assessment evaluates the existing programs and resources in order to determine the extent of mitigation activities that are already in place and helps to emphasize the potential for new strategies. Through a thorough review of Hood College's financial resources, personnel expertise, and existing mitigation activities, planners can reach a better understanding of factors that may influence the college's ability to implement mitigation strategies that address the effects of the hazards identified in Chapter 3. This assessment includes a comprehensive assessment of:

- Administrative Capabilities
- Plan and Program Capabilities
- Fiscal Capabilities
- Regulatory Environment
- Community Interaction

Administrative Capabilities

Faculty, administrative offices, staff, academic departments and students contain a wealth of physical and metaphysical resources that contribute to the overall functioning, safety, and security of the College. This section attempts to identify those pre-existing resources that may assist in bettering the mitigation strategy.

Administrative Organization

The staff/technical capabilities have been identified as part of the Hood College Steering Committee capability assessment questionnaire. Personnel capabilities include:

- Emergency management
- Resource development staff or grant writers
- Office of Campus Safety

Campus Safety

Hood College's Office of Campus Safety is a full-service public safety provider and is committed to reducing and even removing hazards, risks, conditions, and circumstances associated with crime and fear of crime on campus. The Office is responsible for campus safety, campus crime awareness, and campus crime prevention and education, in addition to parking and ID card services, emergency management, providing safety escorts and vehicle assistance, and managing vehicular and traffic control on campus. The Office of Campus Safety is operated 24 hours a day, seven days a week, all year long.

The College's Whitaker Campus Center also houses the Communications Center, which is always staffed by a campus safety operator. Safety officers patrol the campus on foot and by vehicle and respond to calls both on and immediately near campus.

Academic Organization

Hood College administers more than 33 bachelor's degrees, four pre-professional programs, 19 master's degrees, two doctorates and 12 post-baccalaureate certificates . With 98 full-time faculty and 134 part-time faculty within the Hood College community command expertise in subject matters that may hold potential in assisting the development and implementation of a Hazard Mitigation and Climate Adaptation Plan. In Table 19 below, academic areas of study have been selected as potential resources.

Table 4.1. Academic Programs with Potential for Hazard Subject Matter Expertise

Academic Programs	
Computer Sciences and Information Technology (including Cybersecurity and Bioinformatics)	Natural Sciences (including Biology, Environmental Science)
Physical Sciences (including Chemistry, Biochemistry)	Social Sciences and Humanities (including Sociology, Social Work, Psychology, History, Political Science, Art)
English and Communication Arts	Business Administration (including Economics, Finance and Accounting)
Law and Criminal Justice	Counseling
Nursing	Public Health

Plan and Program Capability

The College has invested significantly in its emergency planning and preparedness programs. These programs have contributed to the wellbeing of community residents, employees and visitors, as well as enhancing the ability of the College to respond to major events.

College Plans and Programs

Hood College is in the process of reviewing all College Policies and Procedures. Table 4.2 and Table 4.3 describe the various plans that the College and local community have in place and provide recommendations, where appropriate, for integration with the hazard mitigation plan.

Table 4.2. Hood College Planning Capabilities

Plan Name	Description	Integration Options
Campus Master Plan (2015)	Includes a narrative highlighting any facility deficiencies or needs, the responsibilities of the college, background data on campus facilities, facility user data, an evaluation of existing facilities, a description of programs and services at the college and any changes to these programs, an evaluation of the adequacy of the facilities to meet current and projected needs, proposals to address the assessed needs, and a	Ensure Master Plan and HMCAP recommendations are integrated, where appropriate.

Plan Name	Description	Integration Options
	prioritized list of recommended projects based on the assessed needs.	
Strategic Plan (2017-2022)	Outlines the mission, values, vision and goals for Hood College.	
Emergency Operation Plan (2018)	Provide guidance for responding to the event of an emergency incident on Hood College Campus.	Identify potential mitigation strategies and ensure objectives are aligned.
Campus Landscape Plan (2021 Draft)	Outlines objectives and actions to maintain and improve Hood College's campus.	Identify potential mitigation strategies and ensure objectives are aligned or not in conflict with HMCAP, where appropriate.
Capital Budget (annual)	Capital project funding requests are submitted to the College's planning, budgeting and assessment committee annually for preliminary approval, before the Board of Trustees approves an annual capital budget each June.	Identify potential mitigation projects from list of capital projects.
IT Disaster Recovery	Provide guidance for responding and recovering from the event of a cyberterrorist attack or technology-based hazard on Hood College Campus.	Identify potential mitigation strategies and ensure objectives are aligned or not in conflict with HMCAP.
IT Strategic Plan (2020-2025)	Outlines objectives and actions needed to improve Hood College's IT infrastructure.	Identify potential mitigation projects from list of capital projects.

Table 4.3. Local Plans and Programs

Plan Name	Description	Integration Options
Frederick County Hazard Mitigation and Climate Adaptation Plan & Manmade Annex (2021 Update)	The Frederick County Hazard Mitigation and Climate Adaptation Plan identifies goals and measures for hazard mitigation and risk reduction to better ensure that the participating communities are disaster resistant. The plan not only addresses current concerns but has also been developed to help guide and coordinate mitigation activities and local policy decisions for future land use. This plan follows FEMA's planning requirements and associated guidance for developing Local Hazard Mitigation and Climate Adaptation Plans.	Recommendations: Continue coordination between college and county.

Plan Name	Description	Integration Options
Frederick County Emergency Operations Plan	The basic plan describes the concept of emergency operations and assigns duties and responsibilities to agency heads or organizations which are either part of, or will serve in support of, local government in time of emergency. It becomes the organizational and legal basis for emergency operations. Functional annexes and hazard-specific appendices to the basic plan provide additional guidance and set forth detailed procedures as needed to assure an appropriate level of emergency preparedness.	Recommendations: Ensure the College participates in next update of the Emergency Operations Plan.

Fiscal Capability

Hood College's operating and capital budget are potential funding sources for hazard mitigation projects. The College also has insurance policies that would respond to covered claims. For declared disasters, funding could also come from FEMA.

Maryland State Policies and Plans

Maryland State Hazard Mitigation and Climate Adaptation Plan

Maryland State's most recent Standard Hazard Mitigation and Climate Adaptation Plan was approved by FEMA in August 2016. Sections 1-5 and 1-6 outline the process to engage Maryland's 23 counties and 139 municipalities in hazard mitigation planning.

The Mitigation Strategy (Section 5) describes the process to create, and refine the state's mitigation goals, objectives, and actions. Table 4.4 outlines the goals and objectives within the plan relevant to Hood College's mitigation plan.

Table 4.4. 2016 Maryland State Mitigation Goal and Objectives

Goal	To protect life, property, and the environment from hazard events through:
Objectives	Increased public awareness of hazards, mitigation, preparedness, and resiliency.
	Enhanced coordination with local jurisdictions and linkages between state and local mitigation and resiliency efforts.
	Protection of State assets, infrastructure, and critical facilities
	Promote actions that protect natural resources, while enhancing hazard mitigation and community resiliency.
	Efficient use of State resources

Actions were developed by five subcommittees which formed during topical break-out sessions during the meeting:

1. Programs, Policy, Planning and Funding
2. Mitigation of High Hazard Structures
3. Local Planning Interface
4. 2014 Vulnerability Analysis
5. Education and Outreach

Maryland's 2016 Standard Hazard Mitigation and Climate Adaptation Plan further identifies the criteria used in prioritizing mitigation actions. The Hood College mitigation strategy development process will take these criteria – as well as the State's goals and objectives – under consideration when identifying its own goals, objectives and strategies for Hood College.

State of Maryland Response Operations Plan - March 2015

The Maryland State Response Operations Plan describes the roles and responsibilities of entities within Maryland during incident response operations. Response operations focuses on ensuring that the State is able to effectively respond to any threat or hazard, including those with cascading effects, in order to save and sustain lives, protect property and the environment, stabilize the incident, rapidly meet basic human needs, and restore essential community services and functionality.[14]

The objectives of the State of Maryland Response Operations Plan include:

- Maintain 24/7 situational awareness across the State of Maryland, the nation, and around the world.
- Coordinate the activities of State, local, Federal agencies, nonprofit organizations, and private-sector partners in support of incident response.
- Facilitate the transition from incident response to disaster recovery.

The State of Maryland Response Operations Plan addresses the risks identified in the State's annual Threat and Hazard Identification and Risk Assessment, and triennial Hazard Identification and Risk Assessment.

Regulatory Environment

State

Uniform Statewide Building Code

Maryland's law related to building codes is called the Maryland Building Performance Standards. It requires each jurisdiction in Maryland to use the same edition of the same building codes. They are the International Building Code, the International Residential Code, and the International Energy Conservation Code. The State has modified the International Building Code and the International Residential Code to coincide with other Maryland laws. The International Building Code , the International Residential Code, and the International Energy Conservation Code, with modifications by the State, constitute the Maryland Building Performance Standards.

[14] Maryland State Response Operations Plan . Retrieved from https://mdem.maryland.gov/Documents/State of Maryland Response Operations Plan_V3_03_MAR-15.pdf

Each local jurisdiction in Maryland may modify these codes to suite local conditions with exception to the 2021 International Energy Conservation Code and Maryland Accessibility Code. The Energy Code and the Accessibility Code can be made more stringent but not less by the local jurisdictions.

Maryland building performance standards are based on the 2021 I-codes. Effective May 2011, Maryland became the first state to legislatively adopt International Code Council Standards.[15] This includes:

- 2021 International Building Code
- 2021 International Energy Conservation Code
- 2018 International Green Construction Code
- 2021 International Mechanical Code
- 2018 International Plumbing Code
- 2018 International Residential Code

In addition, Frederick County has jurisdictionally adopted:

- 2021 International Building Code
- 2021 International Energy Conservation Code
- 2021 International Fuel Gas Code
- 2021 International Mechanical Code
- 2018 International Plumbing Code
- 2021 International Residential Code

Establishing Preparedness Initiatives in State Government

Governor Martin O'Malley issued Executive Order 01.01.2013.06 on October 29, 2013 to adopt the Maryland's Emergency Preparedness Program.[16] The order outlines the roles and responsibilities related to the four mission areas used for measuring preparedness — prevention and protection, hazard mitigation, incident response and disaster recovery. Maryland Department of Emergency Management , Maryland State Police, and other state agencies are charged with fulfilling the activities that support those four core mission areas. The executive order requires that state agencies develop or maintain documents necessary to support Maryland's Emergency Preparedness Program, at a minimum Continuity of Operations Plans that are updated bi-annually.

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[15] International Code Council. State Adoptions. http://www.iccsafe.org/about-icc/government-relations/map/maryland/

[16] Maryland State Executive Order 01.01.2013.06 http://mema.maryland.gov/Documents/MEPP_01.01.2013.06eo.pdf

CHAPTER 5. MITIGATION AND ADAPTATION STRATEGY

This chapter presents a series of goals and objectives to help Hood College identify and select mitigation and adaptation actions to address its vulnerabilities, as discussed in Chapter 3. The selected mitigation actions will help the college avoid, prevent, or otherwise reduce damages from hazards.

Mitigation Goals and Objectives

Definitions

Goals: general guidelines that explain what you want to achieve; usually broad, long-term policy statements representing global visions.

Objectives: define strategies or implementation steps to attain the identified goals; specific and measurable.

Frederick County's Hazard Mitigation and Climate Adaptation Planning Committee, which included Hood College representation, met October 14, 2021 to discuss goals and objectives for the mitigation plan. At this meeting, members discussed the results of the including the Hazard Identification and Risk Assessment, which identified vulnerabilities in the context of the capability assessment, prior to establishing the revised mitigation goals.

The Hood College Planning Team reviewed the mitigation goals from the main Frederick County Hazard Mitigation and Climate Adaptation Plan and adapted them to better align with the College's specific needs and vision. The adapted goals and objectives for Hood College are outlined in Table 5.1.

Table 5.1. Goals and Objectives

Mitigation Category	Goal	Objective
Physical Projects 	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk.	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
		Objective 2: Increase the percentage of critical equipment and property that is protected from hazards (e.g., data storage, paperwork, lab equipment, hazardous materials).

Mitigation Category	Goal	Objective
Capability and Capacity Building 	Goal B: Enhance the capability and capacity of Hood College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.	Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards.
Forward-Looking Policy and Planning 	Goal C: Adapt to climate change and natural hazards through forward-looking policies and plans.	Objective 4: Integrate hazard mitigation, climate adaptation, and resilience planning into other college planning efforts.
		Objective 5: Implement plans and policies that encourage future—or significantly renovated—infrastructure to be made resilient to future climate impacts.

Identification of Mitigation Actions

At the November 30, 2021 meeting, the Hood College Planning Team was provided with an overview of the types of mitigation actions that could be undertaken. The committee then was provided a range of potential mitigation actions specific to the Hood College's vulnerabilities and capabilities which included the mitigation projects previously proposed by Hood College. The committee reviewed the list and refined it further based on their knowledge of the college. Carry-over actions were included in the list, which the College Planning Team had already evaluated and provided updates for at the first local planning team meeting.

Prioritizing Actions

The Hood College Planning Team used the STAPLE/E (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) criteria to select and prioritize the most appropriate mitigation and adaptation alternatives (see Table 5.2). This methodology requires that social, technical, administrative, political, legal, economic, and environmental considerations be taken into account when reviewing potential actions for the College to undertake. This process was used to help ensure that the most equitable and feasible actions would be undertaken based on the College's capabilities.

Table 5.2. STAPLE/E Selection and Prioritization Criteria for Alternatives

STAPLE/E	Considerations
Social	• Is the proposed action socially acceptable to the college?

STAPLE/E	Considerations
	• Are there equity issues involved that would mean that one segment of the community is treated unfairly? • Will the action cause social disruption?
Technical	• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of the college's other goals?
Administrative	• Can the college implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
Political	• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
Legal	• Is the college authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? • Are there legal side effects? Could the activity be construed as a taking? • Will the college be liable for action or lack of action? • Will the activity be challenged?
Economic	• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account? • Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the college? • What are the budget and revenue effects of this activity? • Does the action contribute to other college goals? • What benefits will the action provide?
Environmental	• How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and state regulatory requirements? • Are endangered or threatened species likely to be affected?

A priority level of high, medium, or low was assigned to each action based on the STAPLE/E assessment. This prioritization method was selected because the Hazard Mitigation and Climate Adaptation Planning Committee and Hood College Planning Team believed it would foster a realistic expectation of what could be accomplished in the next five years. The prioritization process has been significantly enhanced compared to the 2016 method which mainly focused on funding availability to assign priority rankings.

2022 Mitigation Action Plans

The following tables detail the in progress and ongoing mitigation actions selected by the college, as well as the new mitigation actions included in the 2022 Plan. Only the actions with a HMCAP priority of "high" have been developed into full action plans.

Key for Action Header Colors:

Action Added During 2022 Plan Update	Action Added During 2022 Plan Update & Significantly Supports Climate Adaptation*

*As there is a strong connection between traditional hazard mitigation actions and climate adaptation actions, there is considerable overlap between the two action categories (i.e., many of the actions support both). However, for the purpose of easy identification, the actions that *significantly* support climate adaptation are highlighted

Action HC-1	
Description of Action	Starting in the summer of 2022 and every other year afterward, include a hazard mitigation review before starting any construction or renovation projects or plans. This process should identify potential mitigation measures for inclusion in the renovations/maintenance process.
Applicable Goal(s)	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation and climate adaptation projects that efficiently and equitably reduce risk. Goal C: Adapt to climate change and natural hazards through forward-looking policies and plans.
Applicable Objective(s)	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards. Objective 2: Increase the percentage of critical equipment and property that is protected from hazards (e.g., data storage, paperwork, lab equipment, hazardous materials). Objective 4: Integrate hazard mitigation, climate adaptation, and resilience planning into other college planning efforts. Objective 5: Implement plans and policies that encourage future—or significantly renovated—infrastructure to be made resilient to future climate impacts.
Relevant Hazard(s)	Flood
HMCAP Priority	High

Action HC-1	
Responsible Party	Director of Facilities
Estimated Cost	Low
Possible Funding Source(s)	Operating budget; FEMA HMA for mitigation project implementation
Timeline for Implementation	Ongoing

Action HC-2	
Description of Action	Review and update the IT incident response plan, as needed
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Hood College to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 3: Support data collection, studies, plans, and mapping efforts to improve the college's ability to respond to and prepare for future hazards.
Relevant Hazard(s)	Cybercrime
HMCAP Priority	High
Responsible Party	Chief Information Officer
Estimated Cost	Low
Possible Funding Source(s)	Operating budget
Timeline for Implementation	Ongoing

CHAPTER 6. PLAN MAINTENANCE

The long-term success of the Hood College's Hazard Mitigation and Climate Adaptation Plan Annex depends on its success in implementing the plan and in establishing a process to ensure that the plan is current and continues to provide value to the college.

The Frederick County Hazard Mitigation plan is intended to serve as Frederick County's road map for evaluating hazards, identifying resources and capabilities, selecting appropriate actions, and developing and implementing mitigation measures to eliminate or reduce future damage from those hazards in order to protect the health, safety, and welfare of the residents in the community. This annex identifies procedures for keeping this annex current and updated at least once every 5 years, as prescribed by the DMA2K.

Plan Implementation

Responsibility for the overall implementation and maintenance of the College hazard mitigation plan rests primarily with the members of the Steering Committee. The Frederick County Director of Emergency Preparedness will work with the committee to ensure the implementation and maintenance of the plan.

For all mitigation actions, an appropriate College department(s) has been identified that will have primary responsibility for implementation of that particular action. The Steering Committee, in concert with the primary responsible department, has established measures of success and potential funding sources for each high priority hazard mitigation action. The measures of success will be used to gauge how well the plan is being implemented and whether the actions are achieving their intended purpose; while the other criteria create a level of responsibility and accountability for each of the mitigation strategies.

Beyond these initial measures of success, additional implementation needs and measures will be the responsibility of the primary responsible department, the Hood College Director and Chief of Campus Safety and ultimately the members of the Steering Committee (i.e., Director of Facilities and Chief Information Officer). This may include any meetings with local officials, integration measures with other planning documents, identifying additional funding sources, etc.

Just as important as the mitigation actions themselves, is the development of a risk averse culture. The members of the Steering Committee will continue to ensure that the goals and strategies of new and updated planning documents are consistent with the goals and actions of this plan, and that new projects throughout the College consider potential risks and are designed in such a way as to avoid them. Risk reduction principles identified in this plan should be carefully considered when developing new goals and actions of other College planning documents and projects.

Monitoring, Evaluating, and Updating the Plan

Plan maintenance requires an ongoing effort to monitor and evaluate the implementation of the plan, and to update the plan as progress, roadblocks, or changing circumstances are recognized. The Hood College Steering Committee will be responsible for monitoring and updating the plan and the Hazard Mitigation and Climate Adaptation Planning Committee will play an advisory role available for oversight. The team should accomplish the following:

- Annual progress update from departments designated as "Responsible Department" in the mitigation action plan to the Hood College Steering Committee, and

- Participate in the five-year Hazard Mitigation and Climate Adaptation Plan written update that is submitted to the state and FEMA Region III, unless a disaster or other circumstances (e.g., change in regulations) leads to a different time frame.

The timing of the yearly reviews should coincide with either the anniversary of the approval date of this plan or another date chosen by the committee. Re-prioritization of projects may be needed as high priority mitigation actions are completed.

As described above, the Hood College Steering Committee and primary responsible departments for each project will be responsible for evaluating progress in implementing mitigation projects. The Hood College Steering Committee, along with the Department of Emergency Preparedness, during its annual review, also may identify corrective actions for projects. In addition, the Hood College Steering Committee should review its organizational composition annually and adjust membership, if needed.

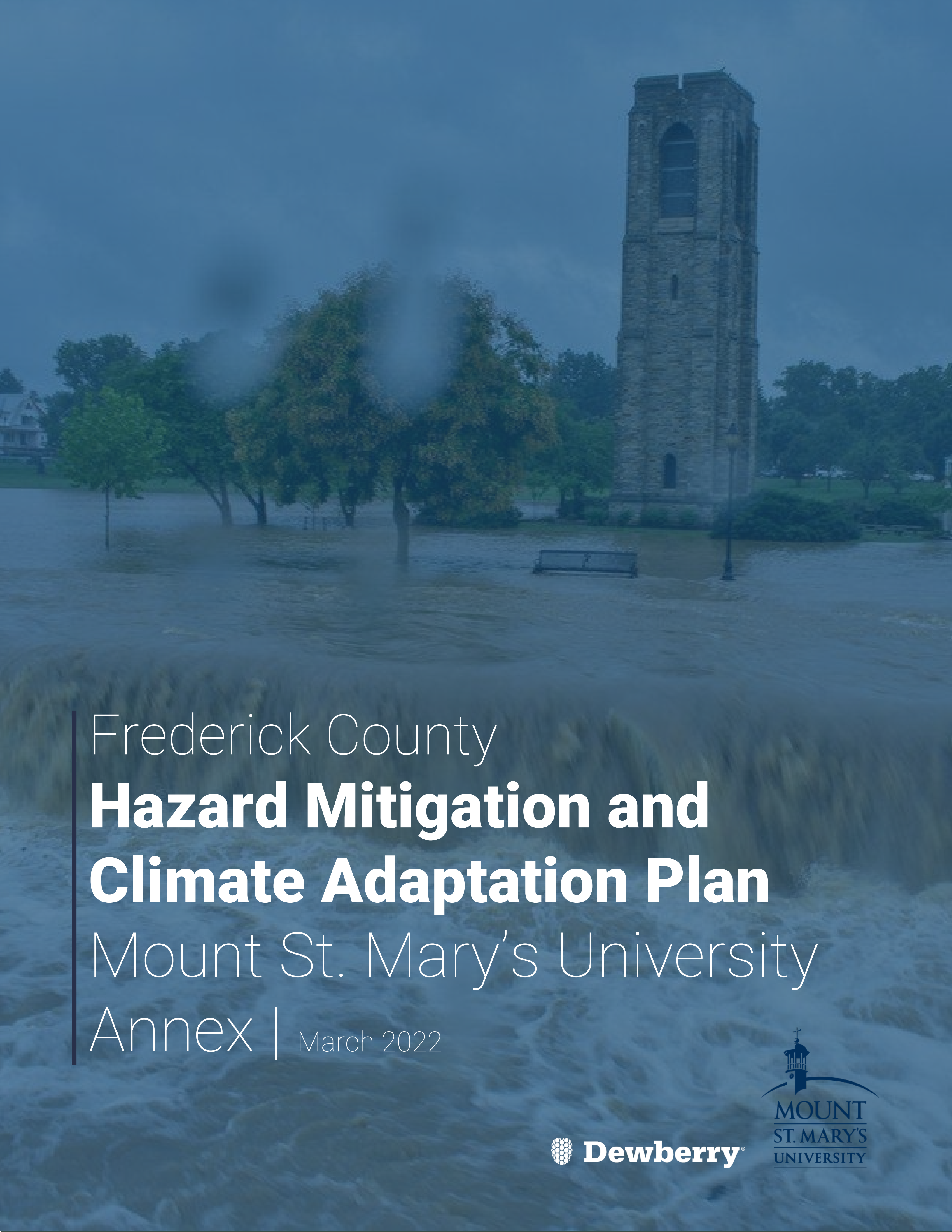
The Hood College Steering Committee, in conjunction with the Department of Emergency Preparedness will determine at its annual meeting if a formal update of the plan is required. At a minimum, the plan will be updated every five years. Factors to consider when determining if an update is necessary include:

- Decreased vulnerability as a result of implementing recommended actions;
- Increased vulnerability as a result of failed or ineffective mitigation actions;
- Increased vulnerability as a result of new development;
- New state/federal laws, policies, or programs;
- Changes in resource availability; and/or
- Applicability of goals/objectives/strategies.

A major event, such as a presidentially declared disaster, may trigger a need to review the plan. If such an event affects Frederick County, the Department of Emergency Preparedness, and the Hood College Steering Committee will coordinate to determine how best to review and update the plan. Major changes to the plan will be submitted to the state and to FEMA Region III.

Campus Community Involvement

Frederick County will hold annual HMCAP reviews that the general public will be informed of. At a minimum, notification will be through web postings and press releases to local media outlets, primarily newspapers. The County will also post a link to the main HMCAP on the Department of Emergency Preparedness's website. The Hood College Planning Team can provide an annual update necessary administrative positions to keep them informed about plan implementation. Members of the Hood College campus community may be invited to participate in the five-year Hazard Mitigation and Climate Adaptation Plan update as deemed appropriate, such as through the campus hazard mitigation survey.



Frederick County

Hazard Mitigation and Climate Adaptation Plan

Mount St. Mary's University Annex | March 2022

Dewberry

MOUNT ST. MARY'S UNIVERSITY

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CHAPTER 1. INTRODUCTION

Plan Purpose

This annex supplements the 2022 Frederick County Hazard Mitigation Plan by focusing on Mount Saint Mary's (MSM) University located on Old Emmitsburg Road in Frederick County, Maryland. The annex focuses on identifying potential hazards and assessing the vulnerability of the campus to these hazards. This plan also assesses the University's existing capabilities to implement a variety of mitigation actions. This plan concludes with implementation and maintenance procedures.

Natural and human-caused hazards can affect higher education institutions through structural damage to buildings and infrastructure or interruptions to daily operations that can last days, weeks, or months at a time. Disruptions to research activities can even threaten a loss of funding or future opportunities. If severe enough, disasters may result in faculty or student departures, causing a loss of educational continuity for students. Institutions may face future financial duress due to rising insurance premiums or costs of necessary repairs and reconstruction in the aftermath of a disaster.

This annex represents one step in a series of proactive actions taken by MSM to reduce the adverse impacts of disasters and to avoid future losses and disruption. This plan focuses on hazard mitigation, but also addresses some aspects of disaster preparedness, response and recovery, which can enhance or hinder this plan's ultimate success. This plan also serves to guide MSM's decision-making regarding land use and development of new buildings, facilities and utilities, and in the renovation of existing structures.

Planning Process

Frederick County included Mount Saint Mary's in its mitigation planning process for the 2022 plan update to improve the region's overall resilience to future hazards. This effort resulted in the following annex that specifically addresses the College's unique vulnerabilities and mitigation efforts. MSM conducted a mitigation planning process modeled after Frederick County's strategy and FEMA's *Building a Disaster-Resistant University*, a guide that closely follows state and local requirements outlined in the Disaster Mitigation Act of 2000 (DMA2K).[1] For the 2022 planning process, MSM participated again to verify and update the information applicable to the University to coincide with Frederick County's latest plan update.

MSM participated in the Frederick County Hazard Mitigation Planning Committee (HMPC) and College Planning Teams (CPT) to support the County's plan update and the development of this annex plan. The University participated in CPT meetings with Frederick County and the contracted consultant, Dewberry, to help gather the information needed for the plan update. Table 1.1 lists the members of the MSM CPT, as well as a brief description of their participation.

Table 1.1. MSM CPT Members

Name	Department	Planning Participation

[1] FEMA. 2003. *Building a Disaster-Resistant University*. Retrieved from https://mitigation.eeri.org/files/FMEA443.disaster.resist.univ.pdf

Kevin Fox	Training and Emergency Management Coordinator, Mount Saint Mary's University	• HMPC Member • Contributed to hazards Survey • Participated in County planning meetings and workshops • Contributed to development of mitigation actions • Final Draft Review Workshop
Ronald Hibbard	Director of Public Safety, Mount Saint Mary's University	• HMPC Member • Coordinated with university leadership • Participated in County planning meetings • Contributed to development of mitigation actions • Final Draft Review Workshop

Guided by the County, the MSM CPT participated in the hazard mitigation plan development process by attending meetings, communicating with the contracted consultant via phone and e-mail, and reviewing and commenting on draft documents. Between meetings, MSM participated in informal conversations and communication via telephone and e-mail to ensure constant and consistent communication between stakeholders. The HMPC and MSM CPT met several times throughout the hazard mitigation planning, outlined in Table 1.2.

Table 1.2. Planning Committee Meetings throughout the Frederick County HMCAP Planning Process

Meeting	Date	Purpose	# of Attendees
CPT Kick-Off	June 23, 2021	Coordinate on hazard mitigation planning process	8
Hazard Mitigation Planning Committee Kick-Off	July 13, 2021	Review the hazard mitigation planning process and discuss new hazard issues/mitigation needs	31
Local/College Planning Team Update Workshops	August 25 – September 16, 2021	Collect updates on hazard mitigation needs, completed projects, 2016 strategy progress, capability assessment, etc. since the 2016 plan	1-17 (varied on specific meeting)
Hazard Identification and Risk Assessment (HIRA) Workshop	October 14, 2021	Review findings from the risk assessment and discuss new goals/objectives	31
Public Meeting #1	October 28, 2021	Provide an overview of the hazard mitigation planning process, solicit input through the Story Map and Survey, review high-level findings from the risk assessment	11
Resilience Strategy Coordination Meeting #1	November 9, 2021	Discuss opportunities for information sharing between the hazard mitigation plan update and the upcoming operations resilience plan	10

Meeting	Date	Purpose	# of Attendees
Local/College Planning Team Strategy Workshops	November 30 – December 2, 2021	Provide final feedback on the goals/objectives and make decisions on mitigation and adaptation actions for each town, city, college, university, and county	34 (total)
Community Rating System (CRS) Workshop	December 8, 2021	Complete a CRS toolkit activity and discuss current potential standing and path forward for the county	10
Public Meeting #2	December 9, 2021	Review hazard mitigation planning process until this point, review goals/objectives/actions highlights, review public feedback received, review risk assessment highlights, provide information on the upcoming plan review period	Aired on TV
Resilience Strategy Coordination Meeting #2	December 14, 2021	Discuss feedback on the climate impacts section, HIRA, new goals/objectives, and mitigation and adaptation actions	9
Hazard Mitigation Planning Committee Plan Review Workshop	January 26, 2022	Reviewed the draft plan, discussed major changes, and provided further feedback on final changes	24

The MSM CPT workshop was held on August 26, 2021 to establish a project timeline, identify priorities, establish relationships, and to request assistance with data collection. The strategy workshop was held on December 2, 2021 to determine progress on previous mitigation actions and to identify new strategies to include in the plan annex. The University provided its completed hazard survey and capability assessment in September 2021. In January 2022, the University provided additional information to add further context to the plan.

Using the results of the HIRA to guide their decision-making process, the University developed a list of comprehensive mitigation actions. In the weeks that followed, the MSM CPT prioritized these actions to develop a mitigation strategy that include mitigation action plans. The plans identify, among other elements, the departments responsible for implementation of the actions and potential funding sources. For more information on this process and the full Frederick Mitigation Strategy, please refer to the main Frederick County Hazard Mitigation and Climate Adaptation Plan.

In January 2022, the final draft plan was provided to MSM CPT for a final review. The CPT vetted and confirmed the contents with only minor changes. The draft plan will be posted to the University's website for comment by college stakeholders.

Existing Studies and Plans Reviewed

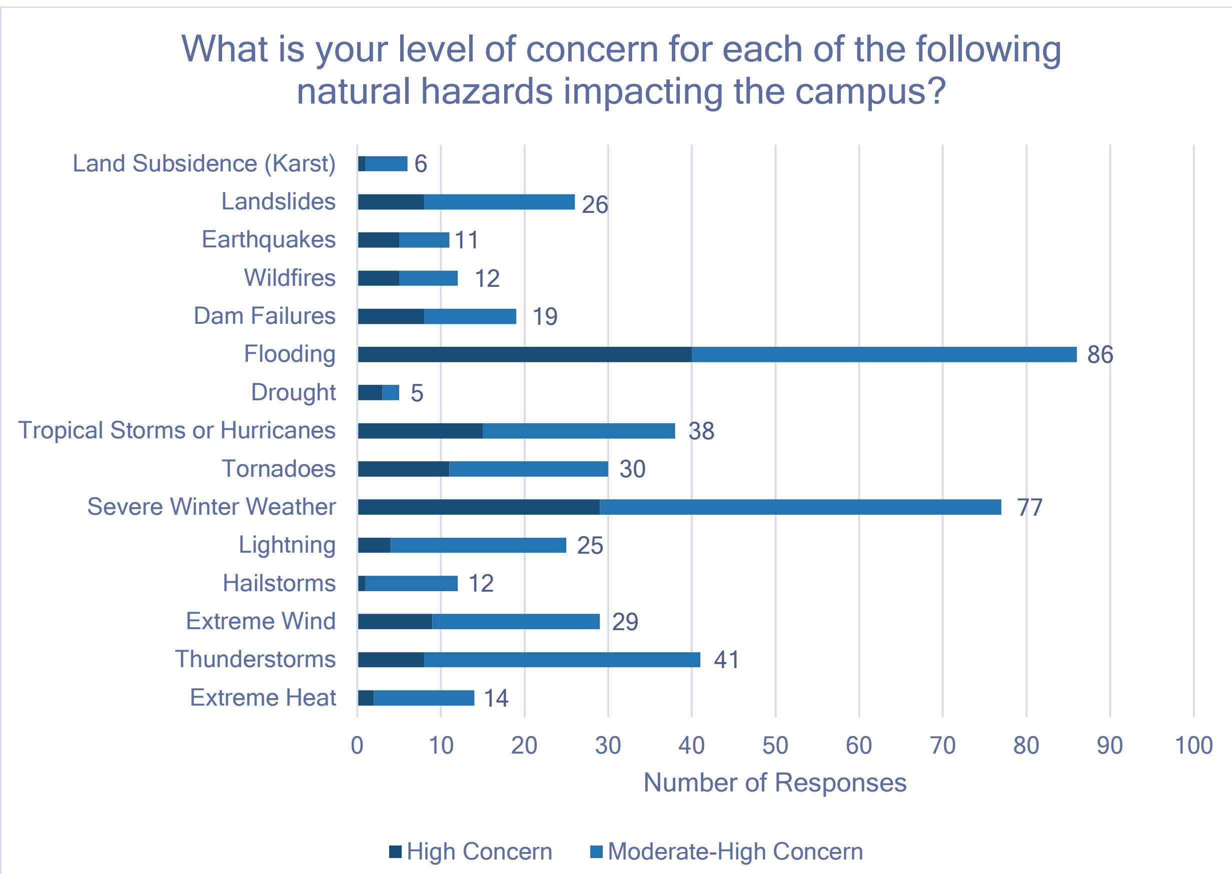
Planning documents, studies, guides, regulations/ordinances and policies were reviewed and incorporated during the initial plan and each following update. These plans included FEMA documents, emergency services documents as well as county and local general plans, community plans, local codes and ordinances, and other similar documents. A full list of reports and plan used as data sources is included in the References section. These included:

- 2018 – 2023 Strategic Plan: Creating Ethical Leaders Who Lead Lives of Significance
- 2015 Mount Saint Mary's University All-Hazards Emergency Plan (Rev. 2017)
- THE NEW PLAN for Mount Saint Mary's University- Summary of 2014 Master Plan
- 2012 - 2027 Facilities Master Plan Summary Document
- FY 2021 Federal Grant Award Worksheet
- Building a Disaster-Resistant University
- FEMA CRS-DMA2K Mitigation Planning Requirements
- 2016 MEMA and FEMA Crosswalk Comments for Frederick County

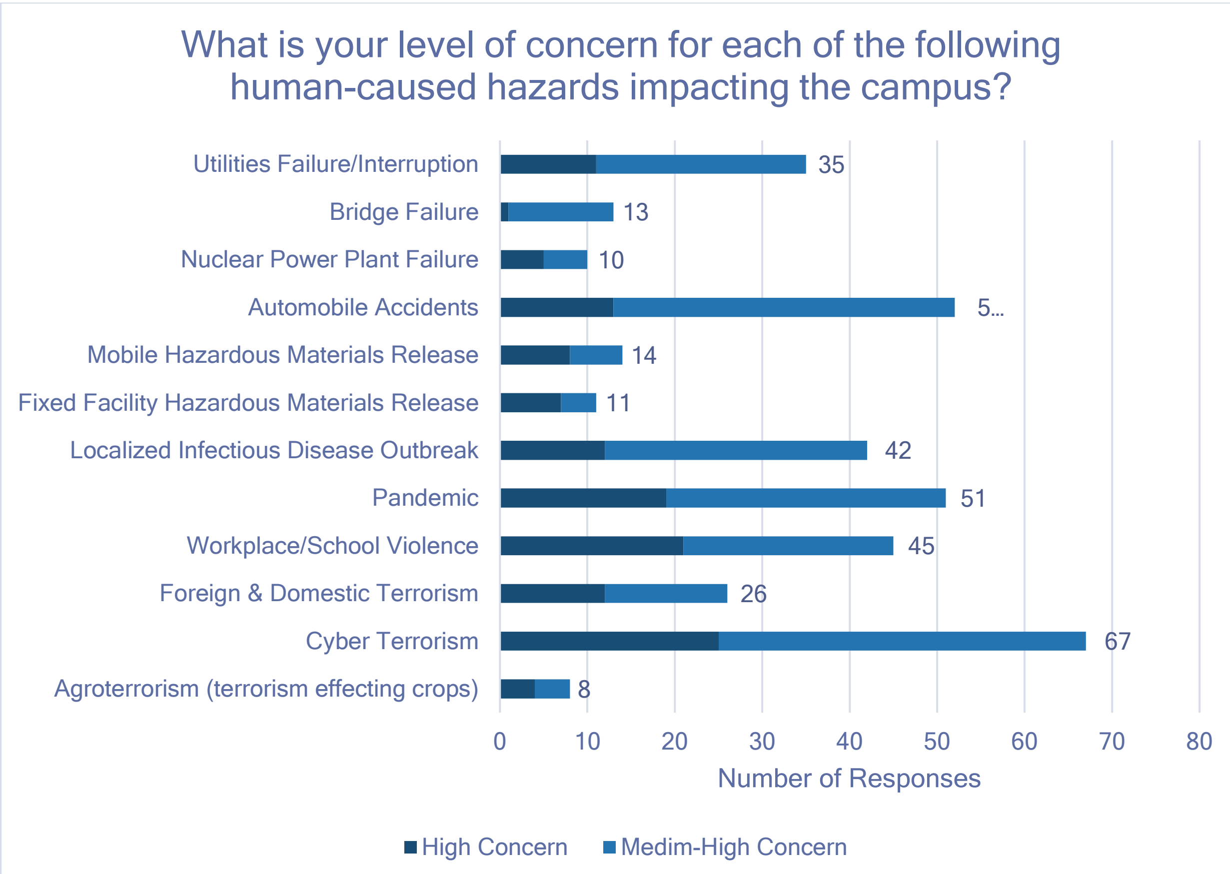
University Survey Results

Of the 684 responses to the Frederick County public survey, 173 participants identified themselves as a student, faculty, or staff member of Mount Saint Mary's University. Majority of respondents (60%) were already aware that the University maintains a hazard mitigation plan.

Respondents most reported moderate-high to high concerns about flooding and severe winter weather affecting Mount Saint Mary's University campus. Few respondents cited significant concerns about land subsidence or drought affecting the campus.



Students, faculty, and staff were also asked to rank their levels of concern for human-caused hazards. Respondents most frequently cited medium-high to high concerns about cyber terrorism, automobile accidents, and pandemics affecting Mount Saint Mary's campus. Few respondents cited agroterrorism or fixed facility hazardous materials releases as medium-high or high concerns.



Majority of respondents (94%) said recent hazard made them more aware of the dangers that hazards pose to their campus. Among specifically cited events and hazards, flooding was the most common, especially related to Hurricane Ida. Students, faculty, and staff were asked to rate on a scale from one to 100 how safe from hazards they feel on campus. On average, respondents rated their feelings of safety a 72 out of 100, but responses ranges from a low of 10 to a high of 100. When asked to identify vulnerable areas on campus, respondents frequently cited areas closest to the mountain, where flood problems are known, as well as Bradley Hall and Pangborn Hall.

Respondents were asked about important actions the University can take to mitigate hazards and become more resilient. Nearly three-fourths identified floodproofing of campus buildings as a key mitigation strategy, the most commonly cited action. Many respondents also identified localized flood risk reduction projects, public education and outreach, and improved cyber security defenses as important mitigation actions. When asked to identify one mitigation action the University could take, many respondents provided open-ended answers related to flood mitigation and control and public education and outreach about hazards for students, faculty, and staff.

Stakeholder Review

The stakeholder review was conducted in January and February of 2022. A copy of the plan and appendices were emailed to select priority stakeholders and also posted online for the public. A survey was used as a feedback collector for half the feedback, and documents containing direct edits and comments in context were utilized by Mount St. Mary's University. In total, 34 sets of comments were received across the main plan and annexes from participating jurisdictions, neighboring counties, dam stakeholders, college/university stakeholders, and the general public. Mount St. Mary's University provided further edits on the MSM Annex during this time but did not receive any other comments from outside sources.

CHAPTER 2. PLANNING CONTEXT

Mount Saint Mary's University

History

Mount Saint Mary's University—also known as "The Mount"— is a private, Catholic liberal arts university located in Emmitsburg, Maryland on 1,400 acres of mountainous and rural land. Mount Saint Mary's is the second oldest Catholic university in the United States after it was founded in 1808 by a priest who was fleeing religious persecution. Over 200 years later, The Mount remains committed to welcoming students of any religious background and now has over 2,000 undergraduate and graduate students and over 100 full-time faculty. The campus also includes the second largest Catholic seminary in the United States with over 150 seminarians from more than 25 dioceses and three religious orders.

Early student life revolved around academics and religious development, with few student organizations. Today, Mount St. Mary's offers more than 70 clubs and honor societies, as well as service-learning portions of the curriculum designed to enable students to give back to their university and community. The university participates in Division I of the NCAA. The Mount participates in 10 varsity men's teams, and 12 varsity women's teams in Division I sports, as well as 23 intramural sports. In the past six years, the university's athletic program has grown from 16 to 24 NCAA Division I team with nearly 600 students participating.

Location

There are 35 buildings on campus as shown in Table 2.1 and Figure 2-1. In addition to the 35 buildings on campus, Mount St. Mary's also maintains one off-site location. The off-site Frederick Campus is the home to graduate and adult undergraduate evening classes as well as the Frederick Conference Center.

Table 2.1. MSM Campus Buildings

Building Name	Functions
Grotto-Maintenance Building	Maintenance
Grotto-Miller Family Visitor Center	Administration
	Gift Shop and Information
Grotto-Sacristy	Chapel
Grotto-St. Mary's Chapel	Chapel
Horning Towers	Residence-Students
Keelty Towers	Residence-Students
Knott Academic Center	Academic
	Administration

Knott Athletic Recreation Center	Athletics
(PNC Sports Complex) Knott ARCC	Recreation
	Administration
Knott Auditorium	Academic
McGowan Center & Patriot Dining Hall	Dining Services
	Administration
	Student Union
Memorial Gym	Athletics
Morton Building Complex- Maintenance Building	Maintenance
Morton Building Complex- Storage Building	Maintenance
National Shrine of Our Lady of Lourdes	Sacred Space
Pangborn Hall	Residence-Students
	Campus Laundry
Pangborn Hall-Mary Queen of Peace Chapel	Chapel
Phillips Library	Library
	Academic
	Administration
Physical Plant - Main Building	Administration
	Maintenance
	Physical Plant Services
Physical Plant-Shop Complex	Boiler Room
	Maintenance
Powell Hall	Residence-Students
Pump House	Utility
Purcell Lounge	Student Activities
Residential Cottages	Residence-Students
Rooney Towers	Residence-Students
Seminary-Gallagher	Residence-Students

Seminary-Keating	Residence-Students
	Academic
	Administration
Seminary-McSweeny	Residence-Students
	Administration
	Chapel
	Academic
Seminary-Mulcahy	Residence-Students
Sheridan Hall	Residence-Students
Solar Field	Solar Energy
Terrace-Brute	Residence-Students
Terrace-DuBois	Residence-Students
	Residence-Professional Staff
	Chapel
Terrace- MacCaffrey	Residence-Students
Walsh Family Team Center (at Waldron Family Stadium)	Athletics
Wastewater Treatment Plant	Utility
Water Storage-Clairvaux Lane	Utility
Water Storage-Service Place	Utility
Water Pumping Station	Utility
House #200	Professional Staff Residence
House #201	Residence-Students
House #203	Residence-Students
House #204-Public Safety	Administration
House #205-9201 Alumni Court	Residence-Students
House #205- 9203 Alumni Court	Residence-Students
House #205-9204 Alumni Court	Residence-Students

House #205-9205 Alumni Court	Residence-Students
House #205-9206 Alumni Court	Residence-Students
House #206	Professional Staff Residence
House #208	Professional Staff Residence
House #209	Professional Staff Residence
House #211	Professional Staff Residence
House #212	Professional Staff Residence
House #213	Residence-Students
House #214	Professional Staff Residence
House #214A	Professional Staff Residence
House #215	Professional Staff Residence
House #216	Professional Staff Residence
House #217	Professional Staff Residence
Outdoor Adventures Challenge Course	Recreation/ Athletics

Figure 2-1. MSM Campus Map

Regional Context

MSM is located in the Town of Emmitsburg in Frederick County. Founded in 1748, Frederick County, Maryland is about an hour northwest of Washington, D.C. and an hour west of Baltimore. Its area encompasses a total of 662.7 square miles[2] and contains approximately 391.7 persons per square mile. Based on the most recent data available from the U.S. Census Bureau, the estimated population in 2019 was 259,547, an 11.2% increase since 2010.[3] Table 2.2 indicates recent and projected change in Frederick County population from 2020 to 2045.

In the County, the City of Frederick is the second largest in Maryland and has a 50-block historic district with many buildings dating back to the 18th and 19th centuries. Frederick has a variety of attractions, including Civil War sites, museums, parks, recreational facilities, wineries, antique shops, restaurants, and entertainment venues.

Table 2.2. Population Projections in Frederick County[4]

Year	Household	Population	Employment
2020	98,400	263,900	117,300
2025	106,300	284,300	123,200
2030	115,400	304,500	128,600
2035	122,400	320,000	135,300
2040	128,100	334,600	141,100
2045	132,100	346,600	145,500

Table 2.3 shows the 2019 U.S. Census population estimates and the 2021 Frederick County Planning estimates for Frederick County municipalities.

Table 2.3. 2019 and 2021 Population Estimates in Frederick County

Municipalities	2019 U.S. Census Population Estimates	2021 Frederick County Population Estimates
Brunswick	6,491	7,826
Burkittsville	165	151
Emmitsburg	3,198	2,866
Frederick City	72,244	72,097

[2] Maryland Department of Commerce. 2021. "Brief Economic Facts: Frederick County, Maryland." Retrieved from https://commerce.maryland.gov/Documents/ResearchDocument/FrederickBef.pdf
[3] U.S. Census Bureau. 2021. "Quickfacts: Frederick County, Maryland Population Estimates." Retrieved from https://www.census.gov/quickfacts/frederickcountymaryland
[4] Frederick County Planning Department, 2021.

Middletown	4,792	4,516
Mount Airy	9,458	3,785*
Myersville	1,838	1,713
New Market	738	1,241
Rosemont	322	296
Thurmont	6,895	6,286
Woodsboro	1,269	1,161
Walkersville	6,415	6,182
Unincorporated County	145,722	86,191
		77,189**
Total	**259,547**	**271,500**

*Portion within Frederick County

** "Other Small Areas"

Land Use and Development Trends

Mount St. Mary's University's main campus is 1,400 tree-lined acres in Emmitsburg, Maryland. No current land use and development plan or policy exist for MSM. The University is in the process of creating a new land use policy.

The 2014 Master Plan summary identifies three guiding principles that frame development. These include:

1. The Mount's Catholic identity and mission must remain evident throughout the campus;
2. The natural environment of the Mount is a vital resource that must be protected, sustained, and improved; and
3. The architectural forms, styles, and materials of the Mount create a cohesive identity for the campus that must be preserved and enhanced in all new development.

Recent changes in development and/or changes to existing land or buildings include the following:

- **Solar Field**. Mount Saint Mary's became the site for Maryland's largest solar power farm in 2012 with the addition of a 100-acre, 16.1-megawatt solar array. The Frederick County Board of Appeals granted a special exception for the $60 million project due to its proposed use within an agricultural zone. Contractors worked with Frederick County to develop a stormwater management concept methodology which allowed the installation of the solar field with minimal grading and impervious footprint. Additionally, civil design contractors mapped the wetlands and forest conservation areas on site in order to facilitate the maximum solar layout area. A 1.6-megawatt portion of the solar plant is used to power the university's Knott Complex and wastewater treatment facility. The larger portion of the facility is used to power Maryland's Department of General Services and the University System of Maryland.[5]

- **Knott Academic Center Expansion.** In June 2021, Mount St. Mary's broke ground on the 12,140 square foot expansion of the Knott Academic Center. The existing building will also be renovated as part of the $7.5 million project. The expansion and renovation is expected to be completed in August 2022.
- **Tennis Courts.** On October 1, 2021, The Mount dedicated newly finished state-of-the-art tennis courts as part of a multi-phase project to promote growth for the Mount's Division I athletic program and student recreation. The former tennis courts are being removed for space to build the new Rooney Athletic Performance Center.
- **Rooney Athletic Performance Center.** In October 2021, Mount St. Mary's broke ground to begin constructing the new Rooney Athletic Performance Center. The multi-phase project is being dedicated to the Rooney family who gifted $6 million to the university's athletic program.
- **Coad Science Building Renovation and Expansion**. As a result of an increased need for additional academic space, and a continued growth in STEM program enrollment, the university will break ground in the summer of 2022 on a $4.1 million, 10,000 square foot expansion to the Coad Science Building. The expansion will include new classrooms, laboratories, offices, and collaborative spaces. The goal to complete the development is fall of 2023. $2 million of the project is being funded by the State of Maryland, the other half will be funded from donations.

Curriculum Overview

Mount St. Mary's Core Curriculum is centered around their Catholic mission and is rooted in the liberal arts. The undergraduate university is divided into four schools—the College of Liberal Arts, the Richard J. Bolte School of Business, the School of Education & Human Services, and the School of Natural Science and Mathematics. The university has over 80 majors, minors, special programs and concentrations. The university also offers more than 70 clubs and honor societies, as well as service-learning portions of the curriculum designed to enable students to give back to their university and community.

Asset Inventory

FEMA guidelines emphasize the use of "best available" data for hazard mitigation plans. The following sections provide information on the data collected and data gaps that currently exist. These gaps may be considered as mitigation actions in future planning cycles.

General Building and Facility Information

The current inventory of buildings on the main campus lists 52 buildings, of which 26 are academic and administrative, and 26 are residential.[6] These buildings total 920,800 gross square feet (GSF), and 588,729 net square feet (NSF). University officials provided an estimated replacement value of the insurable asset inventory, as of November 1, 2021, at $300,000,000.

[5] Constellation Energy: An Exelon Company, Mount St. Mary's Case Study Final: Mount St. Mary's University Graduates to Solar Photovoltaic Power Farm Energy Solution, 2017.
[6] Mount Saint Mary's University. 2013. *2012 – 2027 Facilities Master Plan: Summary Document*. Retrieved from https://www.smcm.edu/facilities/wp-content/uploads/sites/69/2014/09/SMCM2012-2027FacilitiesMasterPlanSummaryDocument20131.pdf

Daily Occupancy/Hours of Use

The University has over 2,000 undergraduate and graduate students. Of these, 68% of undergraduates live on campus, and 60% of all students have cars on campus. The number of visitors on campus varies depending on the date and time but can be as many as 5,000 during athletic events and University or Frederick County high school graduations. Typically, the number of visitors on campus at any one time would be fewer than 100.

The Mount St. Mary's website indicates student to faculty ratio of 12:1, 114 full-time employed faculty, and 52% of the classes offered have fewer than 20 students.

Total Replacement Value

The replacement of the University's physical plant is $414 million. [7]

Critical Facilities and Utilities

Constellation Energy recently leased land on the Mount's East Campus in order to build a 17.4-megawatt solar energy farm. The solar farm is the property of Constellation Energy and is not University-owned. The renewable energy produced by the solar farm will be purchased by the University System of Maryland and Mount St. Mary's University. The State of Maryland will use 16.1 megawatts while the remaining 1.3 megawatts of power will go to the University, primarily the Mount's PNC Sports Complex. This arrangement helps fulfill the University's pledge to the American College & University President's Climate Change Commitment (ACUPCC).

Critical facilities on-site were noted in the MSM 2021 planning survey to include:

- Water, power lines, communication systems
- Leasing property for urgent care center (2022)
- Public safety department in partnership with local fire, EMS, sheriffs

[7] Mount Saint Mary's University. 2013. *2012 – 2027 Facilities Master Plan: Summary Document*. Retrieved from https://www.smcm.edu/facilities/wp-content/uploads/sites/69/2014/09/SMCM2012-2027FacilitiesMasterPlanSummaryDocument20131.pdf

CHAPTER 3. HAZARD IDENTIFICATION AND RISK ASSESSMENT

The purpose of the Hazard Identification and Risk Assessment (HIRA) is to identify the hazards that could affect Mount Saint Mary's University and assess what unique risk the campus may have to those hazards. Hazards were identified as part of the Frederick County Hazard Mitigation and Climate Adaptation Plan Update and were validated and prioritized for the campus by the Mount St. Mary's CPT during the 2022 plan update process.

The following chapter profiles and assesses risk for hazards identified high or medium-high priorities by the MSM CPT. These sections include an abbreviated profile of the hazard that is more fully described in the main Frederick County Hazard Mitigation and Climate Adaptation Plan, with specific focus on the MSM campus and the Town of Emmitsburg, where the main campus is located. The 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan should be referenced for a complete hazard review.

Hazard Identification

MSM CPT members were asked to identify major concerns with respect to the campus and hazards that were likely to impact the College. Frederick County assessed natural hazards for the 2022 plan update and previously, examined human-caused hazards. The County decided not to assess human-caused hazards during this planning process.

In alignment with the County's plan update, the risk assessment is organized by the primary climate interaction each hazard faces. The 2016 Plan was organized by hazard type (i.e., atmospheric, hydrologic, wildfire, geologic), but setting each hazard in the context of climate factors will allow for a better understanding of how risk from each hazard may change in the future. The primary climate interactions included are:

- Changes in precipitation,
- Rising temperatures, and
- Extreme weather.

Earthquake and human-caused hazards are organized under a "non-climate-influenced" hazard category.

The hazards are given priority levels as a part of the hazard profiling process. They are determined based on FCC CPT input as well as the five criteria summarized below to assign a quantitative ranking. Each criterion identifies and categorizes the comparative probability and potential vulnerability for the identified hazards. The framing criteria/questions are shown in the list below and Table 3.1 provides the thresholds for each of the risk levels.

The five main parameters include:

1. **Probability/History**: Has the hazard occurred in the area before, and if so, how often based on the historical record? Weighting Factor: 0.25
2. **Vulnerability**: If the expected event does occur, how many people might be killed, injured, or contaminated, and how much property might be damaged or destroyed (e.g., the percent of people or property vulnerable to the hazard)? Weighting Factor: 0.20

3. **Maximum Threat**: What is the worst-case scenario of the hazard and how bad can it get? What will the loss of life and property damage be if the worst-case scenario occurs (e.g., the percent of the campus impacted by the hazard)? Weighting Factor: 0.10
4. **Warning Time**: How much time is the campus given to prepare for an event? Weighting Factor: 0.10
5. **Ranking in Previous Plan**: The ranking from the 2011 Hazard Mitigation Plan (Significant, Moderate, Limited) was factored in the 2016 ranking. Weighting Factor: 0.35

Table 3.1. Hazard Priority Ranking Criteria

Probability / History	Vulnerability	Maximum Threat (Geographic Area Affected)	Warning Time	2016 Ranking
Weighting Factor: 0.25	*Weighting Factor: 0.20*	*Weighting Factor: 0.10*	*Weighting Factor: 0.10*	*Weighting Factor: 0.35*
Unlikely No documented occurrence with annual probability <0.01	**Negligible** 1 to 10% of people or property	**Isolated** < 5% of community impacted	**Extended** More than 3 days	**Low**
Somewhat Unlikely Infrequent occurrence with at least one documented event and annual probability between 0.5 and 0.01	**Slight** 10% to 20% of people or property	**Minor** 5 to 15% of community impacted	**Slight** 3 days	**Medium-Low**
Somewhat Likely Moderate occurrence with at least two documented events and annual probability between 0.5 and 0.01	**Limited** 20 to 30% of people or property	**Small** 15 to 25% of community impacted	**Limited** 2 days	**Medium**
Likely Frequent occurrence with at least three documented events and annual probability between 1 and 0.5	**Critical** 25 to 50% of people or property	**Medium** 25 to 50% of community impacted	**Minimal** 1 day	**Medium-High**
Highly Likely Common events with annual probability >1	**Catastrophic** > 50% of people or property	**Large** > 50% of community impacted	**No Notice** < 24 hours	**High**

Table 3.2 and Table 3.3 summarize the Frederick County and MSM assigned priority levels. For natural hazards, the MSM CPT identified winter weather, thunderstorms, and flooding as high priorities, and extreme wind as a

medium-high priority. For human-caused hazards, MSM ranked cyber-terrorism, workplace or school violence, pandemics, localized infectious disease outbreaks, mobile hazardous materials release, automobile accidents, and utilities failure as medium-high priorities.

In the 2021 college survey, MSM cited specific major concerns regarding human-caused hazards, including cybersecurity breaches, preparedness and training for violence or assailant attacks, the continued spread of the ongoing COVID-19 pandemic, and utility disruptions. When asked about specific major concerns regarding natural hazards, MSM cited property damage due to flooding and stormwater, as well as lightning.

Table 3.2. Natural Hazard Priority Level Comparison

Natural Hazards Type	2022 Priority Level	
	Frederick County	Mount Saint Mary's University
Primary Climate Interaction: Changes in Precipitation		
Flood	High	High
Dam and Levee Failure	Low	Medium
Karst and Land Subsidence	Medium-High	Medium-Low
Drought	Medium	Medium-Low
Landslide	Medium-Low	Low
Wildfire	Medium	Medium
Primary Climate Interaction: Rising Temperatures		
Extreme Heat	Medium	Medium
Primary Climate Interaction: Extreme Weather		
Winter Storm	High	High
Thunderstorm	Medium-High	High
Tornado	Medium-High	Medium
Tropical Cyclone	Medium	Medium
Non-Climate-Influenced Hazards		
Earthquake	Medium-Low	Low

Table 3.3. Human-Caused Hazard Priority Level Comparison

Human-Caused Hazards Type	Mount Saint Mary's University 2022 Priority Level
Non-Climate-Influenced Hazards	
Agroterrorism	Low
Cyberterrorism	Medium-High
Foreign and Domestic Terrorism	Medium
Civil Disobedience	Medium
Workplace or School Violence	Medium-High
Pandemic	Medium-High
Localized Infectious Disease Outbreak	Medium-High
Fixed Facility Hazardous Materials Release	Medium-Low
Mobile Hazardous Materials Release	Medium-High
Automobile Accidents	Medium-High
Rail Accidents	Low
Air Accidents	Low
Nuclear Power Plant Failure	Low
Bridge Failure	Low
Utilities Failure or Interruption	Medium-High

Areas of Concern

As part of the campus survey, Mount St. Mary's CPT provided additional areas of impact and vulnerability. Vulnerable areas and reoccurring problems were taken into consideration during the analysis phase. Questions posed to committee members included the following:

- What are your major concerns with respect to the campus and the hazards identified?
- Have there been noteworthy events in the past? Were there major consequences?
- What events do you think are likely to occur?
- What specific vulnerabilities exist on the campus?

Problem spots fell into three main areas (1) entrances and evacuation, (2) cyber hacks, and (3) drainage and frozen parking lots.

The problem spots are described in Table 3.4. These areas should be considered as potential mitigation actions to reduce future risk and injury. It should be noted that this list only indicates concerns held by members of the Mount St. Mary's CPT; it is not comprehensive, nor does it completely describe the vulnerabilities of the University.

Table 3.4. Institutional Knowledge of Building Vulnerabilities and Areas of Concern

Areas of Concern	Summary of Vulnerability
2016 Plan Update	
Coad Science Building	Storage location for various chemicals (liquid and gases).
Athletic Recreation Convocation Complex (ARCC)	Storage location for various chemicals (liquid and gases).
PNC Sports Complex/ARCC	Air pressurized; roof vulnerable to high winds and winter storm.
US Route 15	Divides the campus and the risk of hazardous spills is a possibility.
Wooded Mountain Side	Potential for wildfire from 500+ acres of wooded mountain on the west end of campus.
Solar Farm	Possible target for vandalism which may impact energy capabilities on East campus.
Man-Made Violence	Is a concern on campus. The possibility is low but, the impact could be enormous.
Population Density	Increase risk of infectious disease outbreak.
2022 Plan Update	
Purcell Hall	Susceptible to stormwater flooding; improvements made in 2018.
Bradley Hall	Susceptible to stormwater flooding; improvements made in 2018.
IC Chapel	Susceptible to stormwater flooding.
Delaplaine Fine Arts Center	Susceptible to stormwater flooding.
Terrace Residence Hall	Susceptible to stormwater flooding.
Pangborn Residence Hall	Susceptible to stormwater flooding. No fire sprinkler systems; susceptible to fire damage.
Sheridan Residence Hall	No fire sprinkler systems; susceptible to fire damage.
Powell Hall & Cottages	No generator backup; risk for power outages.

Bradley and Pangborn Parking Lots & University Way	Susceptible to stormwater flooding.
US Route 15	Primary access to the campus located at an at-grade intersection on major highway; vulnerable to automobile hazards. Risk of evacuation in the event of a significant transportation incident on Route 15.

Damage History

The data collection effort utilized meetings with Mount St. Mary's officials, steering committee members, existing reports and studies, state and national data sets and other sources such as newspaper archives. Hazard data collected at the state or national level, such as the National Center for Environmental Information (NCEI) Storm Event Database, is aggregated at a county level and does not provide site-specific information. To the greatest extent possible, information specific to the Institute was included.

Historical hazard data was used to estimate future hazard probability for the events that are among the highest concern for the university. Hazard records were also used to quantify the impacts of each event on the University within the historical record period. In each hazard profile, when applicable, damage history claims by hazard type have been summarized in a table. Information regarding insurance claims was received from MSM Department of Accounting and Financial Affairs and provided by the Director of Public Safety

National Centers for Environmental Information (NCEI) Storm Events

NCEI storm events data is published by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The storm events database contains information on storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce from 1950 to March 2021. Records for the majority of weather events were reported starting in 1996, with the exception of tornado, thunderstorm, and hail.

Table 3.5 summarizes the natural hazards profiled for the Frederick County 2022 plan update. Because this data is provided at a county-level, these events occurred throughout the County, and not all may have affected the University. The information summarized in Table 3.5 supports the hazard identification completed by the MSM CPT. Detailed hazard event information is presented in the Frederick County 2022 Hazard Mitigation and Climate Adaptation Plan and the hazard-specific sections in this annex.

There has been a total of 1,248 events for the hazards profiled in this report. Total property damages from these events exceed $96 million (adjusted for inflation). These estimates may underrepresent the actual losses experienced due to both hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCEI database; this is especially true with crop damages.

As shown in the Table 3.5 several of the hazards are not collected in the NCEI storm events database. Each of the individual hazard sections use the best available national and local data. In most cases, Frederick County departments have provided supplemental data for past events and damages.

Table 3.5. NCEI Storm Events for Frederick County, MD

Hazard Type	Period of Record	Total Events	Property Damage (2021$)	Crop Damage (2021$)	Injuries	Deaths
Primary Climate Interaction: Changes in Precipitation						
Flood	1996 - 2021	237	$83,237,213	$67,228	1	6
Dam and Levee Failure	*Data not collected by NCEI. Analysis source to be used: USACE National Inventory of Dams and Levees.*					
Karst and Land Subsidence	*Data not collected by NCEI. Analysis source to be used: USGS Engineering Aspects of Karst data and County historical data.*					
Drought	1996 - 2021	12	$0	$40,277,677**	0	0
Landslide	*Data not collected by NCEI. Analysis source to be used: USGS Landslide susceptibility data.*					
Wildfire	*Data not collected by NCEI. Analysis source to be used: AMS fire database.*					
Primary Climate Interaction: Rising Temperatures						
Extreme Heat	1996 - 2021	44	$0	$0	6	2
Primary Climate Interaction: Extreme Weather						
Winter Storm	1996 - 2021	265	$406,988	$208,282	0	1
Thunderstorm* **	1955 - 2021	496	$2,578,924	$115,983	7	2
Extreme Wind* **	1996 - 2021	57	$2,174,353	$145,543	2	1
Hailstorms* **	1955 - 2021	79	$6,124	$21,438	0	0
Lightning* **	1996 - 2021	22	$1,788,766	$0	5	1
Tornado	1950 - 2021	36	$6,067,480	$84,034	1	0
Tropical Cyclone	1996 - 2021	2*	$5,863	$0	0	0
Non-Climate-Influenced Hazards						
Earthquake	*Data not collected by NCEI. Analysis source to be used: USGS Earthquake Hazards Program data.*					
Total		**1,248**	**$96,265,711**	**$40,920,185**	**22**	**12**

***There are tropical storm/hurricane events were categorized as floods or not recorded in the NCEI database, due to the kind of damage and if damages were recorded.**

**** Zonal damages for three regional droughts spanning 1997 – 1999.**

*****Thunderstorms, extreme wind, hailstorms, and lightning are presented collectively under the Thunderstorm hazard profile. Previous plans, including the 2016 plan update, presented these hazards separately.**

Federal Declared Disasters

Presidential disaster declarations are issued for counties, independent cities, and towns when an event has been determined to be beyond the capabilities of state and local governments to respond. An emergency declaration is more limited in scope and does not provide the same long-term federal recovery programs as a presidential disaster declaration.

Two important sources for identifying hazards that can affect a locality are the record of federal disaster declarations and historic storm data. According to FEMA, since 1962, there have been 25 major disaster declarations for Maryland, of which 13 have been declared for Frederick County. Nine of the declarations were for flooding/severe storm and four were for winter weather. In addition, there have been five emergency declarations in Maryland; Frederick County was included in all five declarations. Table 3.6 presents the declared disasters in Frederick County and available FEMA recovery programs since 1962. While these events affected Frederick County, not all may have affected MSM's campus and facilities.

Table 3.6. Presidential Declared Disaster for Frederick County, MD

Disaster Number	Incident Type	Incident Date	Programs Declared			
			IH	IA	PA	HM
DR-309	Flooding, Severe Storm	8/17/1971		✓	✓	✓
DR-341	Flooding, Heavy Rains (Tropical Storm Agnes)	6/23/1972		✓	✓	✓
DR-489	Flooding, Heavy Rains	10/4/1975		✓	✓	✓
DR-522	Severe Storms, Flooding	10/14/1976		✓	✓	✓
DR-601	Severe Storms, Tornadoes & Flooding	9/14/1979		✓	✓	✓
EM-3100	Severe Snowfall & Winter Storm	3/13/1993			✓	✓
DR-1016	Severe Winter Weather & Ice Storm	2/8/1994			✓	✓
DR-1081	Severe Snow Storm (Blizzard of '96)	1/6/1996			✓	✓
DR-1094	Severe Storms, Flooding	1/19/1996		✓	✓	✓
DR-1139	Severe Storms, Flooding (Tropical Storm Fran)	9/6/1996		✓		✓
DR-1324	Severe Winter Storm	1/25/2000			✓	✓

Disaster Number	Incident Type	Incident Date	Programs Declared			
			IH	IA	PA	HM
EM-3179	Severe Snow Storm	2/14/2003			✓	✓
DR-1492	Flooding, Severe Storms, Wind (Hurricane Isabel)	9/18/2003	✓	✓	✓	✓
EM-3251	Sheltering, Evacuation (Hurricane Katrina)	8/29/2005			✓	
DR-1910	Severe winter storms and snowstorms	2/5/2010			✓	✓
EM-3335	Hurricane (Irene)	8/26/2011			✓	
EM-3349	Hurricane (Sandy)	10/26/2012			✓	
DR-4091	Hurricane (Sandy)	10/26/2012	✓		✓	✓
DR-4261	Severe winter storms and snowstorms	1/22/2016			✓	✓
DR-4374	Severe Storms, Flooding	5/15/2018			✓	
EM-3430	COVID-19	1/20/2020			✓	
DR-4491	COVID-19 Pandemic	1/20/2020		✓		

IH = Individual Housing PA = Public Assistance

IA = Individual Assistance HM = Hazard Mitigation

Source: FEMA Declared Disasters (as of August 2021).

Insurance Claims and Institutional Knowledge

Insurance claims were provided by the university Director of Public Safety. Information includes when the loss or event occurred, type of hazard event, and the claims for the specific event. Table 3.7 summarizes the number and amount of damages estimated as the result of various types of hazards, based on insurance claims and institutional knowledge provided by the Mount St. Mary's CPT for events impacting campus. Events with losses totaling less than $50,000 did not reach the insurance deductible; therefore, repairs were made by non-budgeted MSM funds.

Table 3.7. Historical Events Impacting Mount St. Mary's University

Date	Event	Buildings Impacted	Insurance Claims	Loss
12/13/2009	Major Winter Storm	No loss information available.	No loss information available.	No loss information available.
2/6/2009	Bullet struck Residence Hall Window	Residence Hall	No loss information available.	No loss information available.

2/10/2010	Severe Snowstorm	No loss information available.	No loss information available.	No loss information available.
8/23/2011	Earthquake	No loss information available.	No loss information available.	No loss information available.
8/28/2011	Hurricane Irene	No loss information available.	No loss information available.	No loss information available.
10/29/2012	Hurricane Sandy	No loss information available.	Claim # CA10967485	$402,633.98
7/19/2013	Lightning Fire	IC Chapel	Claim # E2975675	$561,788.21
12/8/2013	Major Winter Storm	No loss information available.	No loss information available.	No loss information available.
2/19/2015	Waterline Break	Coad Science Building	Claim # 2R820099	$277,529.00
6/25/2015	Waterline Break	No loss information available.	Claim # E2C22837	$23,515.52
1/25/2016	Major Winter Storm	Dillion Field House - roof collapse	Claim #5115707968US	$1,115,665.00
August 2016	Lightning Strike	Terrace	N/A	<$50,000
1/24/2018	Pipes Burst - Flooding in January 2018	Keating, Keelty Towers, Terrace, Memorial Gym, Auditorium	Claim #5115707968US	<$50,000
7/22/2018	Rainstorm - Flooding	Terrace	Claim #1833937371US	$347,646
6/26/2019	Pipe Burst - Flooding	Bradley	Claim #ABK4039001H	$81,864
2/16/2020	Pipe Burst - Flooding	Powell	N/A	<$50,000
9/1/2021	Rainstorm - Flooding	Terrace	N/A	<$50,000

Mount St. Mary's committee members for the **2015 plan update** indicated the following vulnerabilities that exist on campus:

- Open campus presents threats from non-campus members to do violence;
- Wooded mountain side (500+ acres of wooded mountain on the west end of campus) presents forest fire risk;
- Dense population presents risk of infectious disease outbreak.

Mount St. Mary's committee members for the **2021 plan update** indicated the following vulnerabilities that exist on campus:

- Weather events such as flooding, and lightning are a primary concern as water runoff from nearby mountain continues to plague the university. Significant rainfall events often result in water accessing lower levels of facilities in close contact with the mountain.
- Weather monitoring and notification systems exist on main campus but not the East campus where most outdoor activity is held. Freshman also park on the East campus and walk sometimes significant distances which can make them vulnerable to severe weather events. Weather monitoring improvements needed, such as adding a weather station on campus.
- Pangborn and Sheridan Halls lack fire sprinkler systems which makes them susceptible to fire damage. This was noted as an ongoing vulnerability that remains funding dependent.
- Several housing units, Powell Hall and cottages, do not have generator backup. This ongoing issue remains with no update since the 2015 plan update.
- Increased cyberterrorism risks with dependence on technology systems could directly impact the university's education mission if compromised in a cybersecurity breach.
- The Department of Public Safety often called upon to provide students, faculty and staff to provide training and education on best practices for active assailant events. Requires significant staff hours for training and first aid equipment.
- Utilities can be disrupted through intentional or unintentional acts causing an interruption of power, water and sewer, fuel shortages, and disruption of natural gas service which could impact the university's ability to house and educate students.
- A major highway dividing the campus increases likelihood of large transportation accidents that may include hazardous materials release. Vulnerable to evacuation which could disrupt- the East and main campus.
- Vulnerability to automobile/transportation accidents as primary access to campus is at an at-grade intersection on a major North/South highway (Route 15).
- The COVID-19 pandemic is presenting daily challenges for students, faculty and staff due to adversely being affected by loss in revenue due to cancelled events and decreased participation in activities.
- COVID vaccination rate in the Emmitsburg region is low in comparison to other areas of Frederick County which could pose a risk to students visiting off-campus locations.[8]

Natural Hazards

Primary Climate Interaction: Changes in Precipitation

The frequency, severity, and magnitude of floods are affected by the amount of precipitation received in a region. As precipitation patterns change, so too does Frederick County's vulnerability to certain hazards. By the end of this century, Frederick County is projected to receive more than 46 inches of precipitation every year, an increase of roughly 16% compared to historical averages.[9] The region is also expected to experience more frequent and intense severe rainfall events. Given these projections, Frederick County's vulnerability to the following hazard may intensify in the coming decades.

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[8] https://frederickcountymd.gov/8094/COVID-19-in-Frederick-County

[9] NOAA. National Weather Service: Climate Prediction Center. 2021. Retrieved from https://www.cpc.ncep.noaa.gov/

Flood

Hazard Identification

Hazard Description

Flooding is the most frequent and costly natural hazard in the United States. A majority of presidential disaster declarations result from weather events where flooding was a major component. Flooding, as defined by the National Flood Insurance Program for insurance purposes, is "a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from: overflow of inland or tidal waters, unusual and rapid accumulation or runoff of surface waters from any source, or a mudflow."

A flood occurs when an area that is normally dry becomes inundated with water. Flooding can occur at any time of the year, with peak volume in the late winter and early spring. Snowmelt and ice jam breakaway contribute to winter flooding, while seasonal rain patterns contribute to spring flooding. Torrential rains from hurricanes and tropical systems are more likely in late summer. Development of flood-prone areas tends to increase the frequency and degree of flooding.

According to FEMA, there are several different types of inland flooding:

- **Riverine Flooding**: Also known as overbank flooding, it occurs when channels receive more rain or snowmelt from their watershed than normal, or the channel becomes blocked by an ice jam or debris. Excess water spills out of the channel and into the channel's floodplain area.
- **Flash Flooding**: A rapid rise of water along a water channel or low-lying urban area, usually a result of an unusually large amount of rain and/or high velocity of water flow (particularly in hilly areas) within a very short period of time. Flash floods can occur with limited warning.
- **Shallow Flooding**: Occurs in flat areas where a lack of a water channel results in water being unable to drain away easily. The three types of shallow flooding include:
  - **Sheet Flow**: Water spreads over a large area at uniform depth.
  - **Ponding**: Runoff collects in depressions with no drainage ability.
  - **Urban Flooding**: Occurs when man-made drainage systems are overloaded by a larger. amount of water than the system was designed to accommodate.

Frederick County largely suffers from riverine and flash flooding. Flash flooding (stormwater or pluvial flooding) as the name suggests, occurs suddenly after an intense but brief downpour, generally less than 6 hours. They move fast and terminate quickly. Although the duration of these events is usually brief, the damages can be quite severe. Flash floods also result as a secondary effect from other types of disasters, including dam breaks and denuded ground from large wildfires. Wildfires remove vegetative cover and alter soil characteristics, increasing the quantity and velocity of storm water runoff, and dam breaks release large quantities of water into receiving drainage ways in a very short timeframe. Flash floods can also deposit large quantities of sediments on floodplains and can be destructive of vegetation cover not adapted to frequent flood conditions. For more details on pluvial flood hazards, refer to Appendix A of the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Riverine (or fluvial) flooding occurs when a channel, such as a stream or river, receives more water than it can hold, and the excess water overflows the channel banks, flooding the surrounding area. Heavy rain and large amounts of snow melt can cause riverine flooding. Riverine flooding is a longer-term event than flash flooding, maybe lasting days or weeks. Riverine floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies use historical records to determine the probability of occurrence for different extents of flooding. The probability of occurrence is expressed as the percentage chance that a flood of a specific extent will occur in any given year.

On the other hand, flash floods are more difficult to predict accurately and happen whenever there are heavy storms. For more details on flood hazards, refer to the flood section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Location

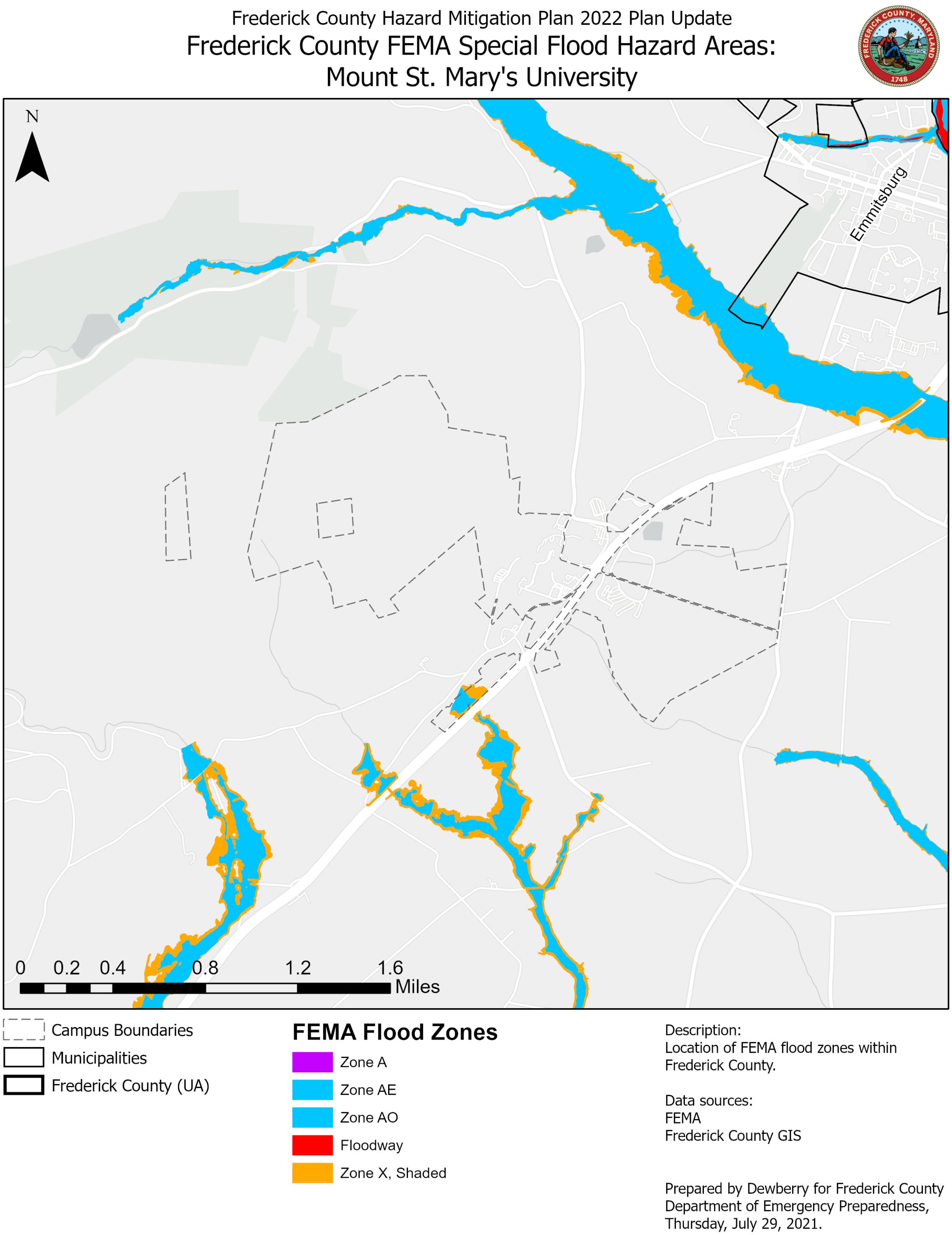
According to FEMA, most municipalities in the United States have at least one clearly recognizable area at risk of flooding around a river, stream, or large body of water. In support of the National Flood Insurance Program (NFIP), FEMA identifies and maps areas of flood risk (floodplains). The floods are often described in terms of annual percentage chance of occurrence. Floodplains have been delineated by FEMA to reflect the 1% and 0.2% annual flood events previously known as 100-year and 500-year floods, respectively. The area that has a 1% -annual-chance to flood each year is delineated as a Special Flood Hazard Area (SFHA) for the purposes of the NFIP. This flood is often referred to as the "base flood" or "100-year flood." The 0.2%-annual-chance floodplain indicates areas of moderate flood hazard.

SFHAs in the county are delineated on a Flood Insurance Rate Map (FIRM) produced as part of a Flood Insurance Study (FIS). Major watercourses in Frederick County typically have SFHAs mapped as Zone AE while smaller tributary streams are mapped as Zone A. Other small streams have shading as Zone X, and other classifications are also possible. Table 3.8. Description of FEMA Flood Zones presents the various flood hazard zones (including coastal zones which will be discussed in the subsequent section) mapped on FIRM panels in Frederick County.

Table 3.8. Description of FEMA Flood Zones

Zone	Description
A	An area with a 1% chance of flooding in any given year for which no base flood elevations (BFEs) have been determined.
AE	An area with a 1% chance of flooding in any given year for which base flood elevations have been determined. This area may include a mapped floodway.
AO	An area with a 1% chance of flooding in any given year where average depths of flooding are between one and three feet.
X (Shaded)	An area with a 0.2% chance of flooding in any given year for which no base flood elevations have been determined.
X (Unshaded)	An area that is determined to be outside of the 1% and 0.2%-annual-chance floodplains.

Figure 3-1. FEMA Flood Zones near Mount St. Mary's University Campus



Extent

A number of factors contribute to the extent of a flood and the relative vulnerabilities of certain areas in the floodplain. Development, or the presence of people and property in the hazardous areas, is a critical factor in determining vulnerability to flooding. Additional factors that contribute to flood extent and vulnerability include:

- **Flood depth**: The greater the depth of flooding, the higher the potential for significant damages.
- **Flood duration**: The longer duration of time that floodwaters are in contact with building components, such as structural members, interior finishes, and mechanical equipment, the greater the potential for damage. Floodwaters may linger because of the low relief of the area, but the degree varies.
- **Velocity**: Flowing water exerts force on the structural members of a building, increasing the likelihood of significant damage. A one-foot depth of water, flowing at a velocity of five feet per second or greater, can knock an adult over and cause significant scour around structures and roadways.
- **Elevation**: The lowest possible point where floodwaters may enter a structure is the most significant factor contributing to its vulnerability to damage due to flooding. Data on the specific elevations of structures in Frederick County has not been compiled for use in this analysis.
- **Construction type**: Certain types of construction are more resistant to the effects of floodwaters than others. Masonry buildings, constructed of brick or concrete blocks, are typically the most resistant to flood damages simply because masonry materials can be in contact with limited depths of water without sustaining significant damage. Wood frame structures are more susceptible to flood damage because the construction materials used are easily damaged when inundated with water. The type of construction throughout Frederick County varies.

The strength or magnitude of a flood hazard is dependent on the factors above. For example, during a riverine flood, water slowly climbs over the edges of a stream or riverbed and spreads to the surrounding area. Observing the slow rise of water along with an area-wide flood warning usually gives adequate time to evacuate; however, because the rainfall associated with flash flooding is so intense and fast moving, it is not as easy to predict when a flash flood will occur. Specific extent of flash flooding is difficult to determine in advance because local terrain, soil conditions, and construction play a role in how much stormwater can percolate into the soil, be accommodated by waterways, or cause flash flooding.

Previous Occurrences

According to the NCEI, 21 flood events were reported in the Town of Emmitsburg, where the University is located, from 1996 to March 2021. Of these, 54 events were classified as flash floods. None of these events reported property or crop damage, as shown in Table 3.9.

However, the University experienced significant stormwater flooding in 2018 that caused damages not captured in NCEI. The flood event occurred on July 22, 2018 as a result of stormwater runoff from the nearby Catoctin Mountains. The University experienced a total loss of $347,646. Officials performed analyses to determine the source of flooding and made several improvements to mitigate stormwater runoff from the mountain. Improvements included the purchase of freestanding temporary flood barriers, installation of jersey barriers, rebuilding of the stormwater management pond above Purcell Hall, and the stream to a large drainage cattle grate behind Bradley Hall. Improvements were also made to frequently flooded buildings such as the Terrace residence halls and the Seminary.

For a record of events for all jurisdictions, refer to the flood section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Table 3.9. NCEI Record of Frederick County Flooding Events for Town of Emmitsburg

Jurisdiction	Events	Property Damage (2021$)	Crop Damage (2021$)	Total Damage (2021$)
Town of Emmitsburg	21	$0	$0	$0
Frederick County (Total)	230	$36,819,292	$67,228	$36,886,520

Probability and Severity of Future Occurrences

Mount Saint Mary's contains small portions of the 1%-annual-chance and the 0.2%-annual-chance flood zones. This area does not contain any building footprints. The University has a low chance of experiencing damage from riverine flooding. However, recent severe flood events which took place at MSM in 2018 and 2021 (detailed in Hazard History section above) have since heightened concerns of future flooding, specifically pluvial or stormwater flooding, on the campus.

According to university officials, if stormwater management improvements had not been made following the costly flooding event in 2018, the university would have experienced significant damage on September 1, 2021 as remnants of Tropical Depression Ida brought substantial rainfall through the area. MSM officials noted that the "2018 systems worked well" to mitigate potential flood damage due to Ida, however, the stormwater management pond became overwhelmed as "sheets of water" rushed down Mary's Mountain towards the northwest side of the campus breaching the temporary jersey barricades. Most of the flooding occurred in parking lots of Bradley and Pangborn buildings, and University Way. Minor flooding also occurred in the basement/ mechanical room of IC Chapel, and the first floor of Delaplaine Fine Arts Center. Water was released behind Terrace Hall and the Seminary to help alleviate accumulation of water which rapidly disappeared as rainfall subsided. Officials noted that MSM staff were able to clear clogged drains and shore up flood barriers following the flash flood event. University officials have confirmed they are committed to minimizing future flood damage by reviewing these flood events to determine if modifications should be made to the stormwater management system built in 2018.

There is always a risk for flash floods, poor drainage and low-lying floods, along with other riverine and stream flooding. While climate factors are expected to impact precipitation patterns, the probability of future floods can be discussed in relation to the benchmark flood, or the "1%-annual-chance" flood.

In addition to this statistical probability, there is also an increased chance of flooding in communities that are not maintaining natural floodplains and infrastructure. Urban flooding can often be minimized or avoided with consistent drainage system maintenance. In addition, by working to maintain clean floodways, natural floodplains will be allowed to flood normally, minimizing adjacent property damage. Table 3.10. shows the flood probability for the region.

Table 3.10. Flood Probabilities for the Region

Recurrence interval (years)	Probability of occurrence in any given year	Chance of occurrence in any given year
500	1 in 500	0.2%

Recurrence interval (years)	Probability of occurrence in any given year	Chance of occurrence in any given year
100	1 in 100	1%
50	1 in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%

It is important to note that although a recurrence interval is given for a storm of a certain magnitude, that does not mean this size storm only occurs once in a certain number of years. For example, a 1%-annual-chance flood, or 100-year flood, has a 1% chance of occurring each year. There is always a chance that a storm of the same magnitude can occur in the same year.

Based on NCEI data, the Town of Emmitsburg, which encompasses MSM, experienced 21 flood events that recorded $0 in damages within a 25-year period between 1996 and 2021. Based on these occurrences, MSM can expect to witness less than one flood event and no property and crop damages in any given year. However, given the University's recent experiences, this data does not capture the full extent of flood events and damages that MSM has experienced.

Jurisdiction	Events	Annualized Events	Total Damages (2021$)	Annualized Damages (2021$)
Town of Emmitsburg	21	0.84	$0	$0
Frederick County (Total)	**230**	**9.2**	**$36,886,520**	**$1,475,461**

National Flood Insurance Program (NFIP)

The National Flood Insurance Program (NFIP) is a federal program that enables property owners in participating communities to purchase insurance for flood losses. Floodplain management begins at the community level with operation of a community program of corrective and preventative measures for reducing flood damage. For a community to participate in the NFIP they must adopt FEMA's flood risk maps and the Flood Insurance Study as well as floodplain management regulations that reduce future flood damages. For more information on the NFIP, refer to the flood section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Table 3.12 summarizes community participation in the NFIP for the Town of Emmitsburg, which encompasses MSM. The current effective maps for MSM are from September 2007, with preliminary products issued 2020. As of August 2021, there were seven flood insurance policies in effect throughout the Town, with total annual premiums of $4,434 covering more than $1.5 million in property. The loss statistics from FEMA's Community Information System (CIS) database for the Town of Emmitsburg indicate that there have been 13 flood insurance claims processed by the NFIP since 1978. These statistics are summarized in Table 3.12.

Table 3.11. Community Participation in the National Flood Program (as of August 2021)

Community Name	Initial FHBM Identified	Initial FIRM Identified	Current Effective Map Date	Date of NFIP Entry
Town of Emmitsburg	03/29/74	09/17/80	09/19/07	09/17/80

Table 3.12. Flood Insurance Policy Statistics and Claims (as of August 2021)

Community Name	No. of Policies	Total Premium	Total Coverage	Total Claims since 1978	Total Payments
Town of Emmitsburg	7	$4,343	$1,560,200	13	$40,951

Flood insurance is available to anyone in Frederick County, including structures outside of the mapped SFHA, provided they are located in an NFIP-participating community. In some cases, therefore, the number of policies includes policies for structures that are outside the mapped SFHA. As MSM is located within a participating community and therefore can acquire flood insurance, MSM does possess a flood insurance policy.

Impact Summary

Primary Impacts

Flood damage to property and populations can be devastating, both emotionally and financially. Flood damage to employment centers, like institutions of higher education, could result in loss of income, wages, and tax revenues. Buildings are susceptible to damage and sometimes collapse as a result of a severe flood. Floodwaters can also block roadways and evacuation routes, as well as damage vehicles, if drainage in parking lots or along roadways is insufficient.

Secondary Impacts

Flooding can disrupt utilities and result in the accumulation of debris and garbage. Gas and electrical services may be interrupted, either because the lines got damaged by the floodwaters itself or suspended items like rocks or trees.

Vulnerability Assessment

Structures in the affected areas are more likely to experience the greatest effects of flooding. Flooding directly affects MSM's ability to function by damaging facilities and blocking roadways, preventing people from traveling to or from the campus. MSM facilities that are flooded may sustain damage to the structure and its contents that disrupt research or related activities, risking loss of existing or future grant funding.

Primary Climate Interaction: Extreme Weather

The frequency, severity, and magnitude of the hazards in the following section – winter storms and thunderstorms – are all affected by climate factors. In Frederick County, average air temperatures and annual precipitation amounts are both projected to rise in the coming decades. As temperatures rise, certain atmospheric conditions that are ideal for extreme weather events to form may become more frequent, while others, like winter storms, may become rarer.

Winter Storm

Hazard Identification

Hazard Description

Winter storms can vary in size and strength and include heavy snowstorms, blizzards, freezing rain, sleet, ice storms, and blowing and drifting snow conditions. Extremely cold temperatures accompanied by strong winds can result in wind chills that cause bodily injury, such as frostbite and death. A variety of weather phenomena and conditions can occur during winter storms. For clarification, the following are National Weather Service-approved descriptions of winter storm elements:

- **Heavy snowfall** - the accumulation of six or more inches of snow in a 12-hour period or eight or more inches in a 24-hour period.
- **Blizzard** - the occurrence of sustained windspeeds over 35 mph accompanied by heavy snowfall or large amounts of blowing or drifting snow for more than three hours.
- **Freezing drizzle/freezing rain** - precipitation that falls as liquid, but freezes on contact with roads, trees, power lines and other surface structures that are below 32 degrees F, forming a dangerous glaze of ice.
- **Ice storm** - a type of winter storm characterized by freezing rain which results in a dangerous coating of ice on trees, power lines, and road surfaces.
- **Sleet** - solid grains or pellets of ice formed by the freezing of raindrops or the refreezing of largely melted snowflakes. Sleet does not cling to surfaces.
- **Wind chill** – a calculated temperature index that describes the combined effect of wind and low air temperatures on exposed skin.

For more details on this hazard, refer to the winter storm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Location

Winter weather affects the entirety of Frederick County, including MSM campus. While the probability of a winter storm occurring is roughly the same in all parts of the region, the risk of damage will vary depending on the density of infrastructure and development. There is a high probability for traffic accidents and traffic jams during heavy snow and light icing events. Roads may become impassable, inhibiting the ability of emergency equipment to reach trouble spots and the accessibility of medical and shelter facilities.

Extent

The severity of a winter storm is often relative to the conditions that the area of focus is accustomed to. There are some standardized tools that can be used to provide estimates on expected storm impacts, such as the National Weather Service's Winter Storm Severity Index (WSSI). This index is outlined in the winter storm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Previous Occurrences

There have been seven federal disaster declarations since 1993 related to severe snowfall and winter storms in Frederick County (Table 3.14). There was a total of 265 winter related events in Frederick County between 1996 and 2021 Table 3.13. According to the NCEI, there were 65 major winter storms, 1 major blizzard, 7 heavy snow events, and 7 ice storms. The remaining 184 events were classified as general winter weather events. These events have resulted in $406,988 of property damages and $208,282 in crop damages. For more details on these events, refer to the winter storm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Table 3.13. NCEI Historical Severe Winter Storm Events in Frederick County

Hazard Events	# of Events	Deaths	Injuries	Property Damage	Crop Damage	Total Damage
Blizzard	1	0	0	$33,614	$0	$33,614
Cold/Wind Chill	9	0	0	$0	$0	$0
Extreme Cold/Wind Chill	6	0	0	$0	$0	$0
Frost/Freeze	46	0	0	$0	$184,015	$184,015
Heavy Snow	7	0	0	$0	$0	$0
Ice Storm	7	0	0	$74,023	$24,267	$98,290
Winter Storm	65	1	0	$299,351	$0	$299,351
Winter Weather	124	0	0	$0	$0	$0
Grand Total	**265**	**1**	**0**	**$406,988**	**$208,282**	**$615,270**

Table 3.14. Presidentially Declared Disasters for Frederick County since 1993[10]

Disaster Number	Incident Type	Incident Date	Programs Declared			
			IH	IA	PA	HM
EM-3100	Severe Snowfall & Winter Storm	3/13/1993			✓	✓
DR-1016	Severe Winter Weather & Ice Storm	2/8/1994			✓	✓
DR-1081	Severe Snowstorm (Blizzard of '96)	1/6/1996			✓	✓
DR-1324	Severe Winter Storm	1/25/2000			✓	✓
EM-3179	Severe Snowstorm	2/14/2003			✓	✓

[10] FEMA Declared Disasters (as of August 2021).

DR-1910	Severe winter storms and snowstorms	2/5/2010			✓	✓
DR-4261	Severe winter storms and snowstorms	1/22/2016			✓	✓
IH=Individual Housing IA=Individual Assistance			PA=Public Assistance HM=Hazard Mitigation			

Four federally declared disasters have data related to Public Assistance grants. Table 3.15 lists some of the statistics for each disaster. There was a total of 96 projects for these 4 declarations. These projects had six different project types between them: debris removal, protective measures, roads and bridges, public buildings, public utilities, and recreational or other.

Table 3.15. Declared Disaster Public Assistance Statistics for Frederick County

Disaster Number	Incident Type	Incident Date	Number of Projects	Total Project Amount	Total Federal Amount
DR-1324	Severe Winter Storm	1/25/2000	14	$449,779	$337,334
DR-1910	Severe winter storms and snowstorms	2/5/2010	38	$1,373,538	$1,030,153
EM-3179	Severe Snowstorm	2/14/2003	16	$517,226	$387,919
DR-4261	Severe winter storms and snowstorms	1/22/2016	28	$2,217,175	$1,662,723
Totals			**96**	**$4,557,717**	**$3,418,130**

Frederick County typically experiences 10 to 11 severe winter events each year, this is up from 6 to 7 events as reported in the 2016 Hazard Mitigation Plan. Two such events since 2015 are described below. Events before 2015 are included in Appendix A.

- On January 22 to 23, 2016, coastal low pressure in the Mid-Atlantic paired with high pressure from the North resulted in blizzard conditions throughout the County. Heavy snowfall was reported in several communities: New Market reported 35in., Myersville reported 32in., and Thurmont reported 26in. On March 4, 2016, the event received a Federal Disaster Declaration (referenced in Table 3.15).
- Higher than average amounts of ice were reported between December 16 to 17, 2019, particularly over the Catoctin Mountains. Sabillasville and Thurmont received 0.45-0.50in. of coverage; Other areas only received up to 0.1in. of coverage.

For the University, winter storms have caused classes to be cancelled and campus to be shut down, resulting in loss of instructional time. Several insurance claims have been filed due to winter related events and damages (Table 3.16).

Table 3.16. Damage History Due to Severe Winter Weather

Loss Date	Description	Damage Amount
12/13/2009	Major Winter Storm	None recorded
2/10/2010	Severe Snowstorm	None recorded
January/February 2013 (multiple events)	Major Winter Storm	None recorded
1/25/2016	Major Winter Storm	PNC Sports Complex/Knott Athletic Recreation Convocation Complex (ARCC) roof collapse (Claim # 5115707968US) Loss estimate $1,115,665.00

Probability and Severity of Future Events

The Mount St. Mary's campus is vulnerable to winter storms. With many winter storms occurring during the past, the probability of winter storms occurring in the future is probable, and the effects of the storm may impact the University. NCEI-recorded winter weather events happen about five times a year, winter storms about two to three every year, an ice storm and a heavy snow event every three years, and some sort of cold/wind chill every one to two years. This information is summarized in Table 3.17.

Table 3.17. NCEI Probability of Severe Winter Storm Events in Frederick County

Hazard Events	# of Events	Annualized Events
Blizzard	1	0.04
Cold/Wind Chill	9	0.36
Extreme Cold/Wind Chill	6	0.24
Frost/Freeze	46	1.84
Heavy Snow	7	0.28
Ice Storm	7	0.28
Winter Storm	65	2.6
Winter Weather	124	4.96
Frederick County Total	**265**	**10.6**

Impact Summary

Primary Impacts

The primary impact of excessive cold is increased risk for frostbite, and potentially death as a result of over-exposure to extreme cold. If power outages occur and there is a lack of readily available heat sources, these impacts can become more widespread. Transportation delays and disruptions to power distribution networks can make getting aid to those affected more difficult, which can further place lives at risk. The impacts of winter storms are usually minimal in terms of property damage and long-term effects.

Secondary Impacts

Winter weather has the capacity to immobilize a region, cut communities off from emergency management personnel, and make travel impossible. When winter weather is paired with freezing rain and ice storms, utilities including water, gas, and electric can be compromised. Health threats can become severe when frozen precipitation makes roadways and walkways very slippery, when prolonged power outages occur, and when fuel supplies are jeopardized.

Vulnerability Assessment

Vulnerability to the effects of winter storms on buildings depends on the age of the building (and the building codes in effect at the time of construction), type of construction, and condition of the structure (i.e., how well it has been maintained, materials used, etc.).

Severe winter storms result in the loss of utilities, increases in traffic accidents, impassable roads, and lost income since normal commuting can be hindered. Snow and ice can be extremely hazardous because visibility is reduced, and surface accumulation reduces traction and strains power lines, roofs, and other structures.

Severe storm activity poses a significant threat to unprotected or exposed lifeline systems. Generally, commercial power networks are very susceptible to interruption from snow and ice conditions. Other utilities, including underground pipelines, may be impacted if not protected from exposure. All campus buildings are vulnerable to the effects of severe winter storms due to the potential disruption of services and transportation systems as well as possible structure failure due to heavy snow loads

Thunderstorm

For the purposes of this hazard mitigation plan update, thunderstorm includes non-hurricanic and non-tornadic wind, lightning, and hail. Wind associated with hurricanes, wind associated with tornados, flooding, and winter storm are evaluated in their own sections.

Hazard Identification

Hazard Description

A thunderstorm is a convective rain or snow shower accompanied by lightning and thunder.[11] The National Weather Service (NWS) defines a thunderstorm as a localized storm produced by a cumulonimbus cloud and accompanied by lightning and thunder. Thunderstorms are typically the result of warm, moist air that is pushed upwards into the atmosphere where it cools and forms into cumulonimbus clouds. As the air continues to cool, it starts to form water droplets or ice. As these droplets or ice start to fall, they may collide and combine many times into larger forms before reaching the Earth's surface. Instability can be caused by surface heating or upper tropospheric (approximately 50,000 feet) divergence of air (rising air parcels can also result from airflows over mountainous areas).

[11] Nese, Jon M. and Grenci, Lee M. Kendall/Hunt. *A World of Weather, Third Edition.* Penn State Meteorology.

Thunderstorms can form in any geographic region and are sometimes the cause of other natural phenomena such as downburst winds, heavy rain, flash floods, large hailstones, lightning, tornadoes, and waterspouts. While many thunderstorms produce relatively little damage, stronger "supercell" thunderstorms can produce heavy winds, hail, significant damaging lightning strikes, and even tornadoes. Such storms have historically caused significant damage, injury, and even death through the destruction of trees; damage to buildings, vehicles, and power lines; and direct lightning strikes.

This hazard also includes non-hurricanic and non-tornadic wind (straight-line and downburst winds), lightning, and hail, which are described in the following sections. For more details on these types of events, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Straight-Line Winds

Extreme wind events occur when there is a large difference in atmospheric pressure over a short distance, called a pressure gradient. High winds may occur during severe thunderstorms, in mountainous regions (wind flow down mountains), and in strong weather systems. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. The larger the pressure gradient over a certain area, the stronger the winds will generally be. Strong cold fronts and low-pressure systems separating two distinctly different air masses lead to strong winds. Typically, non-thunderstorm strong wind events occur most often in autumn, winter, and spring when the temperature difference between air masses is the greatest.

For more details on these types of winds and NWS classifications, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Downburst Winds

"Downbursts" cause the high winds in a thunderstorm. A downburst is a severe localized wind blasting down from a thunderstorm. Downburst activity is sometimes mistaken for tornado activity. Both storms have very damaging winds (downburst wind speeds can exceed 165 mph) and are very loud. These "straight line" winds are distinguishable from tornadic activity by the pattern of destruction and debris such that the best way to determine the damage source is to fly over the area. They are more common than tornadoes in Maryland. Downburst winds result from the sudden descent of cool or cold air toward the ground. As the air hits the ground, it spreads outward, creating high winds. Unlike tornadoes, downburst winds move in a straight line, without rotation. Depending on the size and location of downburst events, the destruction to property may be significant. Downbursts fall into two categories:

- **Microbursts** affect an area less than 2.5 miles in diameter, last 5 to 15 minutes, and can cause damaging winds up to 168 mph.
- **Macrobursts** affect an area at least 2.5 miles in diameter, last 5 to 30 minutes, and can cause damaging winds up to 134 mph.

Another widespread thunderstorm wind event is known as a derecho. Derechos are associated with lines (squall lines) of fast-moving thunderstorms that might vary in length and have the potential to travel hundreds of miles. Winds in these types of events can rival those of "weaker" tornadoes with gusts of 80 to 100 mph covering a wide area.

Lightning

Lightning is defined by the NWS as a visible electrical discharge (i.e. lightning bolt) produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground or between the ground and a cloud. According to NOAA, the creation of lightning during a storm is a complicated process that is not fully understood. In the initial stages of development, air acts as an insulator between the positive and negative charges. However, when the potential between the positive and negative charges becomes too great, a discharge of electricity (lightning) occurs. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes, but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder.

In-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom. Cloud-to-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom of a second cloud. Cloud-to-ground lightning is the most dangerous. In summertime, most cloud-to-ground lightning occurs between the negative charges near the bottom of the cloud and positive charges on the ground.

Hail

Hail is precipitation in the form of ice pellets larger than five mm that forms in thunderstorms between currents of rising air (updrafts) and currents of descending air (downdrafts). Hailstorms are violent and spectacular phenomena of atmospheric convection, always associated with heavy rain, gusty winds, thunderstorms, and lightning. Hail is a product of strong convection and occurs only in connection with a thunderstorm where the high velocity updrafts carry large raindrops into the upper atmosphere (where the temperature is well below the freezing point of water). For more details on hail, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Location

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. All areas of Frederick County are susceptible to thunderstorms and severe weather events. Fortunately, in Maryland, injury and death due to these events is relatively uncommon. Since 1996, only 4 deaths and 15 injuries were reported to NCEI. Although thunderstorm damage is expected each year, most events do not cause significantly reported or measured damage.

Most thunderstorm damage is associated with downbursts, which typically have a greater effect on elevated areas such as hilltops, ridges, and "wind corridors" within communities. Areas with more trees in proximity to power lines and structures are more vulnerable to the effects of thunderstorm damage than more urban areas.

Hailstorms occur more frequently in the late spring and early summer and are more common in the Midwest. The land area affected by individual hailstorms is not much smaller than that of a parent thunderstorm, an average of 15 miles in diameter around the center of a storm.

Extent

The strength of a thunderstorm is typically measured in terms of its effects, namely the speed of the wind, the presence of significant lightning, and the size of hail. In general, thunderstorm winds are less than tropical cyclone speeds, but strong winds associated with downbursts can be extremely hazardous and reach speeds up to 168 mph.

The NWS issues alerts for both thunderstorms and wind events. NWS Storm Prediction Center (SPC) issues Day 1, Day 2, and Day 3 Convective Outlooks that depict non-severe thunderstorm areas and severe thunderstorm threats across the contiguous United States. The categorical forecast specifies the level of the overall severe weather threat via numbers (e.g., 5), descriptive labeling (e.g., HIGH), and colors (e.g., magenta). The probabilistic forecast directly expresses the best estimate of a severe weather event occurring within 25 miles of a given point. The text narrative begins with a listing of severe thunderstorm risk areas by state and/or geographic region. This is followed by a concise, plain-language summary of the type(s) of threat along with timing that is focused on the highest-risk areas.

For more detail on the NWS classification system, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Wind

The NWS issues the following wind alerts:

- **Wind Advisory**—when sustained non-thunderstorm winds range from 25 mph to 39 mph and/or gusts to 57 mph.
- **High Wind Watch**—when there is the potential for non-thunderstorm high wind speeds to develop and pose a hazard, or otherwise be life-threatening.
- **High Wind Warning**—when non-thunderstorm high wind speeds are occurring and may pose a hazard or are life-threatening. For a High Wind Warning to be issued, non-thunderstorm winds either must be sustained at 40 mph or greater for one hour or longer, or 58 mph or greater than 58 mph for any duration.

Lightning

While there is no established index for lightning, a lightning strike is of minimum severity when it has limited impacts on the natural and built environment (ex. tree limbs and buildings) and major severity when it causes extensive damage (ex. loss of life, fire, structural damage). The potential damages resulting from lightning strikes are primarily injury, loss of life, power outages, business interruption, fire and minor structural damage. A false sense of security often leads people to believe that they are safe from a lightning strike because it may not appear to be near their location. However, lightning can strike 10 miles away from a rain column, which puts people who are still in clear weather at risk.

Hail

The severity of hail is measured by duration, hail size, and geographic extent. All of these factors are directly related to thunderstorms, which creates hail. There is wide potential variation in these severity components. Using the NWS definition for a severe thunderstorm, dime-sized hail is considered a minimum hazard and quarter-sized hail is considered a major hazard. Quarter-sized hail can cause significant damage to agricultural crops and livestock, as well as property such as automobiles, aircraft, and roofs. Although rare, large hailstones may even cause injury or death. The amount of cover obtained during a hailstorm can greatly reduce the risk to human health during these events. The size of hailstones is a direct function of the severity and size of the storm.

Previous Occurrences

There have been 6 federal disaster declarations related to severe storms in Frederick County. A summary of notable (e.g., damages greater than $10,000) of severe weather events can be found in the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Mount St. Mary's has not experienced events or damages related to thunderstorms. A lightning event caused a fire at the IC Chapel on July 19, 2013 and resulted in $561,788.21 damages (Table 3.18). Mount St. Mary's has not experienced events or damages related to extreme wind but has had two hurricane related events impact campus (Table 3.19).

Table 3.18. Damage History Due to Lightning

Loss Date	Description	Damage Amount
7/19/2013	Lightning Fire	IC Chapel (Claim # E2975675); Loss $561,788.21
August 2016	Terrace Lightning Strike	<$50,000

Table 3.19. Damage History Due to Extreme Wind

Loss Date	Description	Damage Amount
8/28/2011	Hurricane Irene	None recorded
10/29/2012	Hurricane Sandy	Claim # CA10967485 Loss $402,633.98

Table 3.20 lists the number of severe weather events recorded in the Town of Emmitsburg, along with injuries, deaths, and damages. There have been 10 reports of thunderstorms since 1955, when the NOAA began keeping track of these occurrences in the NCEI Storm Events Database. Cumulatively, these events incurred more than $19,000 in damages.

Table 3.20. NCEI Total Thunderstorm Events (1955 - March 2021) for Town of Emmitsburg

Jurisdiction	Events	Injuries	Deaths	Total Damages (2021$)
Town of Emmitsburg	10	3	0	$19,305
Frederick County (All Jurisdictions)	**652**	**15**	**4**	**$6,831,131**

Probability and Severity of Future Events

Thunderstorms are a common occurrence in Maryland and occur on approximately 27 to 36 days each year. Lightning strikes are relatively infrequent in Maryland but can occur on any day, even if a thunderstorm is not happening. Windstorms, as mentioned previously, may occur as part of thunderstorms or independently. The predicted wind speed given in wind warnings issued by the NWS is for a one-minute average; gusts may be 25 to 30% higher. Hail does not occur with every thunderstorm. Although, it causes nearly $2 billion in crop and property damages, on average, each year in the United States.

This section summarizes the potential recurrence intervals for all of Frederick County based on recorded events and losses in the NCEI Storm Events database. In order to determine the average annualized number of hazard events, the total number of recorded events in the NCEI Storm Events Database were divided by the number of years the hazards were recorded. Table 3.21 shows the total period of record for each hazard event in this section. It is important to note that not all damages are captured in the NCEI data, so the number of events and dollar figures are likely higher than shown. All values were adjusted to 2021 dollars using CPI calculations to account for inflation.

Table 3.21. NCEI Record Periods (Severe Weather Events)

Hazard Type	NCEI Record Period	Years Recorded
Thunderstorm	1953-2021	68
Hailstorm	1955-2021	66
Lightning	1996-2021	25

Extreme Wind	1996-2021	25

As summarized in Table 3.22, the Town of Emmitsburg can expect to experience thunderstorm events less than once every other year. These events can be expected to incur roughly $772 in damages in any given year. Table 3.22 only includes thunderstorm events because no extreme wind, hailstorm, or lightning events or related damages were recorded in the NCEI database for the Town of Emmitsburg. For maps depicting probabilistic extreme wind events, refer to Figures 27 through 33 in Appendix E: Maps.

Table 3.22. Thunderstorm Events in NCEI Storm Events Database (1955-2021)

Jurisdiction	Total Number of Events	Annualized Events	Total Loss	Annualized Loss
Town of Emmitsburg	10	0.40	$19,305	$772
Frederick County Total	**652**	**24.14**	**$6,831,131**	**$252,939**

Table 3.23. Thunderstorm and Related Events in NCEI Storm Events Database (1955-2021) for Frederick County

Hazard	Total Number of Events	Annualized Events	Total Loss (2021$)	Annualized Loss (2021$)
Extreme Wind	57	2.28	$2,319,896	$92,795
Hailstorm	78	1.18	$27,562	$418
Lightning	22	0.88	$1,788,766	$71,550
Thunderstorm	495	7.28	$2,694,907	$39,631
Total	**652**	-	**$6,831,131**	-

The formation of thunderstorms is linked to climate factors, but currently, the understanding of how climate factors will affect the future frequency and severity of thunderstorms is still in development. Some studies show that climate factors may lead to more frequent and intense severe thunderstorms, but to what extent this will affect Frederick County is unclear.[12] For more detail on the probability and severity of future events for Frederick County and all jurisdictions, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

[12] The Fourth National Climate Assessment. Volume II, Impacts, Risks, and Adaptation in the United States. U.S. Global Change Research Program, 2018.; Revised February 2020. https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf.

Impact Summary

Primary Impacts

The primary hazard caused by thunderstorm winds is the transport of debris, which can cause casualties and property damage. Immobility and damage to utilities are common impacts. Roads may become impassable due to flooding, downed trees, or a landslide, preventing students, staff, and faculty from accessing MSM's facilities. High winds may also cause damage to poles and lines carrying electric, telephone, and cable television service.

Lightning is responsible for many fires around the world each year and can injure or kill people as well as damage buildings not properly grounded. Hail up to the size of softballs damages cars, windows and structures, and kills livestock caught out in the open.

Strong (up to more than 120 mph) straight-line winds associated with thunderstorms knock down trees, power lines and mobile homes.[13] Extreme wind events pose a danger to Frederick County because they can result in localized or widespread power outages, property damage, and falling trees. Injury or death to people can result from falling objects or flying debris. For more details on estimating damages from wind, refer to the thunderstorm section of Chapter 5 in the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan.

Secondary Impacts

The most significant secondary hazard of windstorms is utility failure resulting from downed power lines and tree branches. As noted, high windstorms can cause localized or regional power outages, thus leading to exposure extreme temperatures for vulnerable populations. An example was the widespread power outages following Superstorm Sandy and the exceptionally cold temperatures which led counties to open additional shelters for displaced residents. An additional secondary hazard is traffic accidents that may occur when power to traffic control devices is disrupted.

Hailstorms, like many of the other hazards discussed, are often accompanied by other severe weather. One secondary effect of hailstorms is the damage to critical infrastructure which in turn may lead to utility failure. Additionally, extreme hailstorms impact traffic routes and may lead to transportation accidents.

Flash flooding, particularly in low lying areas, is a secondary effect of thunderstorms as intense rain often accompanies thunderstorms.

Vulnerability Assessment

During the 2016 plan annex process, the Mount St. Mary's Department of Public Safety identified the following vulnerabilities associated with severe weather:

- Several housing units, Powell Hall and cottages, do not have generator backup. This ongoing issue remains with no update since the 2015 plan update.
- Weather events such as flooding, and lightning are a primary concern as water runoff from nearby mountain continues to plague the university. Significant rainfall events often result in water accessing lower levels of facilities in close contact with the mountain.
- Weather monitoring and notification systems exist on main campus but not the East campus where most outdoor activity is held. Freshman also park on the East campus and walk sometimes significant distances which can make them vulnerable to severe weather events. Weather monitoring is needed, such as the addition of a weather station on campus.

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[13] NOAA. "Severe Weather 101: Thunderstorms." Retrieved from https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

Human-Caused Hazards

Non-Climate-Influenced Hazards

Cyberterrorism

Hazard Identification

Hazard Description

Cyberterrorism refers to pre-meditated attacks against information, computer systems, computer programs and data, and infrastructure which results in disruption or violence. While recognizing the ongoing and growing threat of cyber-attacks worldwide, Mount St. Mary's offers a cybersecurity program through the School of Natural Science and Mathematics to provide students the necessary skills and tools to keep data secure and organizations safe. A graduate certificate in Risk Management and Cybersecurity is also offered.

Location

According to Microsoft Global Threat Activity models, education is the most affected sector for malware attacks when compared to other industries. The models suggest that, in addition to businesses and professional services, colleges and universities are prime targets for ransomware attacks. In October 2021, educational organizations were found to be the target of approximately 5.5 million malware attacks (within the previous 30-days).[14]

Extent

The threat of ransomware in higher education is increasing as cyberattacks surge in frequency and effect. In March 2021, the FBI Cyber Division alerted the public to increasing cyber threats through a ransomware called PYSA in which attackers were found to be targeting educational institutions. PYSA is a malware that has the capability to exfiltrate data and encrypt users' critical data and files stored on their systems. The FBI noted that "the unidentified cyber actors have specifically targeted higher education, K-12 schools, and seminaries," and have used PYSA to "exfiltrate data from victims prior to encrypting victims' systems to use as leverage in eliciting ransom payments."[15] Recommended mitigations for such attacks include regularly backing up data, implementing network segmentation and recovery plans, installing updates and patch operating systems, regularly changing passwords, auditing users, installing anti-virus and anti-malware software, disabling hyperlinks in emails, and focusing on awareness and training for system users.

[14] Microsoft Security Intelligence. *Cyberthreats, Viruses, and Malware*. Retrieved from https://www.microsoft.com/en-us/wdsi/threats
[15] Department of Justice, Federal Bureau of Investigation. 2021. *Increase in PYSA Ransomware Targeting Education Institutions*. Retrieved from https://www.ic3.gov/Media/News/2021/210316.pdf

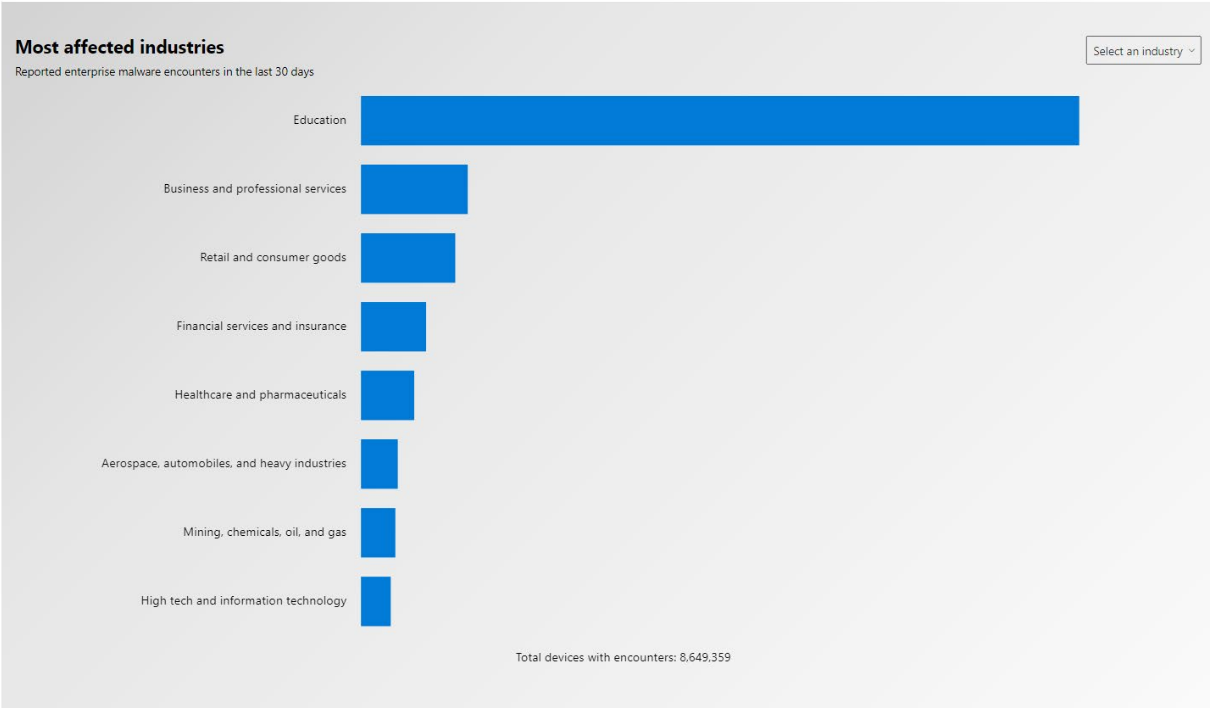

Figure 3-2. Microsoft Global threat Activity: Most Affected Industries (October 2021)

Today, governments and industries rely on technology for everyday operations. In almost every sector, organizations take advantage of processing, communications, and other complex technologies to ensure smooth, efficient operations. A cyber terrorist can infiltrate many institutions including banking, medical, education, government, military, communication, and infrastructure systems. The majority of effective malicious cyber activity has become web based. Recent trends indicate that hackers are targeting users to steal personal information and moving away from targeting computers by causing system failure. [16]

The duration of a cyber-attack is dependent on the complexity of the attack, how widespread it is, how quickly the attack is detected, and the resources available to aid in restoring the system. Common types of cyber-attacks are summarized in Table 3.24. One of the difficulties of malicious cyber activity is that its origin could be virtually anyone, virtually anywhere. Table 3.25 summarizes common sources of cybersecurity threats.[17]

Table 3.24. Common Types of Cyber Attacks

Type of Attack	Description
Botnet	A collection of compromised machines (bots) under (unified) control of an attacker (botmaster).
Denial of service	A method of attack from a single source that denies system access to legitimate users by overwhelming the target computer with messages and blocking legitimate traffic. It can prevent a system from being able to exchange data with other systems or use the internet.

[16] Symantec, "Internet Security Threat Report" Volume 17 (2011), www.symantec.com/threatreport
[17] United States Government Accountability Office, "Critical Infrastructure Protection: Department of Homeland Security Faces Challenges in Fulfilling Cybersecurity Responsibilities", Report #GAO-05-434 (May 2005), www.gao.gov/new.items/d05434.pdf

Distributed denial of service	A variant of the denial-of-service attack that uses a coordinated attack from a distributed system of computers rather than from a single source. It often makes use of worms to spread to multiple computers that can then attack the target.
Exploit tools	Publicly available and sophisticated tools that intruders of various skill levels can use to determine vulnerabilities and gain entry into targeted systems.
Logic bombs	A form of sabotage in which a programmer inserts code that causes the program to perform a destructive action when some triggering event occurs, such as terminating the programmer's employment.
Phishing	The creation and use of e-mails and websites—designed to look like those of well-known legitimate businesses, financial institutions, and government agencies—in order to deceive Internet users into disclosing their personal data, such as bank and financial account information and passwords. The phishers then take that information and use it for criminal purposes, such as identity theft and fraud.
Sniffer	Synonymous with packet sniffer. A program that intercepts routed data and examines each packet in search of specified information, such as passwords transmitted in clear text.
Trojan horse	A computer program that conceals harmful code. A Trojan horse usually masquerades as a useful program that a user would wish to execute.
Virus	A program that infects computer files, usually executable programs, by inserting a copy of itself into the file. These copies are usually executed when the infected file is loaded into memory, allowing the virus to infect other files. Unlike the computer worm, a virus requires human involvement (usually unwitting) to propagate.
War dialing	Simple programs that dial consecutive telephone numbers looking for modems.
War driving	A method of gaining entry into wireless computer networks using a laptop, antennas, and a wireless network adaptor that involves patrolling locations to gain unauthorized access.
Worm	An independent computer program that reproduces by copying itself from one system to another across a network. Unlike computer viruses, worms do not require human involvement to propagate.

Table 3.25. Common Sources of Cybersecurity Threats

Threat	Description
Bot-network operators	Bot-network operators are hackers; however, instead of breaking into systems for the challenge or bragging rights, they take over multiple systems in order to coordinate attacks and to distribute phishing schemes, spam, and malware attacks. The services of

	these networks are sometimes made available on underground markets (e.g., purchasing a denial-of-service attack, servers to relay spam or phishing attacks, etc.).
Criminal groups	Criminal groups seek to attack systems for monetary gain. Specifically, organized crime groups are using spam, phishing, and spyware/malware to commit identity theft and online fraud. International corporate spies and organized crime organizations also pose a threat to the United States through their ability to conduct industrial espionage and large-scale monetary theft and to hire or develop hacker talent.
Foreign intelligence services	Foreign intelligence services use cyber tools as part of their information-gathering and espionage activities. In addition, several nations are aggressively working to develop information warfare doctrine, programs, and capabilities. Such capabilities enable a single entity to have a significant and serious impact by disrupting the supply, communications, and economic infrastructures that support military power—impacts that could affect the daily lives of U.S. citizens across the country.
Hackers	Hackers break into networks for the thrill of the challenge or for bragging rights in the hacker community. While remote cracking once required a fair amount of skill or computer knowledge, hackers can now download attack scripts and protocols from the Internet and launch them against victim sites. Thus, while attack tools have become more sophisticated, they have also become easier to use. According to the Central Intelligence Agency, the large majority of hackers do not have the requisite expertise to threaten difficult targets such as critical U.S. networks. Nevertheless, the worldwide population of hackers poses a relatively high threat of an isolated or brief disruption causing serious damage.
Insiders	The disgruntled organization insider is a principal source of computer crime. Insiders may not need a great deal of knowledge about computer intrusions because their knowledge of a target system often allows them to gain unrestricted access to cause damage to the system or to steal system data. The insider threat also includes outsourcing vendors as well as employees who accidentally introduce malware into systems.
Phishers	Individuals, or small groups, that execute phishing schemes in an attempt to steal identities or information for monetary gain. Phishers may also use spam and spyware/malware to accomplish their objectives.
Spammers	Individuals or organizations that distribute unsolicited e-mail with hidden or false information in order to sell products, conduct phishing schemes, distribute spyware/malware, or attack organizations (i.e., denial of service).
Spyware/malware authors	Individuals or organizations with malicious intent carry out attacks against users by producing and distributing spyware and malware. Several destructive computer viruses and worms have harmed files and hard drives, including the Melissa Macro Virus, the Explore.Zip worm, the CIH (Chernobyl) Virus, Nimda, Code Red, Slammer, and Blaster.
Cyber terrorists	Cyber terrorists seek to destroy, incapacitate, or exploit critical infrastructures in order to threaten national security; cause mass casualties, weaken economies or target businesses; and damage public morale and confidence. Cyber terrorists may use

	phishing schemes or spyware/malware in order to generate funds or gather sensitive information.

Previous Occurrences

There are no recorded cyberterrorism events for Mount St. Mary's University. However, the university's Department of Public Safety listed cyberterrorism as a major concern and vulnerability for the institution as part of the 2021 plan update.

In the fall of 2016, Mount St. Mary's requested approval from the Maryland Higher Education Commission for a new cybersecurity program in an effort to address the growing need for combating cyber threats nationwide. In addition, Mount St. Mary's faculty and staff promoted cybersecurity by hosting a campus-wide educational campaign to teach the public about good security habits. Mount Saint Mary's has since established an undergraduate program in cyberterrorism through the School of Natural Science and Mathematics, as well as a graduate certificate program in Risk Management and Cybersecurity.

Probability and Severity of Future Events

In 2016, Mount St. Mary's Chief Technology Officer noted the institution's cybersecurity efforts following initiatives to implement a new educational system to allow the university to share more learning resources online and allowing students to log in to the system remotely. While useful, the shift to more online learning materials unlocks the potential for more cyber threats. This likely explains why ransomware attacks against colleges and universities more than doubled in 2021 since the onset of the COVID-19 pandemic where the nation saw an enormous shift towards remote learning.[18] However, given the data available, a potential recurrence interval or probability is not able to be calculated.

Impact Summary

Primary Impacts

Cyber-attack typically targets traffic pipelines or powerful servers of an information technology (IT) system. Attackers may seek to compromise their target through service disruption or manipulation. Attacks could utilize destructive worms and viruses, Denial of Service exploits, and intrusions to disrupt targeted networks.

Secondary Impacts

Attacks geared toward critical infrastructure and hospitals can result in the loss of life and the loss of basic needs, such as power and water, to the general public. Cyber-attacks can also lead to the loss of operational capacity.

Vulnerability Assessment

A cyber-attack could be geared toward one organization, one type of infrastructure and/or a specific geographical area. The affected area could range from small to large scale. Cyber-attacks generated toward large corporations can negatively affect the economy. The Congressional Research Service study found the economic impact of cyber-attacks on businesses has grown to over $226 billion annually.[19]

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[18] The Daily Swig: Cybersecurity News and Views. 2021. *Ransomware attacks more than doubled last year as cybercrime operations scale up during coronavirus pandemic*. https://portswigger.net/daily-swig/ransomware-attacks-more-than-doubled-last-year-as-cybercrime-operations-scale-up-during-coronavirus-pandemic

[19] Defense Tech. http://defensetech.org/2008/10/20/the-cyber-attack-danger/

Humans are the weakest link in a chain of cyber security. It remains difficult to continuously monitor and manage human/operator vulnerability. Actors either inside or outside of the asset's organization could carry out acts of sabotage. Attractive targets include government websites and high value networks.

Workplace or School Violence

Hazard Identification

Hazard Description

Workplace or school violence is violence or the threat of violence against workers/students. It includes any act or threat of physical violence, harassment, intimidation, or other threatening disruptive behavior that occurs at the worksite.[20] These incidents can be caused by fellow employees, by employers, students, administrators or by members of the general public. Acts of workplace or school violence could be a one-time incident or could occur repetitively over time, lasting weeks to years. Workplace or school violence can occur at or outside the workplace/school.

An example of workplace or school violence would be an active shooter, who is an individual actively engaged in killing or attempting to kill people in a confined and other populated area. In most cases, active shooters use firearms and there is not a pattern or method to their selection of victims. Active shooter situations are unpredictable and evolve quickly. The shooter in an active shooter scenario may be a sniper. A sniper is a concealed, usually skilled shooter who fires at exposed persons, typically using powerful high-energy, military-style assault rifles.

Location

Workplace or school violence can occur at or outside the workplace or school and can range from threats and verbal abuse to physical assaults and homicide. It can affect and involve employees, students, clients, customers, and visitors. Workplace or school violence includes locations such as churches, malls, etc. and may be the result of a person acting alone.[21]

Extent

Active shooter and workplace or school violence events can last minutes, hours, or days. Depending on the intent of the perpetrator, damages can be limited or extensive and can involve small firearms or large "stand-off" weapons (for example rocket propelled grenades).[22] In most cases in the United States, armed attacks involve small firearms and typically are a short duration (e.g., less than a few hours). Aggressors may target a specific person or group of people; they may also seek to make a political or social statement.

Previous Occurrences

Mount St. Mary's has experienced one incidence of workplace or school violence on campus. In 2009, a nine-millimeter bullet struck a window in Sheridan Hall, a residence hall. [23] The Emmitsburg campus was on lockdown for two hours for the subsequent investigation.

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[20] US Department of Labor, Occupational Safety and Health Act, www.OSHA.gov
[21] US Department of Labor, Occupational Safety and Health Act, www.OSHA.gov
[22] Reference Manual to Mitigate Potential Terrorist Attacks against Buildings. FEMA Publication 426. December 2003
[23] "Bullet hits dorm window at Mount St. Mary's" http://www.fredericknewspost.com/archive/bullet-hits-dorm-window-at-mount-st-mary-s/article_06922c73-3100-5b9b-a89a-928852fea37f.html and "Police still investigating bullet found in Mount dorm window" http://www.gazette.net/stories/02122009/thurnew173713_32476.shtml

Table 3.26 provides a list of some of the deadliest school shootings in US history.[24, 25,26]

Table 3.26. Deadliest US School Shootings

Date	Location	Description
April 16, 2007	Blacksburg, VA	A 23-year-old Virginia Tech student, Cho Seung-Hui, killed two in a dorm, and then killed 30 more two hours later in a classroom building. His suicide brought the death toll to 33, making the shooting rampage the deadliest in U.S. history. Fifteen others were wounded.
December 14, 2012	Newtown, CT	Adam Lanza, a 20-year old armed with an assault rifle, and two semi-automatic pistols entered Sandy Hook Elementary School and killed 20 children under the age of 7, and six employees. Prior to driving to the school, the gunman killed his mother in their Newtown home.
August 1, 1966	Austin, TX	Charles Whitman, 25 years old and a former engineering student, at the University of Texas, killed his wife and mother before he opened fire on the school from the school's tower. He killed 16 and injured 31.[27]
April 20, 1999	Littleton, CO	Eric Harris, 18, and Dylan Klebold, 17, opened fire at Columbine High School, killing 12 students and teachers and wounding 23 others before shooting themselves. The shooters had plotted to kill at least 500 and blow up the school for a year.
March 21, 2005	Red Lake, MN	After killing his grandfather and grandfather's companion, Jeff Weise, 16, opened fire at his school where he killed a teacher, a security guard, 5 students, and finally himself, leaving a total of 10 dead.
April 3, 2012	Oakland, CA	Former student One Goh killed seven people and injured three more at Oikos College.
October 1, 2015	Roseburg, OR	Christopher Sean Harper-Mercer shot and killed eight fellow students and a teacher at Umpqua Community College.
June 12, 1976	Fullerton, CA	Edward Allaway, a disgruntled janitor, shot and killed 7 and California State University at Fullerton[28]

[24] Workplace Shootings. http://www.emergency-management.net/workplace_shoot.htm
[25] "A Timeline of Recent Worldwide Shootings." http://www.infoplease.com/ipa/A0777958.html
[26] "Deadliest U.S. mass shootings | 1984-2015" Los Angeles Times. Retrieved from http://timelines.latimes.com/deadliest-shooting-rampages/ on December 4, 2015.
[27] "University of Texas Shooting Remembered." NPR. http://www.npr.org/templates/story/story.php?storyId=9619382
[28] Pfeifer, Stuart. "Mass Killer Says He's No Longer Mentally Ill." Los Angeles Times, 5 June 2001. http://articles.latimes.com/2001/jun/05/local/me-6582

Probability and Severity of Future Events

There has only been one recorded incident of workplace or school violence at Mount St. Mary's University. The typical approach of the hazard history to estimate future vulnerability would result in a near 0% probability. A 2014 study of active shooter incidents found an increasing trend in the number of events between 2000 and 2010 nationwide, which makes a zero percent probability seem unrealistic.[29]

Impact Summary

Primary Impacts

If an active shooter scenario were to occur, Frederick County's hospital could become overtaxed as the number of hazard-related trauma injuries increases. Victims may require differing levels of trauma care and will rely on hospitals from neighboring jurisdictions for support.

Secondary Impacts

Following an active shooter situation, those involved will need mental health screening and support. Additionally, some students, staff, and faculty may decide not to return to the University following an event, resulting in a drop in enrollment and employees.

Vulnerability Assessment

All schools and workplaces are vulnerable to this type of event, and the occurrences in cities throughout the country underscore the susceptibility of all areas to general domestic violence.

Localized Infectious Disease Outbreak

Hazard Identification

Hazard Description

A localized infectious disease outbreak is a sudden rise in the occurrence of a disease. Some outbreaks are expected each year, like influenza, or other respiratory or gastrointestinal diseases. Such infectious disease outbreaks can be foodborne, waterborne, vector-borne, environmental, or transmitted person-to-person.[30]

The following list summarizes potential disease outbreaks that could affect MSM and its campus:

- **Middle East Respiratory Syndrome** (MERS) is viral respiratory illness first reported in Saudi Arabia in 2012. It is caused by a coronavirus called MERS-CoV. Most people who have been confirmed to have MERS-CoV infection developed severe acute respiratory illness. They had fever, cough, and shortness of breath. About 30% of these people died. All the cases have been linked to 6 countries in or near the Arabian Peninsula. CDC continues to closely monitor the MERS-CoV situation globally and work with partners to better understand the risks of this virus, including the source, how it spreads, and how infections might be prevented. The risk to the general public is low.
- The **H5N1 or avian influenza**, was first detected in Guangdong, China in 1996 and has since been found in birds in numerous countries throughout Africa, Asia, and Europe.31 Asian H5N1 was first detected in humans in 1997 during a poultry outbreak in Hong Kong and has since been detected in poultry and wild birds in more than 50 countries in Africa, Asia, Europe, and the Middle East. Six countries are considered

[29] Federal Bureau of Investigations, Law Enforcement Bulletin, January 2014. https://leb.fbi.gov/2014/january/active-shooter-events-from-2000-to-2012

[30] Monterey Bay Flu Watch. http://cns.miis.edu/flu_watch/history.htm

[31] The Prioritization of Critical Infrastructure for a Pandemic Outbreak in the United States Working Group Final Report. National Infrastructure Advisory Council. 16 January 2007. www.dhs.gov/xlibrary/assets/niac/niac-pandemic-wg_v8-011707.pdf

endemic for Asian H5V1 (Bangladesh, China, Egypt, India, Indonesia, and Vietnam. H5N1 is the most likely cause of a pandemic, though it is not the only possible cause.[32]

- **Foot and Mouth Disease** (FMD) is a severe, highly contagious viral disease of cattle and swine. It also affects sheep, goats, deer, and other cloven-hooved ruminants. It can be spread, unintentionally through contact with people wearing contaminated clothes/shoes. FMD causes production losses and hardships for farmers. As shown in the Agro Terrorism section, hoofed animals and products are a mainstay for farmers in Frederick. If an FMD outbreak occurs in the US, the disease could spread rapidly to all regions of the country through routine livestock movements.

Location

Disease outbreaks are more likely to occur in areas where individuals are traveling from other places and in close contact with one another, making it possible for a disease to spread.

Extent

The severity and duration of a disease outbreak will depend on the disease's specific characteristics, such as how it is transmitted, and the available countermeasures, such as treatments or medications.

Hazard History

Mount St. Mary's has not experienced events or damages related to localized infectious disease outbreaks. The following list summarizes non-major animal or plant disease historical incidents:

- The 2014 Ebola Virus Disease outbreak primarily affected countries in western Africa, though Ebola cases were diagnosed in the United States and other countries. The Frederick County Health Department monitored the situation and worked closely with community and state partners in preparing for and responding to situations that might be related to Ebola. Although there were no cases of Ebola Virus Disease in Maryland, the Maryland State Department of Health and Mental Hygiene monitored hundreds of travelers returning from affected countries. The Frederick County Health Department was involved in monitoring those returning travelers categorized at a higher risk level. The county health department continues to work to improve its capabilities to handle patients with Ebola or other highly communicable diseases.
- A strain of bird flu, scientifically known as Highly Pathogenic Avian Influenza (HPAI), entered the Pacific Northwest in December 2014 by migratory waterfowl. As of July 2015, the virus has infected more than 48 million birds in 15 states. As of August 2015, no detections had been reported in Maryland.[33] The virus is not known to threaten human health but can wipe out flocks of poultry within days. In Frederick County, several birds tested positive, but through a site inspection and additional testing, it was determined that the virus was not HPAI.
- There have been 24 confirmed cases of bovine spongiform encephalopathy (BSE) ("mad cow disease") in North America from 1993 through February 2015.[34] Twenty of the cases were in Canada and four in the US. Between 1996 and 2014, there have been four US cases of Variant Creutzfeldt-Jakob Disease (vCJD).[35] Millions of cattle have been destroyed on suspicion of contracting mad cow disease, costing billions of dollars. National milk producers have worked on plans for mitigating milk movement.

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[32] CDC Highly Pathogenic Asian Avian Influenza. August 2015.

[33] USDA Animal and Plant Health Inspection Services. http://www.aphis.usda.gov August 2015

[34] Centers for Disease Control and Prevention. BSE in North America. http://www.cdc.gov/prions/bse/bse-north-america.html August 2015.

[35] Centers for Disease Control and Prevention. Variant Creutzfedt-Jakob Disease. http://www.cdc.gov/prions/vcjd/index.html August 2015.

- In 1996, a small outbreak of a fungus disease called Karnal blunt occurred in wheat seeds in Arizona. As a result, more than 50 countries restricted trade with the U.S. The total cost of clean-up was around $45 million, and the reduction in exports cost $250 million.[36] In 1983, highly pathogenic avian influenza struck Pennsylvania. About 17 million chickens were disposed of, costing $86 million. The price of poultry increased, costing consumers $548 million, and an additional $7 million in wages were lost.
- Between 1970 and the present, several versions of leaf blight have destroyed over 10 million acres and $1 billion of crops.

Probability and Severity of Future Events

University campuses due to their relatively high density of population and residential nature are susceptible to disease outbreak. Given the data available, a potential recurrence interval or probability is not able to be calculated.

Impact Summary

Primary Impacts

The primary impacts of a disease outbreak will be felt by those who contract the disease, but specific effects will depend on the disease characteristics. If the disease prevents infected individuals from attending work or school, then MSM may witness lowered class attendance or even understaffing of facilities. The risk of property and infrastructure damage is low or even nonexistent.

Secondary Impacts

Depending on the disease characteristics, localized outbreaks could result in cancelled classes or events to prevent additional transmission or due to low student attendance and available staff.

Vulnerability Assessment

All college campuses are vulnerable to localized disease outbreaks due to their relatively higher density of people working and interacting with another for extended periods of time.

Pandemic

Hazard Identification

Hazard Description

A pandemic refers to an infectious disease outbreak that spreads across countries or continents.[37] This type of hazard affects more people than a localized outbreak or epidemic.

At the time of this plan update, the novel coronavirus (COVID-19) pandemic continues to affect Frederick County and has disrupted lives and economic activities worldwide since its first appearance in late 2019. Since early 2020, COVID-19 has infected more than 310 million people and resulted in roughly 5.5 million deaths.[38] In Frederick County alone, there have been more than 37,000 cases and nearly 425 recorded deaths due to COVID-19 as of mid-January 2022.[39]

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[36] Kohnen, Anne. Responding to the Threat of Agro terrorism: Specific Recommendations for the United States Department of Agriculture. October 2000. http://ianrhome.unl.edu/c/document_library/get_file?folderId=3562&name=DLFE-282.pdf p. 4-5

[37] State of Maryland. 2021. *2021 State of Maryland Hazard Mitigation Plan*. Retrieved from https://aecomviz.com/MEMA-Maryland-360/Doc/MEMA%20HazMitPlan.pdf#page=156

[38] The New York Times. 2022. "Coronavirus World Map: Tracking the Global Outbreak." Retrieved from https://www.nytimes.com/interactive/2021/world/covid-cases.html.

[39] Frederick County. 2022. "COVID-19 in Frederick County." Retrieved from https://frederickcountymd.gov/8094/COVID-19-in-Frederick-County

Location

By definition, pandemics are infectious diseases that affect large geographic areas, such as entire countries or event worldwide. The locations that are affected by pandemics will depend on how the disease is transmitted, such as whether it is transmitted from animals to humans or human to human.

Areas that are more densely population are more likely to experience a higher transmission rate. However, some rural areas tend to have higher shares of people that have pre-existing conditions or limited access to healthcare that make them more susceptible to infection or severe illness.

Extent

The severity of a pandemic depends on the disease's specific characteristics, such as how it is transmitted, the availability of countermeasures and treatments, its mortality rate, and to what extent the population has pre-existing immunity to the disease.

Previous Occurrences

At the time of this plan update, the COVID-19 pandemic is still active, with new cases recorded daily in Frederick County. Prior to 2020, there were no recorded occurrences of pandemics affecting MSM. The following list summarizes major pandemics that have affected the county:

- The **1918 Spanish Flu Pandemic** was caused by an H1N1 virus with genes of avian origin, but unknown geographic origin. The Spanish Flu spread globally between 1918 and 1919, infecting 500 million – a third of the world's population – and killing at least 50 million globally, including 675,000 in the United States.[40] In Maryland specifically, the first cases were recorded at Camp Meade in September 1918, and by the next year, tens of thousands of cases were reported in Baltimore.[41]
- The **2009 H1N1 "Swine" Flu Pandemic** was first detected in the United States and quickly spread throughout the country, resulting in the Maryland Governor declaring a State of Emergency and the closure of many Maryland schools. By April 2010, more than 1,700 cases of the swine flu had been recorded in Maryland, resulting in at least 45 deaths.[42] In 2010, the widespread deployment of the Swine Flu vaccine ended the pandemic.
- The **2020 COVID-19 Pandemic** is a respiratory virus that first appeared in Wuhan, China in late 2019. In Maryland, the first recorded cases were identified on March 3, 2020, at which points the Governor declared a State of Emergency. Throughout March 2020, the COVID-19 cases rose globally and in Maryland, resulting in the closure of schools, private businesses, and government buildings. By March 26, 2020, FEMA issued a Major Disaster Declaration for Maryland for the COVID-19 pandemic. At the time of this plan update, Maryland has had more than 850,000 reported cases of COVID-19 and more than 12,000 deaths.[43]

Probability and Severity of Future Events

College campuses, due to their relatively high density of population and residential nature, are susceptible to the quick spread of pandemics. Given the data available, a potential recurrence interval or probability is not able to be calculated.

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[40] Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases (NCIRD). 2019. *1918 Pandemic (H1N1 virus).* Retrieved from https://www.cdc.gov/flu/pandemic-resources/1918-pandemic-h1n1.html

[41] State of Maryland. 2021. *2021 State of Maryland Hazard Mitigation Plan.* Retrieved from https://aecomviz.com/MEMA-Maryland-360/Doc/MEMA%20HazMitPlan.pdf#page=158

[42] State of Maryland. 2021. *2021 State of Maryland Hazard Mitigation Plan.* Retrieved from https://aecomviz.com/MEMA-Maryland-360/Doc/MEMA%20HazMitPlan.pdf#page=159

[43] The New York Times. 2022. "Tracking Coronavirus in Maryland: Latest Map and Case Count" https://www.nytimes.com/interactive/2021/us/maryland-covid-cases.html

Impact Summary

Primary Impacts

The primary impacts of a pandemic will be felt by those who contract the disease, but specific effects will depend on the disease characteristics. If the disease prevents infected individuals from attending work or school, then MSM may witness lowered class attendance or even understaffing of facilities. The risk of property and infrastructure damage is low or even nonexistent.

Secondary Impacts

As witnessed with COVID-19, pandemics can result in the disruption of economic and everyday activities. To prevent further spread of pandemic, some activities may be canceled or transitioned to a virtual environment. For example, MSM transitioned to virtual learning to accommodate students during the COVID-19 pandemic. The inability to conduct research work or other economic activity could result in loss of income for MSM and businesses in the area.

Vulnerability Assessment

All college campuses are vulnerable to pandemics due to their relatively higher density of people working and interacting with another for extended periods of time.

Mobile Hazardous Materials Release

Hazard Identification

Hazard Description

Hazardous materials (HAZMATs) consist of elements or compounds—of which chemical, biological or radiological—that may have a detrimental impact to public health and the environment if released. Sources of hazardous materials include but are not limited to chemical manufacturers, service stations, hospitals, hazardous materials waste. A mobile release refers specifically to a spilling or unplanned discharge of hazardous materials from a vehicle (such as a truck or train) in transit.

Location

The location of an event will depend on where the vehicle is located at the time of the materials' discharge. By definition, these events will be near transportation corridors, such as a roadway or railway, or intermodal transfer points.

The Maryland Department of the Environment provides regulatory oversight for hazardous waste which are distributed across Maryland's Land Management Administration. Major revisions were recently made to Maryland's hazardous waste generator regulations on May 3, 2021 to integrate EPA provisions. The 2021 update to the MD Hazardous Waste Generator Regulations revised a variety of features including the adoption of new flexibilities made available in federal regulations, as well as the adoption of new, more stringent federal requirements.

Extent

Hazardous materials have a varying severity of impacts depending on the form and quantity that are released. HAZMATs have the potential to cause serious injury, long-lasting health effects, property damage, or even death. These substances may include disease-causing agents, or highly reactive, flammable, corrosive, or radioactive.

Previous Occurrences

No large-scale hazardous materials incidents have occurred in Frederick County, but because of the potential and nature of utilities failure, it is worthwhile to study recent examples from around the state. The following list summarizes previous mobile release events in the region:

- On January 18, 2011, a train carrying hazardous materials was stopped in Anne Arundel County, MD after leaving Washington, D.C. The train was stopped after several construction workers suffered from respiratory problems while performing maintenance on a rail bridge. No active leak was uncovered following an inspection from a hazardous materials team.
- On October 4, 2021, a hazardous materials crew was dispatched to attend to a fuel spill that occurred in South Baltimore, MD. Officials confirmed an unknown amount of diesel fuel spilled into the Cabin Branch and Curtis Creek waterways. The Maryland Department of Environment and the U.S. Coast Guard were called in to assist Baltimore firefighters to contain the spill. The cause of the spill was not released by media, but the waterways impacted were right off Pennington Avenue.
- There have been numerous reports of warehouse fires in Maryland in the last several decades. These fires have caused major concerns over hazardous material dangers throughout the state.
    - In 2010, a warehouse fire in Glen Burnie, MD left two individuals dead.
    - In 2012, a fire occurred inside of a warehouse in Baltimore. It was later revealed that 650-gallon containers containing sulfuric acid were being stored in the warehouse, totaling over 8,000 gallons of acids used for plating operations. The water used to put out the fire flushed some of these acids into storm drains leading to the harbor.
    - Several news reports of warehouse fires in Baltimore were found from 2012, 2014, 2019. However, many others have occurred, and not all news reports attribute these warehouse fires to hazardous materials release.

Probability and Severity of Future Events

Given the data available, a potential recurrence interval or probability is not able to be calculated.

Impact Summary

Primary Impacts

The potential impacts of mobile releases will depend on what type of materials are discharged, as well as where the event occurs. If an event occurs in a densely populated area, more people may be affected, assuming the materials pose a threat to human health and safety. People with underlying or pre-existing conditions, as well as the elderly and young children, may be more vulnerable to adverse impacts of material releases, if they are exposed. Some materials may also risk damage to property and infrastructure, such as if they are corrosive or have explosive potential.

Secondary Impacts

Depending on the severity and type of release, these events may cause trauma or other mental health issues for people affected or in the surrounding area. Businesses in the surrounding area may suffer economic losses if people do not wish to travel to or through the affected corridor after an event.

Vulnerability Assessment

It is important to be prepared to quickly respond in the event of a hazardous spill. A few ways one can be prepared for hazardous spills:

- Have updated emergency response procedures;
- Provide community with a list of contacts if a spill occurs;
- Establish primary and secondary evacuation routes and ensure they are known;

- Have spill response materials and know their location;
- Have trained employees in advance of an incident, and to occasionally inspect response materials and maintain inventory.

Automobile Accidents

Hazard Identification

Hazard Description

Automobile accidents refer to collisions between a vehicle and another vehicle, pedestrian or bicyclist, or a stationary obstruction, like a pole, building, or tree.

In 2012, there were 5,615,000 automobile accidents and 32,719 automobile-related fatalities in the United States.[44] Automobile accidents are the leading cause of death among people between the ages of 4 and 34.[45] The US Department of Transportation's 2013 Fatality Analysis Report shows a 3.1% decrease from the previous year and a 25 percent decline in overall highway deaths since 2004. The estimated number of people injured in the crashes also declined by 2.%.[46]

Drivers under the influence of alcohol are a leading cause of automobile accident fatalities nationwide, accounting for approximately 31 percent of all traffic fatalities. In 2013, nearly 10,076 people died in alcohol-related accidents. However, the number of alcohol-related accidents and fatalities has been steadily decreasing since 1982, as a result of public education programs conducted by all levels of government and organizations such as Mothers against Drunk Driving.[47]

Location

Location and time of day also contribute to the likelihood of automobile accidents; the largest percentage of car accidents occurs between 6 p.m. and 9 p.m. The likelihood of accidents increases with speed limit and congestion; accidents are most likely on roads with speed limits of 55 miles per hour or greater.[48]

Extent

The severity of an automobile accident will depend on the number and size of vehicles involved, as well as the velocity of the vehicle at the time of the crash. These events can range from vehicle damage with no injuries to fatal crashes.

Extreme weather conditions in and around Frederick County can contribute to large-scale vehicle accidents. Multi-vehicle pileups generally occur on high capacity, high-speed routes and are one of the deadliest forms of traffic accidents. Causes for these incidents may include low visibility, chain reactions related to weather, and chain reactions related to road conditions.

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[44] United States Department of Transportation; National Transportation Statistics, 2008 http://www.bts.gov/publications/national_transportation_statistics/pdf/entire.pdf

[45] National Highway Traffic Safety Administration's National Center for Statistics and Analysis, 2012

[46] National Highway Traffic Safety Administration's Fatality Analysis Report 2013

[47] National Highway Traffic Safety Administration's National Center for Statistics and Analysis, 2012

[48] United States Department of Transportation; National Transportation Statistics, 2008 http://www.bts.gov/publications/national_transportation_statistics/pdf/entire.pdf

Previous Occurrences

Mount St. Mary's has not experienced a major disruptive event or damages related to automobile accidents. The following list summarizes significant automobile accidents that have occurred within Frederick County and nationally:

- On February 25, 2015, a 75-car pileup in Penobscot County, Maine on Interstate 95 resulted in 17 injuries. A vehicle skidding off the road resulted in a jackknifed tractor trailer and several other crashed vehicles that blocked the highway.[49]
- On January 9, 2015, a crash involving 193 vehicles, including 26 semi-trucks, were involved in a pileup on Interstate 94 near Galesburg, Michigan, amidst a heavy snowstorm. Twenty-three people were injured and one fatality. Among them was a truck that carried 44,000 pounds of hazardous materials and another hauling fireworks. The truck carrying fireworks caught fire and exploded, injuring two firefighters.[50]
- On January 19, 2009, snowy road conditions were the catalyst for a 50-vehicle pile-up on Interstate 70 from Frederick to Washington County. The accident resulted in two deaths and fourteen injuries.[51]
- A tractor-trailer incident that occurred near Myersville, Maryland, on October 6, 2001 may have had the potential to be deadly; however, no hazardous materials were actually released. A truck carrying eight missiles travelling northeast in a construction area hit a construction barrier and careened down an embankment and landed on its side.[52]

Probability and Severity of Future Events

U.S. Route 15 bisects Mount St. Mary's university's campus. Based on daily traffic county maps published by the State of Maryland, an average of 23,020 vehicles travel this portion of U.S. Route 15.[53] This is one of the highest annual average daily traffic counts in Frederick County. An accident causing significant impacts to the university is not unlikely given these traffic counts but based on the data available, a potential recurrence interval or numerical probability is not able to be calculated.

Impact Summary

Primary Impacts

The impacts of automobile accidents will depend on the severity of the event, such as how many vehicles are involved and at what speed the vehicle was moving at the time of the crash. Automobile accidents can cause injuries and even death of drivers, passengers, or bystanders. Crashes can also incur property or infrastructure damage, if a stationary obstruction is involved, such as a pole or building.

Secondary Impacts

Automobile crashes may lead to vehicle congestion or road closures immediately following a crash. These traffic changes will increase travel times or even prevent some travelers from reaching their locations, potentially affecting their ability to access businesses, school, workplaces, or other destinations.

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[49] Ricker, Nok-Noi (26 February 2015). "Police, witnesses piece together details of 75-car crash on I-95". *Bangor Daily News*. Retrieved September 2015.

[50] "One dead, 23 hurt in fiery 193-vehicle I-94 pileup". WZZM. 9 January 2015. Retrieved September 2015.

[51] "A Fatal 50-Car Pile-Up Closes I-70 West Bound on South Mountain in Washington County." Community Rescue Service of Hagerstown, Maryland. http://www.crs75.org/newsMore.aspx?id=31

[52] http://www.dawn.com/2001/10/07/int5.htm Accessed January 22, 2009

[53] State of Maryland Traffic Volume Map. Retrieved from http://sha.md.gov/Traffic_Volume_Maps/Frederick.pdf

Vulnerability Assessment

As previously discussed, MSM is bisected by a major highway, U.S. Route 15, which effectively creases an east and main campus location. The University's primary access point is an at-grade intersection on this route. If a significant crash occurred on Route 15, MSM students, staff, and faculty may be unable to evacuate if needed or otherwise travel between the east and main campus locations.

Utilities Failure or Interruption

Hazard Identification

Hazard Description

Utility interruption hazards are hazards that impair the functioning of important utilities in the energy, telecommunications, public works, and information network sectors. Common utility interruption hazards, although not an exhaustive list, are shown in Table 3.27.

Table 3.27. Common Types of Utility Interruption

Utility Interruption	Description
Geomagnetic Storms	Temporary disturbances of the Earth's magnetic field resulting in disruptions of communication, navigation, and satellite systems.
Fuel or Resource Shortage	Resulting from supply chain breaks or secondary to other hazard events.
Electromagnetic Pulse	Originating from an explosion or fluctuating magnetic field and causing damaging current surges in electrical and electronic systems.
Information Technology Failure	Due to software bugs, viruses, or improper use.
Ancillary Support Equipment	Electrical generating, transmission, system control, and distribution-system equipment for the energy industry.
Public Works Failure	Damage to or failure of highways, flood control systems, deep water ports and harbors, public buildings, bridges, dams.
Telecommunications System Failure	Damage to data transfer, communications, and processing equipment.
Transmission Facility or Linear Utility Accident	Liquefied natural gas leakages, explosions, facility problems.
Major Energy, Power, Utility Failure	Interruptions of generation and distribution, power outages.

Location

Utility failures can occur as a result of almost any kind of natural or manmade disaster (e.g., flood, earthquake, explosion, etc.); they can also be the cause of certain disasters (e.g., transportation accidents, hazardous material release, etc.). They can affect a concentrated group of houses and facilities, or they can be widespread, affecting an entire town, county, or region. The interconnectedness of utilities can have dramatic impacts and result in a cascading failure of successive systems when one of the systems fails.

Extent

Infrastructures such as water supply, transportation, fuel and power stations are interdependent networks that are extremely sensitive to random failure, and in particular to target attacks, such that a failure of a small fraction of nodes from one network can produce an iterative cascade of failures in several interdependent networks.[54]

Power outages, the most common type of failure, can include cascading effects such as overabundance of carbon monoxide due to use of generators, grills, and similar items; spoiling of food; compromised water purification systems resulting in water that may be unsafe to drink; loss of air conditioning, resulting in vulnerability to extreme heat and cold; electric shock resulting from loose power lines and power surges when electricity is restored.[55] Power outages can also result from other natural and man-made disasters, including earthquakes, transportation accidents, and major structural collapses. Power outages can be particularly dangerous for critical facilities. Hospitals, for example, rely on electricity to serve patients. Many vaccinations must be refrigerated, and a power outage could severely deplete the supply of certain vaccines in the affected area.[56]

Depending on the scale of the power outage, power may not be restored for some time. If a power outage occurs during extreme cold, water heaters, plumbing systems, and heating and cooling systems may be susceptible to damage due to freezing. If a power outage occurs during flooding such that electrical equipment and appliances are submerged, electric shock may occur.

Water distribution can be affected in three ways: the amount of water available; the quality of the water; and the viability of the physical components of the distribution systems. The quantity of water is covered in the drought section of the Natural Hazard Mitigation Plan. Contamination of the water supply can occur naturally, as a result of human error, or intentionally. Occasionally, the release of manure or other farming byproducts can contaminate water. Accidents resulting in hazardous material spills can also adversely affect groundwater. Disruption to the distribution system can occur because of loss of power to pumping and treatment stations; it can also be caused by direct physical damage to pumping and treatment stations caused either by natural disaster or intentional acts.

Gas failures or shortages are less common than other utility failures. Disruption to the distribution system can occur because of loss of power to the distribution system components; it can also be caused by direct physical damage to distribution system components caused either by natural disaster or intentional acts. If there would be an extensive gas shortage during winter months, citizens would not have an efficient way to heat their homes.

[54] Critical National Infrastructures. Report of the Commission to assess the threat to the United Stated from Electromagnetic Pulse Attack. http://empcommission.org/docs/A2473-EMP_Commission-7MB.pdf Accessed September 1, 2015.

[55] "What You Need to Know When the Power Goes Out Unexpectedly." Centers for Disease Control and Prevention. http://www.bt.cdc.gov/disasters/poweroutage/needtoknow.asp

[56] "What You Need to Know When the Power Goes Out Unexpectedly." Centers for Disease Control and Prevention. http://www.bt.cdc.gov/disasters/poweroutage/needtoknow.asp

Communications (e.g., phone, Internet) infrastructure can also be affected whether through loss of power to system components or direct physical damage to system components caused either by natural disaster or intentional acts.

Previous Occurrences

In 2015, two water line breaks at MSM resulted in payment of insurance claims of $301,044.52 (Table 3.12).

Table 3.28. Damage History Due to Utilities Failure/Interruption

Loss Date	Description	Damage Amount
2/19/2015	Waterline Break – damage to Coad Science Building	$277,529.00
6/25/2015	Waterline Break	$23,515.52
1/24/2018	Pipes Burst - Flooding in Keating, Keelty Towers, Terrace, Memorial Gym, Auditorium	<$50,000
6/26/2019	Pipe Burst – Flooding in Bradley	$81,864
2/16/2020	Pipe Burst – Flooding in Powell	<$50,000

No large-scale utilities failures have occurred in Frederick County. However, thunderstorms and other severe weather events are the primary causes of power outages in Frederick County. Lightning and high winds in the summer, and ice and snow in the winter can disrupt service to part or the entire county.[57] Other causes of power outages include falling tree limbs, vehicular accidents, and small animals that destroy wiring. When power outages occur, they are typically on a regional scale.

The following list summarizes recent incidences of utility failures and interruptions in Maryland and throughout the country:

- On December 23, 2008, during the early morning commute, a water main broke in a neighboring jurisdiction in Montgomery County, Maryland. According to the Washington Suburban Sanitary Commission (WSSC), a flow rate of 150-thousand gallons per minute was going through the 66-inch wide pipe.[58] Five swift water rescues were conducted, but there were no serious injuries or deaths as a result of the break. Though the cause of the break was undetermined, aging infrastructure has been suspected to be the reason for the break.[59]
- On July 2007, a 24-inch underground steam pipe near the Grand Central Terminal in New York City exploded during rush hour. The explosion sent a 40-story high shower of mud and debris on the streets

[57] Allegheny Power, http://www.alleghenypower.com/CSC/Services/PowerOutages.asp#whatcausePO

[58] http://www.thesentinel.com/293394246391433.php Accessed January 5, 2009

[59] http://www.foxnews.com/story/0,2933,471466,00.html Accessed January 5, 2009

of Midtown Manhattan. Forty-five people were injured, and one person died of a heart attack while fleeing the event. Deficient repair work was cited as the cause of the rupture.[60]

- The largest power outage in American history occurred on August 14, 2003. It began as a surge of electricity in western New York and Canada, and eventually led to power failures in eight states in the Northeast and Midwest from New York to Michigan. Although this event did not affect Frederick County directly, other smaller power outages occur frequently due to weather events and scheduled blackouts. Effects of the blackout included:
  - Commuters were stranded on public transportation and in streets with no traffic signals;
  - Major delays at the three major airports in the New York metropolitan region, affecting flights nationwide;
  - Seven nuclear power plants in New York and New Jersey and two in the Midwest shut down;
  - Disruption of cellular telephone service, mostly due to heavy use and power failures at some cellular transmitters;
  - Looting and vandalism;
  - Increase in heat and heart-related ailments; and
  - Increase in traffic accidents involving pedestrians.[61]

Probability and Severity of Future Events

Given the data available, a potential recurrence interval or probability is not able to be calculated.

Impact Summary

Primary Impacts

The primary impact of utility failure or interruption is a loss of services for the service area population, but the specific impacts will depend on the type of utility that is affected. If it occurs during summer or winter months, power outages can elevate the risk for life-threatening health complications for people with underlying or pre-existing health conditions, as well as the elderly or young children. Utility disruptions can also compromise the safety of food and water for affected populations, elevating the risk of water- and food-borne illnesses.

Secondary Impacts

Disrupted utilities can affect the ability of businesses to conduct transactions or deliver services to customers, potentially risking revenues. Interruptions to utilities may also prevent individuals from traveling to school or work, leading to reduced productivity.

Vulnerability Assessment

The vulnerability of utilities will depend on the degree to which the system has been maintained over its lifespan, whether any mitigation projects have been implemented, and, if relevant, the severity of the hazard event (i.e., thunderstorm or tropical cyclone) that triggered it to fail or be disrupted.

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[60] "Fatal blast is Con Ed's fault". Newsday AM New York. p. 4. Clogged valves caused by repairs to a leaky joint apparently led to a fatal midtown steam pipe explosion.

[61] Barron, James. "The Blackout of 2003: The Overview." The New York Times, 15 August 2003. http://query.nytimes.com/gst/fullpage.html?res=9804E5D81730F936A2575BC0A9659C8B63&sec=health&spon=&pagewanted=1

CHAPTER 4. CAPABILITY ASSESSMENT

A capability assessment evaluates the existing programs and resources in order to determine the extent of mitigation activities that are already in place and helps to emphasize the potential for new strategies. Through a thorough review of Mount Saint Mary's University financial resources, personnel expertise, and existing mitigation activities, planners can reach a better understanding of factors that may influence the University's ability to implement mitigation actions that address the effects of the hazards identified in Section 3. This assessment includes a comprehensive assessment of:

- Administrative Capabilities
- Plan and Program Capabilities
- Fiscal Capabilities
- Regulatory Environment
- Community Interaction

Administrative Capabilities

Faculty, administrative offices, staff, academic departments and students contain a wealth of physical and metaphysical resources that contribute to the overall functioning, safety, and security of the University. This section attempts to identify those pre-existing resources that may assist in bettering the mitigation strategy.

Administrative Organization

The staff/technical capabilities have been identified as part of the Mount St. Mary's CPT capability assessment questionnaire. Personnel capabilities include:

- Emergency management
- Engineers or professionals trained in construction practices related to buildings and/or
- Infrastructure (consultants)
- Engineers with an understanding of natural and/or human-caused hazards (consultants)
- Planners with an understanding of natural and/or human-caused hazards
- Planners with knowledge of land development and land management practices
- Resource development staff or grant writers
- Scientists familiar with the hazards of the community

Police Department/Public Safety

The Department of Public Safety at Mount St. Mary's University is a service-oriented, law enforcement, problem-solving, crisis response organization. Its primary purpose is to provide a safe, secure and orderly environment in which teaching, learning and administrative operations of the university can excel.

The Mount St. Mary's University Department of Public Safety is a 24-hour a day, full-service campus safety and security organization. The Department provides for on-campus safety and security of persons and security of all buildings and property. The Public Safety building also serves as a Campus Information Center and is located at the intersection of Old Emmitsburg Road and Annandale Road, near the main entrance to the Emmitsburg campus from U.S. Route 15.

Public safety officers are trained in campus safety and security procedures. Some officers are certified Emergency Medical Technicians (EMTs). Select officers may exercise police powers on campus in emergencies and special situations. Public Safety officers work closely with local law enforcement officials in maintaining order on campus. All members of the campus community are urged to report violations of the law and/or University policies and regulations to the Department of Public Safety. Confidentiality will be observed whenever possible.

The Mount St. Mary's University campuses are private property, and as such, all employees, students, guests and visitors are subject to the University's policies, regulations and ID requirements. They must identify themselves when asked to do so by Public Safety officers or authorized University officials. Failure to do so may result in removal from campus, banning from future campus access and/or criminal prosecution. Visitors and guests are permitted only in those areas authorized for their use or visits and not in private offices, residences or posted areas.

There are twenty-three (23) emergency blue light telephones on the Emmitsburg campus that may be used to contact Public Safety if assistance is needed. When the receiver is lifted, a dispatcher is automatically notified of the location of the call. All campus members are encouraged to learn where these emergency phones are and use them when necessary. During hours of darkness Public Safety also provides a safety escort service to and from on-campus locations.

Academic Organization

Mount St. Mary's administers over 49 majors and 35 minors. With more than 500 employees including faculty and support personnel within the Mount St. Mary's community command expertise in subject matters that may hold potential in assisting the development and implementation of a Hazard Mitigation Plan. In Table 4.1 below, departments have been selected as potential resources.

Table 4.1. Academic Programs with Potential for Hazard Subject Matter Expertise

Academic Programs	
Business	Sociology/Criminal Justice
Communication	Computer Science
Criminal Justice	Conflict, Peace, and Social Justice
Economics	Cyber Security
Environmental Science	Information Systems

Plan and Program Capability

The University has invested significantly in its emergency planning and preparedness programs. These programs have contributed to the wellbeing of community residents, employees and visitors, as well as enhancing the ability of the University to respond to major events.

University Plans and Programs

Tables 4.2 and 4.3 describe the various plans that the University and local community have in place and provide recommendations, where appropriate, for integration with the hazard mitigation plan. The Department of Public Safety is planning to conduct a review of the All-Hazards Emergency Plan in the near future, and the university is currently conducting a review of its campus-wide emergency response plan.

Table 4.2. Mount St. Mary' Planning Capabilities

Plan Name	Description	Integration Options
THE NEW PLAN for Mount Saint Mary's University- *Summary of 2014 Master Plan*	Summary of the guiding principles, campus priorities, and recommended actions.	*Recommendations:* Ensure Master Plan priorities and HMP recommendations are integrated.
Strategic Plan: Creating Ethical Leaders Who Lead Lives of Significance 2018-2023	Outlines the mission, vision, and priorities for Mount Saint Mary's University.	*Recommendations:* Align strategic priorities with hazard mitigation goals and objectives.
2015 Mount Saint Mary's University All-Hazards Emergency Plan (Rev. 2017)	Provide guidance for planning, prevention, response, and recovery for or in the event of an emergency incident on or near the Mount Saint Mary's University campuses.	*Recommendations:* Ensure Emergency Plan and HMP recommendations are integrated. Use results of 2021 HIRA to inform update/review/exercise.

Table 4.3. Local Plans and Programs

Plan Name	**Description**	**Integration Options**
Frederick County Hazard Mitigation and Climate Adaptation Plan 2022	The Frederick County Hazard Mitigation and Climate Adaptation Plan identifies goals and measures for hazard mitigation and risk reduction to better ensure that the participating communities are disaster resistant. The plan not only addresses current concerns but has also been developed to help guide and coordinate mitigation activities and local policy decisions for future land use. This plan follows FEMA's planning requirements and associated guidance for developing Local Hazard Mitigation Plans.	Recommendations: Continue coordination between college and county.
Frederick County Emergency Operations Plan	The basic plan describes the concept of emergency operations and assigns duties and responsibilities to agency heads or organizations which are either part of, or will serve in support of, local government in time of emergency. It becomes the organizational and legal basis for emergency operations.	Recommendations: Ensure the College participates in next update of the EOP.

	Functional annexes and hazard-specific appendices to the basic plan provide additional guidance and set forth detailed procedures as needed to assure an appropriate level of emergency preparedness.	

Fiscal Capability

Mount St. Mary's FY 2020-21 actual revenue was $71,074,985, with $1,250,600 for capital improvements and $744,604 for public safety. The University's main source of revenue comes from tuition and room and board (Table 4.4. Mount Saint Mary's University Fiscal Year 2020-21 Summary).

Table 4.4. Mount Saint Mary's University Fiscal Year 2020-21 Summary

Function	FY 2017/18 Actual	FY 2018/19 Actual	FY 2019/20 Actual**	FY 2020/21 Budget
Net Student Revenue	$56,135,812	$56,991,439	$50,869,338	$57,339,868
Other Revenue*	$13,352,109	$14,878,080	$13,860,156	$13,735,117
Total Operating Revenue	**$69,487,921**	**$71,869,519**	**$64,729,494**	**$71,074,985**

*Other Revenue= Contributions + Endowments + Investments + Government Grants & Contracts + Auxiliary sales

**Draft of Actual FY revenue

Mount St. Mary's University
Summary Financial Analysis
Actual with Current Year Budget

	FY 17/18 Actual	FY 18/19 Actual	Draft FY 19/20 Actual	FY 20/21 Budget
Operating revenue				
Tuition and fees	$ 74,671,542	$ 79,099,472	$ 81,075,646	$ 91,862,540
Room and board	17,950,279	18,778,184	13,836,143	19,428,036
Scholarship allowances	(36,486,009)	(40,886,217)	(44,042,451)	(53,950,707)
Net student revenue	**56,135,812**	**56,991,439**	**50,869,338**	**57,339,868**
Contributions	4,604,645	4,920,740	3,540,161	4,560,101
Government grants and contracts	2,643,534	3,067,676	4,174,083	3,937,388
Investment income	292,325	563,981	492,720	415,125
Endowment income	2,067,511	2,154,797	2,473,273	2,451,546
Other revenue	2,139,592	2,694,211	2,173,876	1,349,703
Sales and services of auxiliary enterprises	1,604,502	1,476,675	1,006,043	1,021,254
Other revenue	**13,352,109**	**14,878,080**	**13,860,156**	**13,735,117**
Total operating revenue	**69,487,921**	**71,869,519**	**64,729,494**	**71,074,985**

Figure 4-1. Mount St. Mary's Budget Snapshot

Maryland State Policies and Plans

Maryland State Hazard Mitigation Plan

Maryland State's most recent Standard Hazard Mitigation Plan was approved by FEMA in August 2016. Sections 1-5 and 1-6 outline the process to engage Maryland's 23 counties and 139 municipalities in hazard mitigation planning.

The Mitigation Strategy (Section 5) describes the process to create, and refine the state's mitigation goals, objectives, and actions. Table 4.5 outlines the goals and objectives within the plan relevant to MSM's mitigation plan.

Table 4.5. 2016 Maryland State Mitigation Goal and Objectives

Goal	To protect life, property, and the environment from hazard events through:
Objectives	Increased public awareness of hazards, mitigation, preparedness, and resiliency.
	Enhanced coordination with local jurisdictions and linkages between state and local mitigation and resiliency efforts.
	Protection of State assets, infrastructure, and critical facilities
	Promote actions that protect natural resources, while enhancing hazard mitigation and community resiliency.
	Efficient use of State resources

Actions were developed by five subcommittees which formed during topical break-out sessions during the meeting:

1. Programs, Policy, Planning and Funding
2. Mitigation of High Hazard Structures
3. Local Planning Interface
4. 2014 Vulnerability Analysis
5. Education and Outreach

Maryland's 2016 Standard Hazard Mitigation Plan further identifies the criteria used in prioritizing mitigation actions. The MSM mitigation strategy development process will take these criteria – as well as the State's goals and objectives – under consideration when identifying its own goals, objectives and strategies for MSM.

State of Maryland Response Operations Plan (SROP) - March 2015

The Maryland State Response Operations Plan (SROP) describes the roles and responsibilities of entities within Maryland during incident response operations. Response operations focuses on ensuring that the State is able to effectively respond to any threat or hazard, including those with cascading effects, in order to save and sustain lives, protect property and the environment, stabilize the incident, rapidly meet basic human needs, and restore essential community services and functionality.[62]

The objectives of the SROP include:

- Maintain 24/7 situational awareness across the State of Maryland, the nation, and around the world.
- Coordinate the activities of State, local, Federal agencies, nonprofit organizations, and private-sector partners in support of incident response.
- Facilitate the transition from incident response to disaster recovery.

The SROP addresses the risks identified in the State's annual Threat and Hazard Identification and Risk Assessment (THIRA), and triennial Hazard Identification and Risk Assessment (HIRA).

Regulatory Environment

State

Uniform Statewide Building Code

Maryland's law related to building codes is called the Maryland Building Performance Standards (MBPS). It requires each jurisdiction in Maryland to use the same edition of the same building codes that are the International Building Code (IBC), the International Residential Code (IRC), and the International Energy Conservation Code (IECC). The State has modified the IBC and the IRC to coincide with other Maryland laws. The International Building Code (IBC), the International Residential Code (IRC), and the International Energy Conservation Code (IECC), with modifications by the State constitute the Maryland Building Performance Standards (MBPS).

Each local jurisdiction in Maryland may modify these codes to suite local conditions with exception to the 2021 International Energy Conservation Code (IECC - The Energy Code) and Maryland Accessibility Code (MAC - The Accessibility Code). The Energy Code and the Accessibility Code can be made more stringent but not less by the local jurisdictions.

Maryland building performance standards are based on the 2021 I-codes. Effective May 2011, Maryland became the first state to legislatively adopt ICC.[63] This includes:

- 2021 International Building Code
- 2021 International Energy Conservation Code
- 2018 International Green Construction Code
- 2021 International Mechanical Code
- 2018 International Plumbing Code
- 2018 International Residential Code

In addition, Frederick County has jurisdictionally adopted:

- 2021 International Building Code

[62] Maryland State Response Operations Plan (SROP). Retrieved from https://mdem.maryland.gov/Documents/SROP_V3_03_MAR-15.pdf

[63] International Code Council. State Adoptions. http://www.iccsafe.org/about-icc/government-relations/map/maryland/

- 2021 International Energy Conservation Code
- 2021 International Fuel Gas Code
- 2021 International Mechanical Code
- 2018 International Plumbing Code
- 2021 International Residential Code

Establishing Preparedness Initiatives in State Government

Governor Martin O'Malley issued Executive Order 01.01.2013.06 on October 29, 2013 to adopt the Maryland's Emergency Preparedness Program (MEPP) [64]. The order outlines the roles and responsibilities related to the four mission areas used for measuring preparedness — prevention and protection, hazard mitigation, incident response and disaster recovery. Maryland Emergency Management Agency (MEMA), Maryland State Police, and other state agencies are charged with fulfilling the activities that support those four core mission areas. The executive order requires that state agencies develop or maintain documents necessary to support MEPP, at a minimum Continuity of Operations Plans that are updated bi-annually.

[64] Maryland State Executive Order 01.01.2013.06
http://mema.maryland.gov/Documents/MEPP_01.01.2013.06eo.pdf

CHAPTER 5. MITIGATION STRATEGY

This chapter presents a series of goals and objectives to help Mount Saint Mary's University identify and select mitigation and adaptation actions to address its vulnerabilities, as discussed in Chapter 3. The selected mitigation actions will help the University avoid, prevent, or otherwise reduce damages from hazards.

Mitigation Goals and Objectives

Definitions

Goals: general guidelines that explain what you want to achieve; usually broad, long-term policy statements representing global visions.

Objectives: define strategies or implementation steps to attain the identified goals; specific and measurable.

Frederick County's HMPC, which included MSM representation, met October 14, 2021 to discuss goals and objectives for the mitigation plan. At this meeting, members discussed the results of the Hazard Identification and Risk Assessment, which identified vulnerabilities in the context of the capability assessment, prior to establishing the revised mitigation goals.

The MSM CPT reviewed the mitigation goals from the main Frederick County Hazard Mitigation and Climate Adaptation Plan and adapted them to better align with the University's specific needs and vision. The adapted goals and objectives for MSM are outlined in Table 5.1.

Table 5.1. Goals and Objectives

Mitigation Category	Goal	Objective
Physical Projects	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation projects that efficiently and equitably reduce risk and consider future hazard conditions.	Objective 1: Identify opportunities and implement projects to mitigate damage or improve the resilience of existing structures from hazards.
		Objective 2: Increase the percentage of critical equipment and property that is protected from hazards (e.g., data storage, paperwork, lab equipment, hazardous materials).
		Objective 3: Increase the safety of students, staff, and faculty traveling between the main and east campuses.

Mitigation Category	Goal	Objective
Capability and Capacity Building 	Goal B: Enhance the capability and capacity of Mount Saint Mary's University to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.	Objective 4: Support data collection, studies, plans, and mapping efforts to improve the University's ability to respond to and prepare for future hazards.
		Objective 5: Advance hazard mitigation and forward-thinking risk-related training and development.
		Objective 6: Ensure students, faculty, staff, and visitors can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Awareness and Education 	Goal C: Improve the community's awareness of potential hazards, education on resilience planning, and methods to reduce risk.	Objective 7: Use public information and education programs to support community members' decision-making on how to protect themselves from hazard events.
		Objective 8: Increase the public's awareness of their natural hazard risks.
		Objective 9: Increase students, staff, and faculty awareness of cyberterrorism threats to reduce the University's vulnerability to future attacks.
Forward-Looking Policy and Planning 	Goal D: Adapt to future hazard conditions through forward-looking policies and plans.	Objective 10: Integrate hazard mitigation, future hazard and risk information, and resilience planning into other college planning efforts.
		Objective 11: Implement plans and policies that encourage future—or significantly renovated—infrastructure to be made resilient to future climate impacts.

Identification of Mitigation Actions

At the December 2, 2021 meeting, the MSM CPT was provided with an overview of the types of mitigation actions that could be undertaken. The committee then was provided a range of potential mitigation actions specific to the MSM's vulnerabilities and capabilities, which included the mitigation projects previously proposed by the University. Information from the Mount St. Mary's Master Plan and Strategic Plan was also used to inform the discussion. The team members reviewed the list and refined it further based on their knowledge of the university. These actions were evaluated in 2021, and an update was given. Some are completed, some are in progress, and some are ongoing.

Prioritizing Actions

The MSM CPT used the STAPLE/E (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) criteria to select and prioritize the most appropriate mitigation and adaptation alternatives (see Table 5.2). This methodology requires that social, technical, administrative, political, legal, economic, and environmental considerations be taken into account when reviewing potential actions for the University's to undertake. This process was used to help ensure that the most equitable and feasible actions would be undertaken based on the University's capabilities.

Table 5.2. STAPLE/E Selection and Prioritization Criteria for Alternatives

STAPLE/E	Considerations
Social	• Is the proposed action socially acceptable to the college? • Are there equity issues involved that would mean that one segment of the community is treated unfairly? • Will the action cause social disruption?
Technical	• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of the college's other goals?
Administrative	• Can the college implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
Political	• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
Legal	• Is the college authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? • Are there legal side effects? Could the activity be construed as a taking? • Will the college be liable for action or lack of action? • Will the activity be challenged?
Economic	• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account?

STAPLE/E	Considerations
	• Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the college? • What are the budget and revenue effects of this activity? • Does the action contribute to other college goals? • What benefits will the action provide?
Environmental	• How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and state regulatory requirements? • Are endangered or threatened species likely to be affected?

A priority level of high, medium, or low was assigned to each action based on the STAPLE/E assessment. This prioritization method was selected because the HMPC and MSM CPT believed it would foster a realistic expectation of what could be accomplished in the next five years. The prioritization process has been significantly enhanced compared to the 2016 method which mainly focused on funding availability to assign priority rankings.

2022 Mitigation Action Plans

The following tables detail the in progress and ongoing mitigation actions selected by the University, as well as the new mitigation actions included in the 2022 Plan. Only the actions with a HMCAP priority of "high" have been developed into full action plans.

Key for Action Header Colors:

Action Carried Over from 2016 Plan	Action Added During 2022 Plan Update

Action MSM-1	
Description of Action	Update Emergency Operations Plan and ensure it addresses mitigation.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Mount Saint Mary's University to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 6: Ensure students, faculty, staff, and visitors can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	High

Action MSM-1	
Responsible Party	Department of Public Safety
Estimated Cost	Staff time
Possible Funding Source(s)	Existing budget
Timeline for Implementation	30 days
Status since 2016	Completed in 2017. Currently repeating the process.

Action MSM-2	
Description of Action	Update building evacuation plans.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Mount Saint Mary's University to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 6: Ensure students, faculty, staff, and visitors can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	Medium
Responsible Party	Department of Public Safety

Action MSM-3	
Description of Action	Obtain generator for Powell Hall (residence hall). Consider installing quick connects at The Cottages (residence halls).
Applicable Goal(s)	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation projects that efficiently and equitably reduce risk and consider future hazard conditions.
Applicable Objective(s)	Objective 2: Increase the percentage of critical equipment and property that is protected from hazards (e.g., data storage, paperwork, lab equipment, hazardous materials).
Relevant Hazard(s)	Utilities Failure or Interruption

Action MSM-3	
HMCAP Priority	Medium
Responsible Party	Physical Plant - Maintenance

Action MSM-4	
Description of Action	Identify and assess all critical locations to determine if a portable generator is needed. Acquire and install portable generators at all locations determined to need them.
Applicable Goal(s)	Goal A: Protect infrastructure, human health, and the campus environment by implementing physical hazard mitigation projects that efficiently and equitably reduce risk and consider future hazard conditions.
Applicable Objective(s)	Objective 2: Increase the percentage of critical equipment and property that is protected from hazards (e.g., data storage, paperwork, lab equipment, hazardous materials).
Relevant Hazard(s)	Utilities Failure or Interruption
HMCAP Priority	Medium
Responsible Party	Department of Public Safety; Physical Plant - Maintenance

Action MSM-5	
Description of Action	Study and identify flood risk on campus. Floodproof campus buildings that are at risk of floodwaters coming off the mountain.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Mount Saint Mary's University to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.
Applicable Objective(s)	Objective 6: Ensure students, faculty, staff, and visitors can safely evacuate or shelter in the event of hazards or emergencies to reduce the potential for adverse impacts.
Relevant Hazard(s)	Flood
HMCAP Priority	High
Responsible Party	Department of Public Safety; Physical Plant - Maintenance

Action MSM-5	
Estimated Cost	TBD.
Possible Funding Source(s)	Existing budget, FEMA mitigation grant
Timeline for Implementation	1 year

Action MSM-6	
Description of Action	Create a public / student education program about the impacts of all campus hazards. Make available to instructors for inclusion in classroom training and post to the University website and social media platform(s).
Applicable Goal(s)	Goal C: Improve the community's awareness of potential hazards, education on resilience planning, and methods to reduce risk.
Applicable Objective(s)	Objective 7: Use public information and education programs to support community members' decision-making on how to protect themselves from hazard events. Objective 8: Increase the public's awareness of their natural hazard risks.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	High
Responsible Party	Department of Public Safety; Environmental Health and Safety Manager
Estimated Cost	Staff time
Possible Funding Source(s)	Existing budget
Timeline for Implementation	Six months

Action MSM-7	
Description of Action	Establish a central location for all Geographic Information System (GIS) files to be stored. Prioritize GIS data to be acquired, and a system for keeping that data up to date. Digitize and organize all maps of campus and historic building plans and specifications.
Applicable Goal(s)	Goal B: Enhance the capability and capacity of Mount Saint Mary's University to identify vulnerabilities and risks, integrate risk reduction strategies, and implement resilience projects.

Action MSM-7	
Applicable Objective(s)	Objective 4: Support data collection, studies, plans, and mapping efforts to improve the University's ability to respond to and prepare for future hazards.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	Low
Responsible Party	Department of Public Safety; Department of Information Technology

CHAPTER 6. IMPLEMENTATION AND MAINTENANCE

The long-term success of the Mount Saint Mary's University Mitigation Plan Annex depends on its success in implementing the plan and in establishing a process to ensure that the plan is current and continues to provide value to the University.

The Frederick County Hazard Mitigation and Climate Adaptation Plan is intended to serve as Frederick County's road map for evaluating hazards, identifying resources and capabilities, selecting appropriate actions, and developing and implementing mitigation measures to eliminate or reduce future damage from those hazards in order to protect the health, safety, and welfare of the residents in the community. This annex identifies procedures for keeping this annex current and updated at least once every 5 years, as prescribed by the DMA2K.

Plan Implementation

Responsibility for the overall implementation and maintenance of the University Hazard Mitigation Plan rests primarily with the members of the CPT. The Frederick County Director of Emergency Preparedness will work with the committee to ensure the implementation and maintenance of the plan.

For all mitigation actions, an appropriate University department(s) has been identified that will have primary responsibility for implementation of that particular action. The CPT, in concert with the primary responsible department, has established measures of success and potential funding sources for each high priority hazard mitigation action. The measures of success will be used to gauge how well the plan is being implemented and whether the actions are achieving their intended purpose; while the other criteria create a level of responsibility and accountability for each of the mitigation actions.

Beyond these initial measures of success, additional implementation needs and measures will be the responsibility of the primary responsible department, MSM Director of Public Safety and ultimately the members of the CPT. This may include any meetings with local officials, integration measures with other planning documents, identifying additional funding sources, etc.

Just as important as the mitigation actions themselves, is the development of a risk averse culture. The members of the CPT will continue to ensure that the goals and strategies of new and updated planning documents are consistent with the goals and actions of this plan, and that new projects throughout the University consider potential risks and are designed in such a way as to avoid them. Risk reduction principles identified in this plan should be carefully considered when developing new goals and actions of other University planning documents and projects.

Monitoring, Evaluating, and Updating the Plan

Plan maintenance requires an ongoing effort to monitor and evaluate the implementation of the plan, and to update the plan as progress, roadblocks, or changing circumstances are recognized. The Mount St. Mary's CPT will be responsible for monitoring and updating the plan and the HMPC will play an advisory role available for oversight. The team should accomplish the following:

- Annual progress reports from departments designated as "Primary Department" in the mitigation action plan,

- An annual review of these progress reports and the overall plan by the CPT, and sending a report to the County Director of Emergency Preparedness, and
- A 5-year written update to be submitted to the state and FEMA Region III, unless a disaster or other circumstances (e.g., change in regulations) leads to a different time frame.

The timing of the yearly reviews should coincide with either the anniversary of the approval date of this plan or another date chosen by the committee. Re-prioritization of projects may be needed as high priority mitigation actions are completed.

As described above, the Mount St. Mary's CPT and primary responsible departments for each project will be responsible for evaluating progress in implementing mitigation projects. The Mount St. Mary's CPT, along with the Department of Emergency Preparedness, during its annual review, also may identify corrective actions for projects. In addition, the Mount St. Mary's CPT should review its organizational composition annually and adjust membership, if needed.

The Mount St. Mary's CPT, in conjunction with the Department of Emergency Preparedness will determine at its annual meeting if a formal update of the plan is required. At a minimum, the plan will be updated every five years. Factors to consider when determining if an update is necessary include:

- Decreased vulnerability as a result of implementing recommended actions;
- Increased vulnerability as a result of failed or ineffective mitigation actions;
- Increased vulnerability as a result of new development;
- New state/federal laws, policies, or programs;
- Changes in resource availability; and/or
- Applicability of goals/objectives/strategies.

A major event, such as a presidentially declared disaster, may trigger a need to review the plan. If such an event affects Frederick County, the Department of Emergency Preparedness, and the Mount St. Mary's CPT will coordinate to determine how best to review and update the plan. Major changes to the plan will be submitted to the state and to FEMA Region III.

Public Involvement

Public notice of the annual review will be given, and public participation will be invited. At a minimum, notification will be through web postings and press releases to local media outlets, primarily newspapers. In addition, an annual event will be held to publicize progress on implementing the mitigation plan. This event could be timed to coincide with the anniversary of a significant event or annual awareness event (e.g., Hurricane Preparedness Week). The county will also post a link to the mitigation plan on the Department of Emergency Preparedness's website. It is recommended that the University's website serve as a means of communication by providing information about mitigation initiatives and updates to the projects and the plan itself. The CPT also should provide an annual update to the University's Board of Visitors to keep them informed about plan implementation.

APPENDICES

Appendix A: 2016 Mitigation Action Plans

The following tables detail the mitigation actions selected by the University in 2016 and their status as of 2022.

Action	MSM-1
Description of Action	Update Emergency Operations Plan and ensure it addresses mitigation.
Applicable Goal(s)	J
Applicable Objective(s)	Increase university's ability to quickly respond, recover and mitigate against hazard events.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	High
Responsible Party	Department of Public Safety
Estimated Cost	Staff time
Possible Funding Source(s)	Existing budget
Timeline for Implementation	30 days
Status since 2016	Completed in 2017. Currently repeating the process. Carried over to 2022 plan annex.

Action	MSM-2
Description of Action	Develop formal sheltering plans including shelter-in-place.
Applicable Goal(s)	H
Applicable Objective(s)	Be able to safely shelter students for up to 48 hours.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	High
Responsible Party	Director of Public Safety
Estimated Cost	Staff time

Action	**MSM-2**
Possible Funding Source(s)	Existing budget
Timeline for Implementation	30 days
Status since 2016	Partially completed within the "All Hazards Emergency Response Plan"

Action	**MSM-3**
Description of Action	Consider developing an MOU with the American Red Cross to address sheltering.
Applicable Goal(s)	H
Applicable Objective(s)	Enhance capability of university to shelter students on-site.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	High
Responsible Party	Director of Public Safety
Estimated Cost	Staff time
Possible Funding Source(s)	Existing budget
Timeline for Implementation	60 days
Status since 2016	Not completed

Action	**MSM-4**
Description of Action	Complete retrofitting of residence halls with modernized fire suppression systems. Mount Saint Mary's University initiative is to modernize all of its residential Halls as soon as funding is available. The last moderation was to the Terrace (100,000 square feet)) which was completed in 2011, at a cost of 20 million dollars. Pangborn and Sheridan Halls are next for modernization which will require a total retrofit and renovation of the entire envelope of these facilities. This is a priority on Major Capital Projects and the University Executive and Administrative Committee's will continue to strive to develop a strategy for funding to complete these projects.

Action	MSM-4
Applicable Goal(s)	J
Applicable Objective(s)	Protect life safety.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	High
Responsible Party	Facilities Services and Project Management
Estimated Cost	TBD
Possible Funding Source(s)	Capital Improvement Budget
Timeline for Implementation	5 years
Status since 2016	Not completed

Action	MSM-5
Description of Action	Consider hazard risk factors when selecting new building sites or in designing new/rehabilitated buildings.
Applicable Goal(s)	J
Applicable Objective(s)	Enhance the university's resilience to future hazard events.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	Low
Responsible Party	Facilities Services and Project Management
Estimated Cost	Staff time
Possible Funding Source(s)	Existing budget
Timeline for Implementation	5 years
Status since 2016	In progress/on-going; new buildings between 2016-present have been built to code

Action	**MSM-6**
Description of Action	Update building evacuation plans
Applicable Goal(s)	J
Applicable Objective(s)	Protect life safety.
Relevant Hazard(s)	Facilities Services and Project Management
HMCAP Priority	Staff time
Responsible Party	Existing budget
Estimated Cost	1 year
Possible Funding Source(s)	Medium
Timeline for Implementation	In progress for all buildings; evacuation plans are in all dorm rooms
Status since 2016	Update building evacuation plans

Action	**MSM-7**
Description of Action	Implement active shooter policy, conduct awareness training for staff and students and conduct tabletop exercise
Applicable Goal(s)	J
Applicable Objective(s)	Protect life safety.
Relevant Hazard(s)	Workplace or School Violence
HMCAP Priority	High
Responsible Party	Director of Public Safety
Estimated Cost	Staff time
Possible Funding Source(s)	Existing budget
Timeline for Implementation	30 days
Status since 2016	Completed/on-going; moved to capability (at least annually)

Action	MSM-8
Description of Action	Include information on hazards preparedness and mitigation in annual student/parent orientation presentation.
Applicable Goal(s)	A
Applicable Objective(s)	Use public information and education programs to advise students on how to protect themselves from hazard events.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	Medium
Responsible Party	Director of Public Safety
Estimated Cost	Staff time
Possible Funding Source(s)	Existing budget
Timeline for Implementation	90 days
Status since 2016	Completed/on-going; moved to capability (at least annually)

Action	MSM-9
Description of Action	Obtain generator for Powell Hall (residence hall). Consider installing quick connects at The Cottages (residence halls).
Applicable Goal(s)	K
Applicable Objective(s)	Ensure capability for continuity of service and building use.
Relevant Hazard(s)	Utility Failure or Interruption
HMCAP Priority	Medium
Responsible Party	Facilities Services and Project Management
Estimated Cost	TBD
Possible Funding Source(s)	FEMA mitigation grant
Timeline for Implementation	1 year
Status since 2016	None

Action	**MSM-10**
Description of Action	Consider identifying a formal location for a university Emergency Operations Center.
Applicable Goal(s)	J
Applicable Objective(s)	Increase university's ability to quickly respond, recover and mitigate against hazard events.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	High
Responsible Party	Director of Public Safety
Estimated Cost	Staff time
Possible Funding Source(s)	Existing budget
Timeline for Implementation	90 days
Status since 2016	Awarded State grant funding – currently moving forward with equipment acquisition, facility upgrades and implementation.

Action	**MSM-11**
Description of Action	Conduct annual evaluation of trees on campus to ensure they are not at risk and implement trimming as needed.
Applicable Goal(s)	J
Applicable Objective(s)	Reduce likelihood trees could create secondary hazard (e.g., debris creation, fall hazard)
Relevant Hazard(s)	Thunderstorms, Tropical Cyclones
HMCAP Priority	Medium
Responsible Party	Facilities Services and Project Management
Estimated Cost	Staff time
Possible Funding Source(s)	Existing budget
Timeline for Implementation	Annually

Action	**MSM-11**
Status since 2016	In process / ongoing; moved to capability (at least annually)

Action	**MSM-12**
Description of Action	Develop a continuity of operations plan.
Applicable Goal(s)	J
Applicable Objective(s)	Increase university's ability to remain open or quickly re-open if affected by a hazard event.
Relevant Hazard(s)	Multiple Hazards
HMCAP Priority	Medium
Responsible Party	Director of Public Safety
Estimated Cost	Staff time
Possible Funding Source(s)	Existing budget
Timeline for Implementation	90 days
Status since 2016	Completed; exists within the All Hazards Emergency Response Plan.