County Council Of Howard County, Maryland

2019 Legislative Session

Legislative Day No. 1

Resolution No. 6 -2019

Introduced by: The Chairperson at the request of the County Executive

A RESOLUTION adopting the Howard County Natural Hazards Mitigation Plan.

Introduced and read first time January 7, 2019.

By order
Jessica Feldmark, Administrator

Read for a second time at a public hearing on January 22, 2019.

By order
Jessica Feldmark, Administrator

This Resolution was read the third time and was Adopted ✓, Adopted with amendments___, Failed___, Withdrawn___, by the County Council on January 22, 2019.

Certified By
Jessica Feldmark, Administrator

NOTE: [[text in brackets]] indicates deletions from existing law; TEXT IN SMALL CAPITALS indicates additions to existing law; ~~Strike-out~~ indicates material deleted by amendment; Underlining indicates material added by amendment

WHEREAS, the County Council of Howard County, Maryland, recognizes that natural hazards are common occurrences throughout the region and cause significant property damage and loss of life; and

WHEREAS, by passage of County Council Resolution No. 112-2004, the County took proactive measures to reduce the impact of these hazards by adopting the first Natural Hazards Mitigation Plan (NHMP); and

WHEREAS, by passage of County Council Resolution No. 22-2013, the County adopted the second Natural Hazards Mitigation Plan (NHMP); and

WHEREAS, the County remains committed to the mitigation of natural hazards through the concerted efforts of Howard County departments, government partners, and community members; and

WHEREAS, OEM and the Natural Hazard Mitigation Update Steering Committee have updated the NHMP consistent with a federally mandated planning process; and

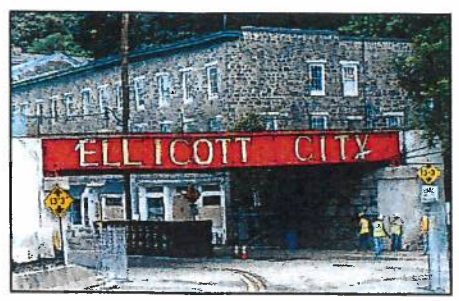
WHEREAS, the NHMP articulates a comprehensive strategy for implementing technically feasible mitigation activities for the area affected by natural hazards; and

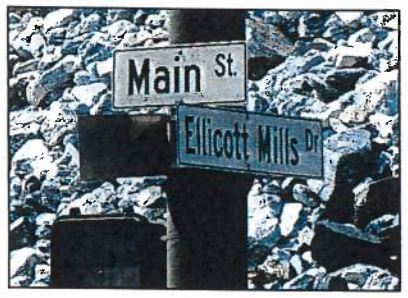
WHEREAS, adoption of the NHMP will make the County eligible for future Federal and State grants to implement the NHMP's recommendations, if and when funds become available; and

WHEREAS, the County Executive recommends that the NHMP be adopted by the County Council.

NOW, THEREFORE, BE IT RESOLVED by the County Council of Howard County, Maryland this ____ day of _____ 2019 that the effort to become more disaster resistant is deemed worthy of support, and that the Howard County Natural Hazards Mitigation

Plan prepared by the Howard County Office of Emergency Management, attached and incorporated by reference, is adopted.





2018 Hazard Mitigation Plan Update

Howard County, Maryland

VISION PLANNING & CONSULTING, LLC

October 1st, 2018

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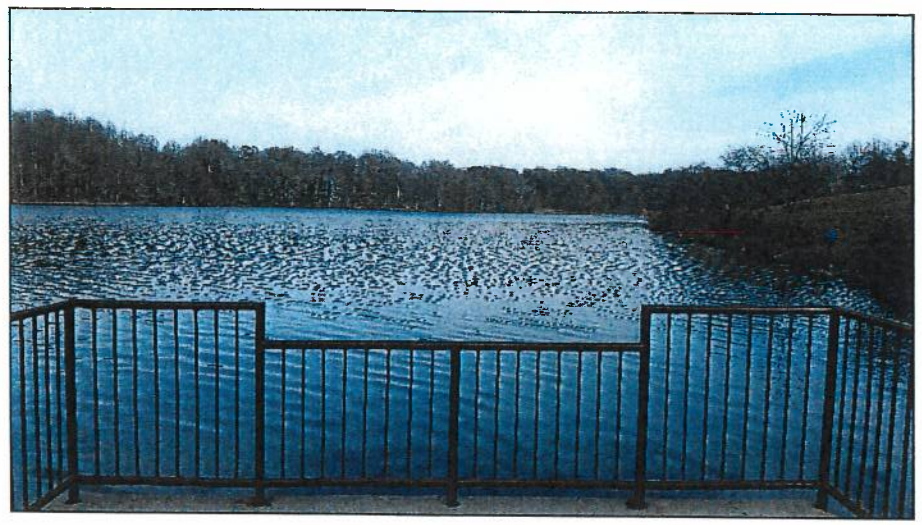
Hazard Mitigation Plan
Howard County, Maryland



October 1, 2018

Acknowledgements

This Hazard Mitigation Plan was prepared under the guidance of the Howard County Office of Emergency Management, and the Joint Steering Committee. The members of the Steering Committee are listed in Chapter 1.

Prepared For:
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LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: Howard County, MD	**Title of Plan:** Howard County All-Hazard Mitigation Plan	**Date of Plan:** October 1, 2018
Local Point of Contact: Mike Hinson		**Address:** Howard County Office of Emergency Management 3430 Courthouse Drive Ellicott City, MD 21043
Title: Senior Emergency Management Specialist		
Agency: Office of Emergency Management		
Phone Number: 410-313-6030		**E-Mail:** mhinson@howardcountymd.gov

State Reviewer:	Title:	Date:

FEMA Reviewer:	Title:	Date:
Date Received in FEMA Region *(insert #)*		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST Regulation (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Pg. 44 - Natural Hazards Mitigation Plan Update Process		
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Pg. 45 - Organize Resources		
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Pg. 47 – Public Participation and Appendix B and D		
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Pg. 122 – Plan Integration and Pg. 157 – Existing Plans, Policies, Programs, and Resources		
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Pg. 163 – Continued Public Involvement		
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Pg. 162 – Monitoring & Progress Reports and Pg. 162 – Circumstances to Initiate HMP Review and Updates		

1. REGULATION CHECKLIST Regulation (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT A: REQUIRED REVISIONS REQUIRED REVISION: REQUIRED REVISION: REQUIRED REVISION: Recommended Revision: Recommended Revision:			
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Pg. 49 – Hazard Identification and Profiling		
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Pg. 49 – Hazard Identification and Profiling and Pg. 103 Vulnerability Assessment and Loss Estimation		
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Pg. 49 – Hazard Identification and Profiling and Pg. 103 Vulnerability Assessment and Loss Estimation		
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Pg. 112 – Residential Repetitive and Severe Repetitive Loss Properties		

1. REGULATION CHECKLIST Regulation (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT B: REQUIRED REVISIONS REQUIRED REVISION:			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Pg. 121 – Capability Assessment and Pg. 157 – Existing Plans, Policies, Programs, and Resources		
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Pg. 138 – Continued Compliance with the National Flood Insurance Program (NFIP)		
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Pg. 133 – Mitigation Goals and Objectives		
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Pg. 140 – Mitigation Actions		
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Pg. 145 – Implementation Table and Pg. 141 – Evaluating Mitigation Actions for Cost-Effectiveness		
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Not Applicable – There are no municipalities in Howard County		

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT C: REQUIRED REVISIONS REQUIRED REVISION:			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Pg. 22 – Scope and Pg. 44 – Natural Hazards Mitigation Plan Update Process and Pg. 25 – Community Profile		
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Pg. 151 – Deleted, Combined, and Removed Actions		
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Pg. 134 – Howard County's Mitigation Goals and Objectives		
ELEMENT D: REQUIRED REVISIONS REQUIRED REVISION:			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	Pg. 164 – Plan Adoption		
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	Not Applicable – There are no municipalities in Howard County		
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			

1. REGULATION CHECKLIST Regulation (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to:

- *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);*
- *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);*
- *Diverse methods of participation (meetings, surveys, online, etc.); and*
- *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of:

1) *A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;*
2) *The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and*
3) *A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.*

How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:

- *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;*
- *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);*
- *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;*
- *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and*
- *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to:

- *Key problems identified in, and linkages to, the vulnerability assessment;*
- *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;*

- *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;*
- *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc);*
- *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;*
- *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and*
- *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to:

- *Status of previously recommended mitigation actions;*
- *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;*
- *Documentation of annual reviews and committee involvement;*
- *Identification of a lead person to take ownership of, and champion the Plan;*
- *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;*
- *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);*
- *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and*
- *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following:

- *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?*
- *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?*
- *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?*
- *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?*
- *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

CHAPTER 1: INTRODUCTION

1.1 Introduction

This Chapter provides a general introduction to the 2018 Howard County Hazard Mitigation Plan (HMP) Update and is comprised of the following sections: Background, Mission, Purpose, Scope, Authority, and Organization.

1.2 Background

The Disaster Mitigation Act of 2000 (DMA2K) established a requirement that jurisdictions must develop and implement natural hazard mitigation plans in order to remain eligible for various Federal Emergency Management Agency (FEMA) grant programs.

Hazard Mitigation is defined by FEMA as "sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects". The hazard mitigation planning process involves the formulation of actions to reduce injuries, deaths, property damage, economic losses, and degradation of natural resources caused by natural and man-made disasters as well as a community's risk. Hazard mitigation is considered one of four phases in the emergency management cycle. The other phases, emergency preparedness, emergency response, and recovery and are defined below.

- Hazard mitigation activities involve actions that reduce or eliminate the probability of an occurrence or reduce the impact of a disaster. The goal of the mitigation phase is to make

communities more resistant to disasters and thereby decrease the need for a response. Mitigation occurs long before a disaster.

- Preparedness activities include planning and preparing for when a disaster strikes and includes response capability actions to ensure an effective and efficient use of resources and efforts to minimize damage. Preparedness occurs just before a disaster.
- Emergency response activities include providing emergency assistance to victims and minimizing property loss. The response phase begins during or immediately after the onset of a disaster.
- Recovery activities include short and long-term activities that help return individuals and communities to normalcy as soon as possible. Recovery actions involve clean-up efforts, temporary housing, and replacement of infrastructure. Recovery activities typically commence several days or weeks after a disaster and are long-term in nature.

1.3 Mission

The Howard County Hazard Mitigation Plan Steering Committee, through the 2018 HMP Update, seeks to develop practical planning solutions for the variety of hazards that pose a risk to Howard County

This all-hazards approach is a comprehensive and proactive planning process. It establishes a more efficient mobilization of resources that will ensure effective mitigation measures to protect life, property, and the environment in Howard County.

1.4 Purpose

The Howard County HMP was developed in accordance with the requirements of FEMA's Section 322 of the Disaster Mitigation Act of 2000. An essential aspect of comprehensive disaster mitigation planning is a thorough understanding of potential hazards, vulnerabilities, and risks. The purpose of the hazard vulnerability analysis is to determine; the extent to which natural hazards threaten Howard County; areas of the community that are at greatest risk; the significance of the threats; any facilities that occupy at-risk areas; and the effects hazards can have on critical facilities. This Plan Update seeks to reduce the County's human, social, environmental and economic loss from future disasters. In addition to the Mitigation Plan Update, the County has also chosen to develop a county-wide Hazard Identification and Risk Assessment (HIRA) which was conducted independently, in advance of the Hazard Mitigation Plan Update process.

1.5 Scope

In October 2017, the Howard County Department of Fire and Rescue Services, Office of Emergency Management contracted with the Vision Planning and Consulting Team, comprised of Vision Planning and Consulting (VPC), from Fulton, Maryland, to develop the 2018 Plan Update in compliance with the requirements of the Disaster Mitigation Act of 2000. This Hazard Mitigation Plan Update was funded by State Homeland Security Grant Program (SHSGP) funds from the Federal Emergency Management Agency (FEMA) and administered by the Maryland Emergency Management Agency (MEMA). The Plan Update covers Howard County and its communities.

This 2018 HMP Update continues the planning cycle begun with earlier incarnations of the plan. The Plan's goals and objectives will be revisited to ensure their continued relevance and efficacy; Mitigation actions from the previous plan will be evaluated to determine which have been

completed, which are pending, and which, if any, were deferred or cancelled; and new actions will be developed with the input and collaboration from the Joint Steering Committee (JSC), and a prioritization and implementation plan developed for all ongoing and new actions.

1.6 Authority

Authority for this Plan originates from the following federal sources:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C., Section 322, as amended
- Code of Federal Regulations (CFR), Title 44, Parts 201 and 206
- Disaster Mitigation Act of 2000, Public Law 106-390, as amended

Authority for this Plan originates from the following Maryland sources:

- Maryland State Hazard Mitigation Plan Update

The following FEMA guides and reference documents were used to prepare this document:

- FEMA. Local Mitigation Planning Tool and Guide. March 2012
- FEMA. Local Mitigation Planning Handbook. March 2013.

1.7 Organization

The 2018 HMP Update comprises eight chapters. Chapter 1 contains this introduction to the Plan Update. Chapter 2 includes a community profile discussion of the geographic, socio-economic and demographic characteristics of the county. Chapter 3 discusses the planning process. Chapter 4 comprises the hazard identification and risk assessment and examines vulnerability and the potential losses from the top priority hazards. Chapter 5 includes a historic profile of hazard types and associated losses as well as a vulnerability assessment, which analyzes the potential for future damages due to the hazards identified. Chapter 6 contains a capability assessment, including a review of existing plans and ordinances from the counties and municipalities. Chapter 7 discusses the mitigation strategy including updated mitigation goals and objectives, mitigation actions, and the method for prioritization and implementation of mitigation actions. Chapter 8 outlines how Howard County will implement the Plan once it is adopted and ways to monitor its progress and ensure continued public involvement. The final chapter (Chapter 8) also includes letters of adoption by the County Council.

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CHAPTER 2: COMMUNITY PROFILE

2.1 Introduction

Prior to addressing the hazards that the community faces, this updated Plan presents a brief overview of Howard County. Information on the County's geographic layout, climate, demographic makeup, and employment and industry profile are included below. The data used to develop the demographic, and housing profiles comes directly from the US Census Bureau's 2015 estimates.

2.2 Geography

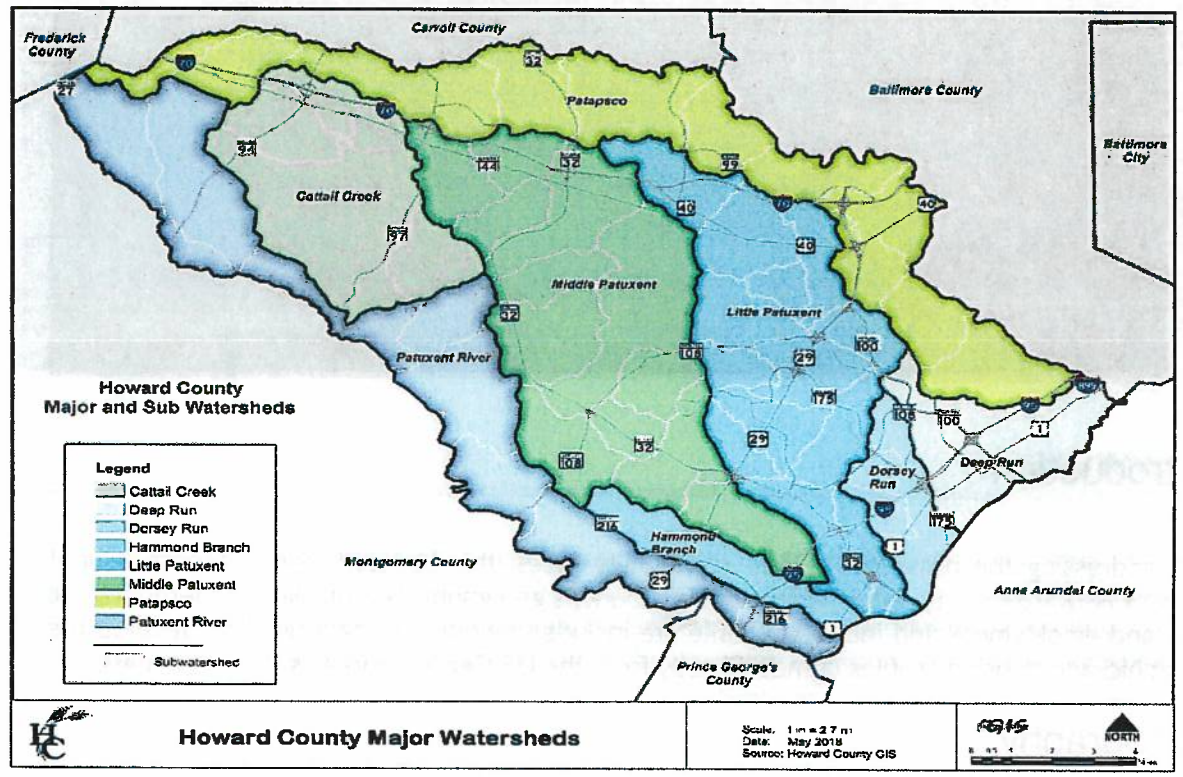
Howard County is located in the central part of Maryland between two major metropolitan areas. The City of Baltimore is roughly fifteen miles to the north/northeast, and Washington, DC is located approximately thirty miles to the south. The County has a land area of 251 square miles, making it Maryland's second smallest County in terms of land area.[1] Located on the Piedmont Plateau, the County can be characterized by gently rolling hills and agricultural land, particularly in western Howard County. The area is moderately to heavily vegetated with a mix of hardwoods, pines, and grasses.

[1] Howard County Economic Development Authority, *Climate & Geography*, available at http://www.hceda.org/why-howard-county/living/climate-geography/.

2.2.1 Watersheds

The County is bound by two major tributaries that flow into the Chesapeake Bay - the Patapsco River to the north and the Patuxent River to the south. Approximately three-quarters of Howard County lies within the Patuxent watershed, which includes the main Patuxent River and two branches, the Middle Patuxent and Little Patuxent. The remaining quarter of the County is within the Patapsco watershed (Figure 2.1). The Patapsco River serves as the political boundaries for Baltimore and Carroll Counties, while the Patuxent River separates Howard County from Montgomery and Prince George's County. Howard County shares a small portion of its western border with Frederick County and the eastern portion of the County is bounded by Anne Arundel County.

Figure 2.1 – Howard County Major Watersheds
(Source: Howard County Dept. of Planning and Zoning)



2.2.2 Physical Features

The average elevation in Howard County is 401 feet above sea level, with the highest point being 873 feet above sea level and the lowest being 20 feet above sea level, creating a relief in the County of 853 feet.[2] The rock formations found in the area are dominated by schist and gneiss rock formations. The Atlantic Seaboard Fall Line runs north to south along the Patapsco River, just west of Interstate 95. The land located east of the Fall Line can be characterized by the Coastal Plain, creating a much flatter topography than the land west of the Fall Line, known as the Piedmont Plateau.[3]

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[2] Maryland Department of Natural Resources, Maryland Geological Survey, *Highest and Lowest Elevations in Maryland's Counties*, available at http://www.mgs.md.gov/geology/highest_and_lowest_elevations.html.
[3] Maryland Department of Natural Resources, Maryland Geological Survey, *Maryland Geology*, available at http://www.mgs.md.gov/geology/.

2.2.3 Planning Zones and Communities

Howard County is part of the Baltimore-Columbia-Towson Metropolitan Statistical Area (MSA), which includes the City of Baltimore, Columbia, Towson, and six other Counties in addition to Howard County. Howard County is also part of the Baltimore-Washington-Northern Virginia Combined Statistical Area (CSA), one of the largest populous metropolitan areas in the United States. Figure 2.2 shows the boundaries of the Baltimore-Columbia-Towson MSA, and its location within the Baltimore-Washington-Northern Virginia CSA.

Figure 2.2 - Washington-Baltimore-Northern Virginia Combined Statistical Area
(Source: United States Census Bureau, 2005)

There are no incorporated municipalities in the County. The major population centers include: Columbia, Ellicott City, Elkridge, Savage, North Laurel and West Friendship. Developed in 1965 by James Rouse, Columbia is considered a popular example of the New Town Movement in the United States.[4] Columbia was designed to be a self-sustaining community and a model for future urban development. Rouse's plan introduced the village and neighborhood concept, plans for business and industry, recreation and open space and the Town Center.

In 2004, a master plan for Downtown Columbia was developed and approved which created the guidelines for the development of Downtown Columbia over the next 20 to 30 years, accounting for mixed-use development, residential units, retail, office space and hotel space.[5]

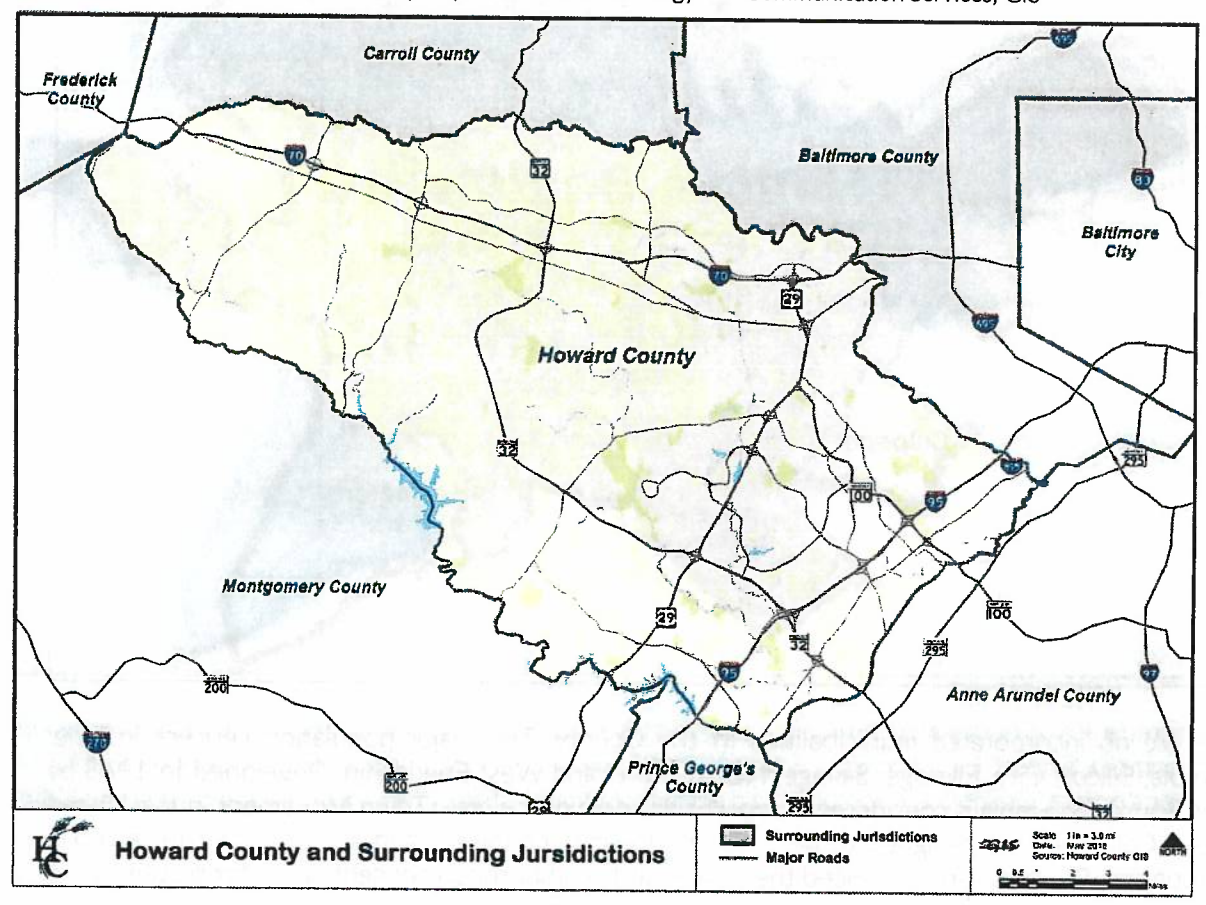
[4] Columbia Association, *History of Columbia*, available at https://www.columbiaassociation.org/facilities/columbia-archives/digital-resources/history-of-columbia/.
[5] Ibid.

Today, Columbia's population is estimated at 99,615 [6], and would be Maryland's second largest city if incorporated. [7]

Ellicott City, located in the northeastern part of the County, serves as the County Seat. Founded in 1772, Ellicott City is prone to flooding from the Patapsco River and surrounding tributaries, which has had a major impact on the history of the town.

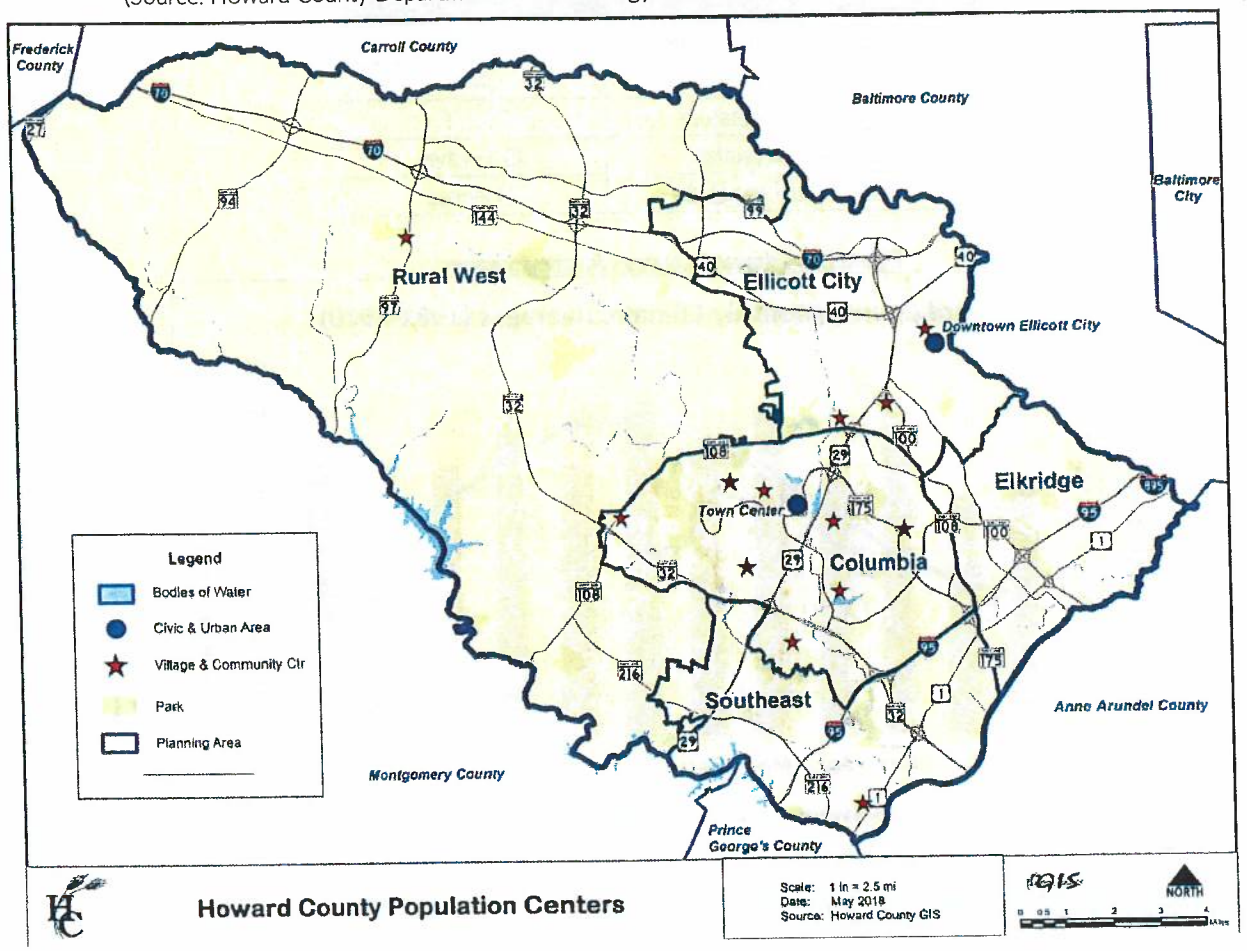
Figure 2.3 is a map of Howard County and the surrounding jurisdictions, while Figure 2.4 identifies population centers and planning areas throughout the County.

Figure 2.3 - Howard County and the Surrounding Jurisdictions
(Source: Howard County Department of Technology and Communication Services, GIS



[6] United States Census Bureau's *Quickfacts, Columbia CDP, Maryland*, available at https://www.census.gov/quickfacts/fact/table/columbiacdpmaryland/PST045217.
[7] Cubit Planning, Inc. 2018, *Maryland Cities by Population*, available at https://www.maryland-demographics.com/cities_by_population.

Figure 2.4 - Howard County Population Centers
(Source: Howard County Department of Technology and Communication Services, GIS Division)



2.2.4 Climate

Howard County's climate is temperate, with four distinct seasons, and characterized by warm, humid summers and moderate winters. The average annual temperatures and precipitation are based on a 30-year average from 1981 to 2010. The average temperature in July is 72.5 degrees, while the average in January is 33.9 degrees. [8] The average annual temperature is 55.5 degrees. Winter months are usually cold, just above freezing with moderate snowfall, with an annual average of 24 inches. [9] Every seventh year since 1995, the Baltimore area has experienced a seasonal snowfall of 58 inches or more. The average annual rainfall is 41.9 inches [10], with July being the wettest month.

Table 2.1 and Figure 2.5 summarizes the climate of Howard County.

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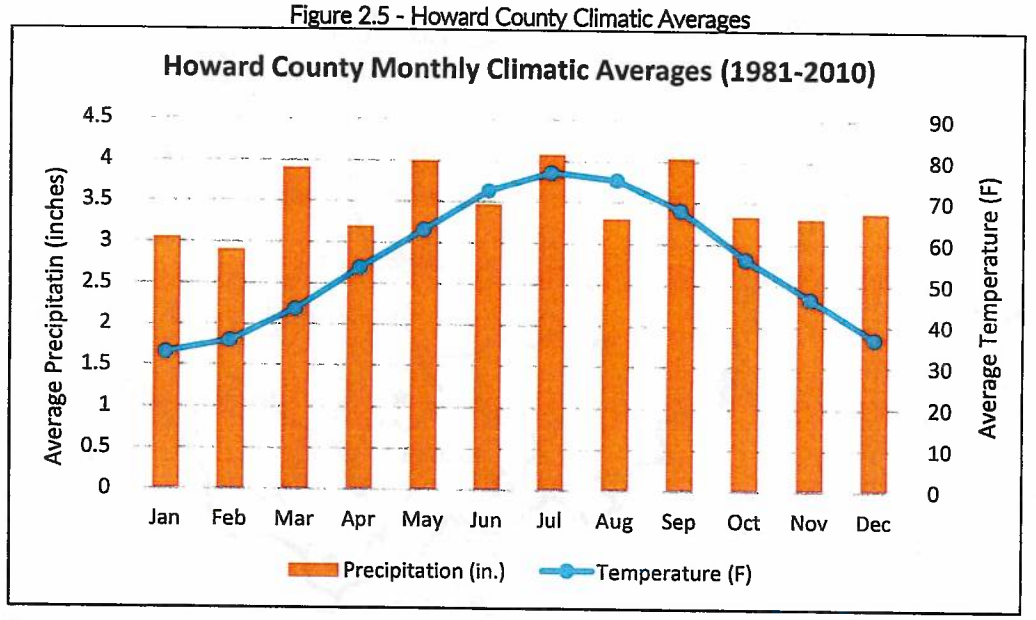
[8] NOAA National Centers for Environmental Information, *Supplemental Monthly Temperature Normals*, available at https://www.ncdc.noaa.gov/normalsPDFaccess/.
[9] Howard County Economic Development Authority, *Climate & Geography*, available at http://www.hceda.org/why-howard-county/living/climate-geography/.
[10] Ibid.

Table 2.1 - Howard County – Climate Statistics
Source: Maryland State Office of Climatology

Climate Category	Annual Average
Average annual temperature	55.5°F
Average January temperature	34 °F
Average July temperature	77.1 °F
Average annual rainfall	43.4 inches
Average annual snowfall	24 inches

Figure 2.5 - Howard County Climatic Averages



2.3 History of Howard County

Howard County played an important role not only in the development and progress of the State of Maryland, but also in the development of the Nation. Howard County's most prominent resident, Charles Carroll of Carrollton, was the only Roman Catholic signer of the Declaration of Independence. Howard County is named after John Eager Howard, a Revolutionary War hero and three-term governor of Maryland. The B & O Rail Terminal in Ellicott City was the first station along the Baltimore and Ohio Railroad.

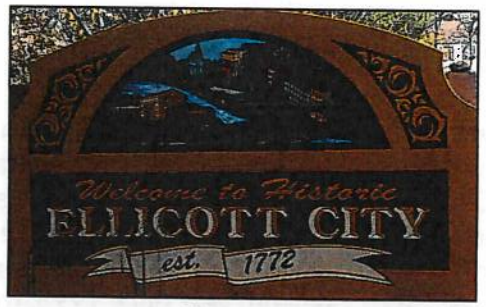


Photo 2.1 Historic Ellicott City Welcome Sign

Elkridge

Howard County's central location between Baltimore and Washington DC, and its abundant natural resources were both instrumental to the development of the County. Prior to the 1700's, settlement in the area was slow, until tobacco became a valuable export. The area now known as Elkridge was initially developed by farmers selling their tobacco to English merchants. As the Industrial Revolution progressed, iron became a major export through the port. Additionally, milling gained popularity along the Patapsco and Patuxent Rivers.

Ellicott City

In 1772, three brothers from Pennsylvania, known as the Ellicott Brothers, bought land on the Patapsco River. The Patapsco River's strong currents provided ideal conditions for milling. The three brothers constructed a mill and settled the area known as Ellicott's Mills, now known as Ellicott City. The Ellicott Brothers further expanded their holdings and acquired several flour and iron mills. Although the opportunities for workers encouraged settlers to migrate towards the Patapsco River region, these settlements remained sparse. By 1851, the area was officially recognized as separate from Anne Arundel County.

The railroad system changed Ellicott Mills from a small industrial town to a robust commercial hub. The first section of the Baltimore and Ohio Railroad was constructed in Ellicott's Mills in the early 1900's. As the first station along the railroad, it revitalized the economy in the Patapsco Valley. By the 1950s however, the town began to decline as the push to migrate to the suburbs gained popularity.

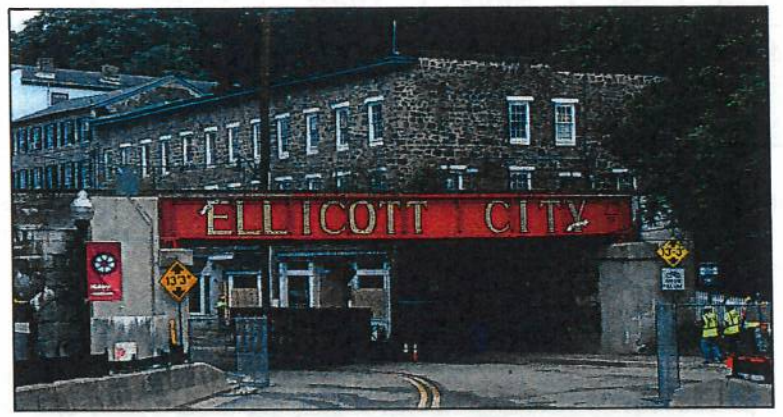


Photo 2.2 Baltimore and Ohio Railroad Tracks in Historic Ellicott City

Columbia

In the early 1960s, land developer James Rouse[11] purchased over 1000 acres of land in Howard County. This area became the community of Columbia. The community was intended to eliminate racial, religious and income segregation. Columbia was to be self-sustaining with resources such as jobs, schools, commercial districts, and health and medical facilities. The "New Town District," designed by Rouse, gave developers more flexibility on where they could develop throughout the community. This included developing without official approval from Howard County.

2.4 Population

The U.S. Census Bureau estimates Howard County's population in 2016 at 317,233 residents.[12] From 2010 to 2016, Howard County has grown significantly, adding an estimated 28,857 people. From 2010 to 2015, Howard County added approximately 8,100 additional housing units.[13] The population projections for 2020 and 2030 were completed by the Maryland Department of Planning (MDP) in 2014. Howard County's population is projected to reach 332,000 residents by 2020, and over 357,000 by 2030.[14] Combining these projections with the statistical information from the U.S. Census paints a clear picture of Howard County's growth and development.

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[11] Columbia Association, *History of Columbia*, available at https://www.columbiaassociation.org/facilities/columbia-archives/digital-resources/history-of-columbia/.
[12] United States Census Bureau's *2016 American Community Survey*, available at https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t
[13] Maryland Department of Planning's (MDP) *Demographic and Socio-Economic Outlook 2014*, available at http://planning.maryland.gov/MSDC/Pages/md_outlook_map.aspx
[14] Ibid.

Table 2.2 below provides past population totals for the years 2000, 2010, and 2016, and future population projections for the years 2020 and 2030, for the County, State, and Nation.

Table 2.2 – 2016 American Community Survey 1-Year Population Estimates for 2000, 2010, 2016 and 2020
Sources: US Census Bureau, American Community Survey, 2016 [15] & MDP Population Projections, 2014 [16]

	Estimated Population					Growth Rate Per Decade		
Location	2000	2010	2016	2020	2030	2000-2010	2010-2020	2020-2030
Howard County	249,599	288,376	317,233	332,250 [17]	357,100 [18]	15.5%	15.2%	7.5%
Maryland	5,311,000	5,786,982	6,016,447	6,224,510 [19]	6,612,190 [20]	9.0%	7.6%	6.2%
United States	282,200,000	309,349,689	323,127,515	334,500,000 [21]	359,400,000 [22]	9.6%	8.1%	7.4%

A further breakdown of Howard County's population growth data is compiled in the Tables 2.3-2.6, and uses 2016 American Community Survey data made available through the U.S. Census Bureau's American Fact Finder website.

Table 2.3 – 2016 American Community Survey 1-Year Estimates: Demographic and Housing Statistics [23]
Source: 2016 American Community Survey

General Characteristics	County Estimate	Percent	U.S.
Total population	317,233	---	323,127,515
18 years and over	239,226	75.4%	77.2%
White	186,168	58.7%	72.6%
Black or African American	58,167	18.3%	12.7%
American Indian and Alaska Native	405	0.1%	0.8%
Asian	57,006	18.0%	5.4%
Native Hawaiian and Other Pacific Islander	56	0.0%	0.2%
Two or more races	12,524	3.9%	3.2%
Hispanic or Latino (of any race)	20,952	6.6%	17.8%
Total housing units	118,056	--	135,702,775
Occupied housing units	112,542	95.3%	87.6%
Vacant housing units	--	4.7%	12.4%

*Note all characteristics are based on 1-year estimates from the 2016 American Community Survey

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[15] United States Census Bureau's *2016 American Community Survey*, available at https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.
[16] MDP's Demographic and Socio-Economic Outlook 2014, available at http://planning.maryland.gov/MSDC/Pages/md_outlook_map.aspx.
[17] Ibid.
[18] Ibid.
[19] Ibid.
[20] Ibid.
[21] Statistica, *Population Projections for the United States*, available at https://www.statista.com/statistics/183481/united-states-population-projection/.
[22] Ibid.
[23] United States Census Bureau's *2016 American Community Survey*, available at https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

Table 2.4 - 2016 American Community Survey 1-Year Estimates: Demographic and Housing Statistics [24]
Source: 2016 American Community Survey

General Characteristics	County Estimate	Percent	U.S.
Total population	317,233	---	323,127,515
Male	154,895	48.8%	49.2%
Female	162,338	51.2%	50.8%
Median age (years)	38.6	---	37.9
Under 5 years	--	6.0%	6.1%
18 years and over	--	75.4%	77.2%
65 years and over	--	13.1%	15.2%
Occupied housing units	112,542	95.3%	118,860,065
Owner-occupied housing units	--	72.8%	63.1%
Renter-occupied housing units	--	27.2%	36.9%

*Note all characteristics are based on 1-year estimates from the 2016 American Community Survey

Table 2.5 - 2016 American Community Survey 1-Year Estimates: Social Characteristics [25]
Source: 2016 American Community Survey

Social Characteristics	County Estimate	Percent	U.S.
Population 25 years and over	212,505	---	218,475,480
High school graduate or higher	--	95.8%	87.5%
Bachelor's degree or higher	--	61.9%	31.3%

*Note all characteristics are based on 1-year estimates from the 2016 American Community Survey

Table 2.6 - 2016 American Community Survey 1-Year Estimates: Economic Characteristics [26]
Source: 2016 American Community Survey

Economic Characteristics	Estimate	Percent	Maryland	U.S.
In labor force (population 16 years and over)	181,417	73.2%		63.1%
Mean travel time to work in minutes (workers 16 and over)	30.7	---	32.8	26.6
Median household income (in 2015 inflation-adjusted dollars)	$120,941	---	$78,945	$57,617
Median family income (in 2015 inflation-adjusted dollars)	$138,956	---	$119,462	$71,062
Per capita income (in 2015 inflation-adjusted dollars)	$52,091	---	$38,662	$31,128

*Note all characteristics are based on 1-year estimates from the 2016 American Community Survey

2.5 Income

The median income for a household in Howard County is estimated to be $120,941 (in 2015 dollars) with a per capita income of $52,091. This is greater than the state median household income of $78,945 and per capita income of $38,662, and greater than the national median household income of $71,062 and per capita income of $31,128. According to the Maryland Department of

[24] United States Census Bureau's *2016 American Community Survey*, available at https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.
[25] Ibid.
[26] Ibid.

Commerce, the county has approximately a 5.4% unemployment rate. This is equal to the state unemployment rate, but less than the national unemployment rate of 5.8%. The counties poverty rate is estimated at 5.2%, which is lower than the state poverty rate of 9.7% [27], and national rate of approximately 14.0%. [28]

2.6 Land Use

Maryland has been progressive in adopting state-wide land use planning and natural resource protection policies. The Maryland State Legislature passed the Economic Growth, Resource Protection, and Planning Act of 1992, which outlines seven goals to guide economic growth. It also mandates local plans to include an environmentally sensitive areas section. In 1997, the Maryland State Legislature passes several programs known as the Smart Growth and Neighborhood Conservation initiatives. The main initiative was the "Priority Funding Areas," which limited State infrastructure funding and economic development in areas local government found unsuitable for growth. The Rural Legacy Program of 1997 provides financial resources to protect agricultural land and natural resources.

Initially, the adopted State resolutions strengthened Howard County's informal growth boundary. The concept was implemented as the "Residential Zoning and Development Stage Plan" in the 1960s. Today, the Planned Service Area has a defined boundary. The area is contained in the eastern portion of the County, which covers approximately 40% of the County's land area. The rest of the County is rural and has been preserved through programs such as the Rural Legacy Program, the County's Agricultural Land Preservation Program, Cluster Zoning, and Density Exchange Option. Although development can occur outside this Rural West boundary, public sewer and water is not provided to that area by the County.

There are fourteen different types of land uses in Howard County, which includes six residential, two commercial, two industrial, and two government and institutional land uses. In addition, there is a Transportation, Communications, and Utilities land use, as well as a use for Parks, Open Space, and Recreation. The Planned Service Area contains all six residential land uses, with the higher density residential land uses, including Single Family Attached, Rental Apartments, and Condo Apartments typically located in Columbia, Elkridge, Ellicott City, Savage, and North Laurel. The residential land uses in the Rural West are mainly characterized by low density residential uses, including Single Family Detached and Undeveloped Residential. The combination of the Preservation Easements, Park and Open Space, and the two previously residential land uses make up a significant portion of the Rural West. In the Planned Service Area, the Park and Open Space land use is frequently located around residential development, acting as a buffer between the floodplain and residential properties.

Approximately 36% of land in Howard County, nearly 60,000 acres, is preserved through some type of land conservation measure. [29] The County preserves land several different ways including public parkland, Columbia Association and other homeowners' association open space, agricultural

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[27] Maryland Department of Planning's Maryland State Data Center's *Poverty Rates for Maryland's Jurisdictions and Places*, available at http://planning.maryland.gov/MSDC/Documents/poverty/SAIPE-2006-2016-Poverty-Rate-Data.pdf.
[28] United States Census Bureau, *Income, Poverty and Health Insurance Coverage in the United States: 2016*, available at https://www.census.gov/newsroom/press-releases/2017/income-povery.html.
[29] Howard County Government, *PlanHoward2030*, 2017, Page 27

preservation, environmental and forest conservation easements, and regulations on floodplain, riparian buffer, and steep slopes in private development.[30]

Photo 2.3 Browns Bridge Recreational Area

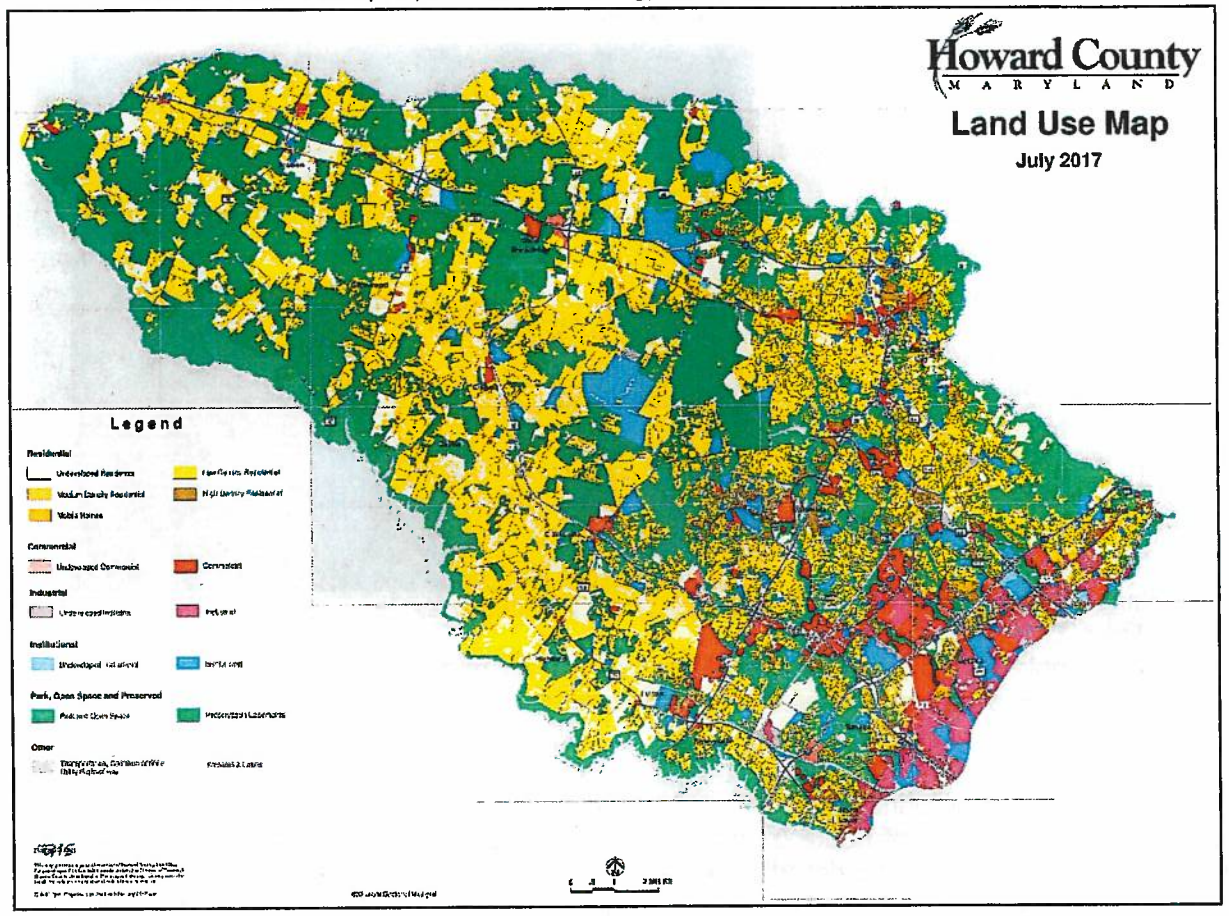
Howard County's two commercial land uses are comprised of Commercial and Undeveloped Commercial. The Commercial land use is primarily located in the Planned Service Area, with several small defined locations along Ten Oaks Road, Route 27, Route 32, Route 94, Route 97, Route 144, Interstate 70, and other small defined locations in the Rural West. Majority of the commercial land use is typically found near major population centers, such as Clarksville, Columbia, Jessup, Elkridge, Ellicott City, Fulton, Savage, and North Laurel. Columbia Town Center, including The Mall in Columbia, serves as a major retail center. Another retail cluster can be found on the Interstate 95 corridor, particularly between Route 32 and Route 175, as well as off Snowden River Parkway.

The Route 1 corridor is the principal location of the County's industrial land uses. Majority of the industrial land is located east of Route 1 and makes up a significant portion of the land between Route 1 and Howard County's border with Anne Arundel County. Clusters of industrial uses are also located off Snowden River Parkway. There are numerous Government and Institutional land uses scattered throughout the County. The most prominent institutional land use is the University of Maryland's Central Maryland Research & Education Center - Clarksville facility, a dairy research center. Other Government and Institutional land used include schools, hospitals, and County government buildings

Figure 2.6 is a visual representation of Howard County's land uses.

[30] Ibid.

Figure 2.6 - Howard County Land Uses
Source: Howard County Department of Technology and Communication Services, GIS Division



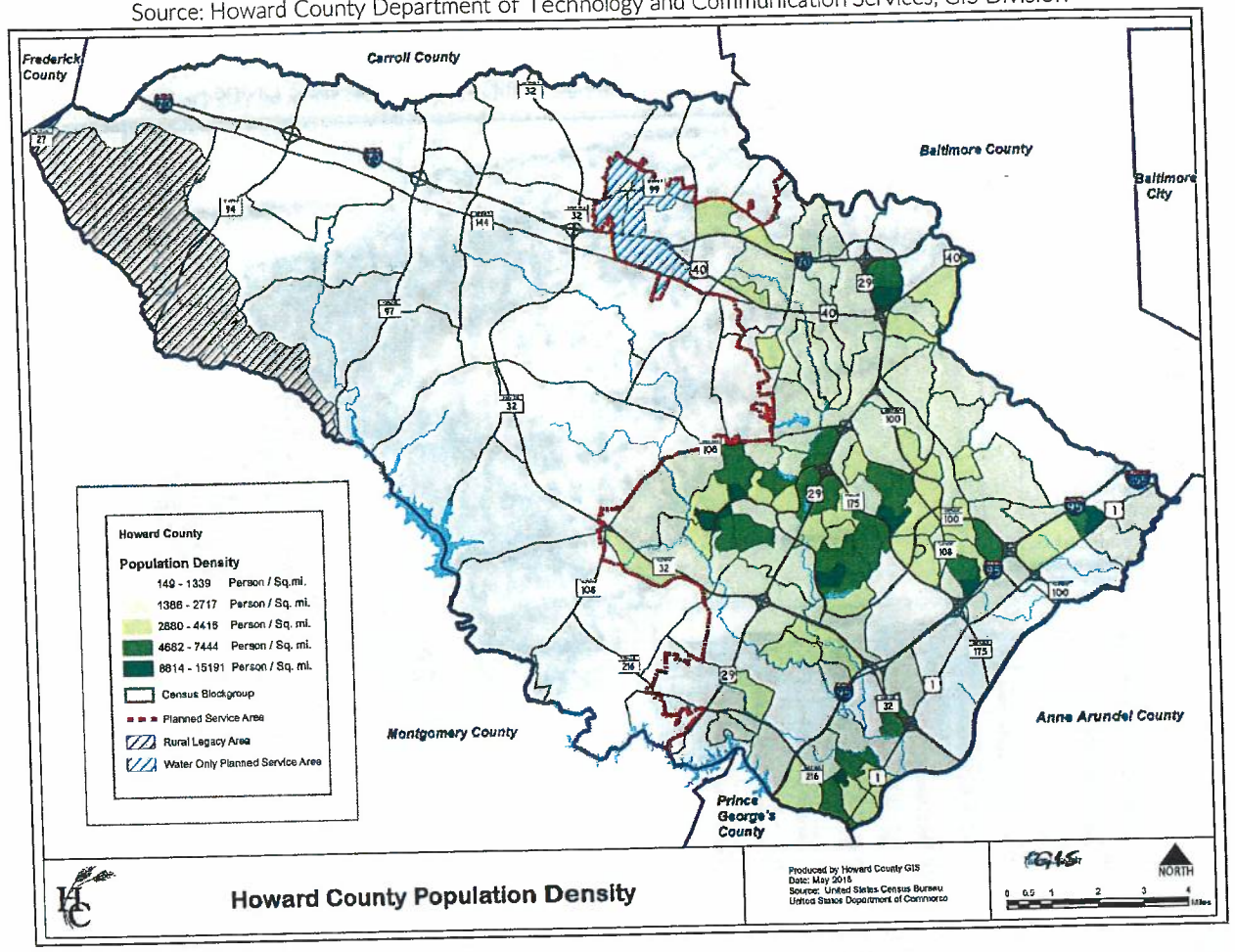
2.7 Growth and Development

The County-wide population density average as of 2016 was roughly 1,230 persons per square mile.[31] The eastern portion of the County, inside the Planned Service Area, has a much greater population density per square mile than does the Rural West, where population density decreases rapidly once outside the Planned Service Area.

As clearly shown in Figure 2.7, population density reflects the residential land uses and the Planned Service Area, with the eastern part of the County being more densely populated than the Rural West.

[31] Open Data Network, *Howard County Population Density*, available at https://www.opendatanetwork.com/entity/0500000US24027/Howard_County_MD/geographic.population.density?year=2016.

Figure 2.7 - Population Density
Source: Howard County Department of Technology and Communication Services, GIS Division



The U.S. Census Bureau estimates the region's population growth has steadily increased in the last ten years. Estimates show a 15.5% increase between 2000 and 2010, and project a 15.2% increase between 2010 and 2020, and a 7.5% increase from 2020 to 2030. The region is expected to continue to grow, but at a slower rate in the coming years.

Table 2.7 provides the total number of residential building permits in the County from 2007 to 2017.

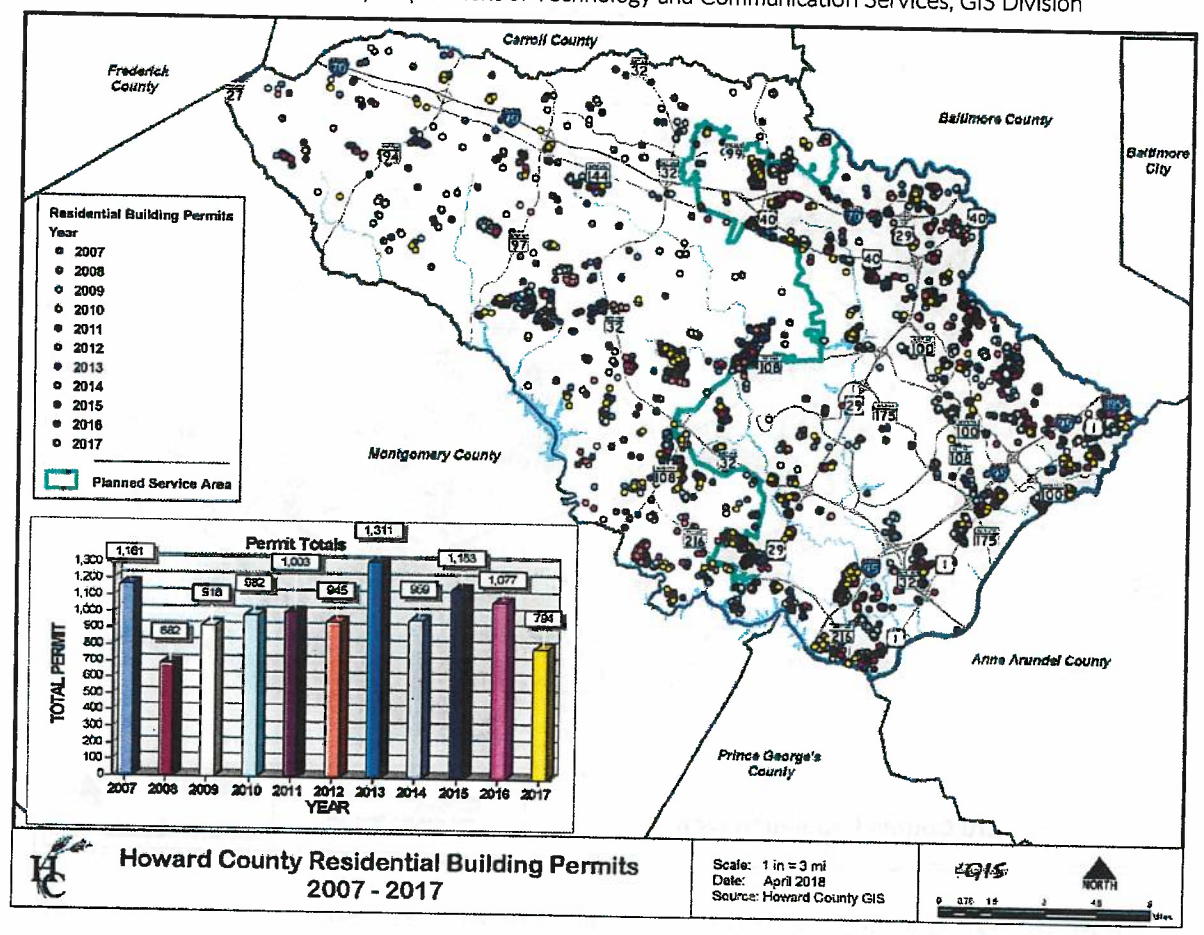
Table 2.7 - Howard County: Residential Permits (2007-2017)
Source: Howard County Department of Planning and Zoning, Research Department

Permits	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total = 10,849	976	860	814	957	1003	945	1311	959	1153	1077	794

Using requests for residential building permits as a metric, this new development has mostly occurred within the Planned Service Area. Between 2007 and 2017, there were 10,849 residential building permits issued. As the Planned Service Area continues to reach capacity, the building of detached single-family housing units is expected to decline and be replaced by the construction of higher density residential uses. The County has anticipated this shift and has developed corridor plans for Route 1, Route 40, and Clarksville Pike (Route 108) and the Downtown Columbia Plan to

reflect this transformation. Figure 2.8 is a visual representation of Howard County's Residential Permits 2007 to 2017.

Figure 2.8 - Howard County Residential Permits 2007 – 2017
Source: Howard County Department of Technology and Communication Services, GIS Division



Howard County's Master Plan, PlanHoward 2030, places heavy emphasis on the environment, sustainability, and Smart Growth. The County recognizes that climate change will impact hazards such as flooding, drought, and wildfire, and efforts to mitigate these risks will be largely driven by controlled and sustainable development and land use policies. In response to the recent flood events in Ellicott City, a one-year building moratorium has been enacted by the Howard County Government, in both the Tiber River and Plumtree Branch watersheds. The Act was passed unanimously by the County Council on July 27th, 2018.

2.8 Employment and Industry Profile

Howard County has experienced rapid employment growth over the last few decades, but is projected to slow in the future years. Historically, a manufacturing and agricultural County, Howard County has shifted to a diverse mix of retail, office, and industrial employers. There were

approximately 165,691 total full and part time jobs in the County in 2001[32]. By 2010, the total number of full and part time jobs had increased to 189,573.[33] This amounts to an increase of 23,883 jobs. From 2010 through 2013, the county added approximately 15,500 new jobs.[34] The County's Economic Development Authority indicated that in 2015 Howard County had approximately 207,600 jobs.[35]

According to Maryland Department of Planning's State Data Center, by 2020 Howard County is projected to have approximately 235,200 total full and part time jobs, 258,200 by the year 2030, and 281,000 by the year 2040.[36] Howard County's robust economy, powered by a range of industries, ensures that job growth in the county will rise by as much as 17% by 2020.[37]

Table 2.8 lists the top fifteen largest private employers in Howard County in 2018. Information on the number of public employers was not provided, including the Howard County Government and Howard County Public Schools, and therefore are not included in this table.

Table 2.8 – Howard County Largest Private Employers (2018)[38]
Source: Howard County Economic Development Authority

Rank	Name	Line of Business	No. of Employees
1	Johns Hopkins University Applied Physics Lab	R&D Systems Engineering	7,000
2	Howard County General Hospital	Nursing Care	1,765
3	Verizon	Telecommunications	1,700
4	Lorein Health Systems	Medical Services	1,190
5	Coastal Sunbelt Produce	Food Products Distribution	1,050
6	Wells Fargo	Financial Services	807
7	Nestle Dreyer's Grand Ice Cream	Frozen Deserts	735
8	Sysco Food Service	Food Products Distribution	680
9	Maxim Healthcare Services	HQ/Medical Staffing/Wellness	675
10	Oracle	Software Development	650
11	Enterprise Community Partners	HQ/Community Development	505
12	W.R. Grace & Co.	HQ/Chemical R&D	500
13	Humanin	Services for People with Disabilities	475
14	Leidos	Engineering Services/Cyber	450
15	Tenable Network Security	Software Development/Cyber	415

2.9 Utilities

[32] Maryland Department of Planning's State Data Center, *Total Jobs by Industry, Historic 2001 to 2013 and Projected 2015 to 2040*, available at http://planning.maryland.gov/MSDC/Pages/projection/employment/naics-jobs.aspx.
[33] Ibid.
[34] Ibid.
[35] Howard County Economic Development Authority, *Demographics*, available at http://www.hceda.org/why-howard-county/business/demographics/.
[36] Maryland Department of Planning's State Data Center, *Total Jobs by Industry, Historic 2001 to 2013 and Projected 2015 to 2040*, available at http://planning.maryland.gov/MSDC/Pages/projection/employment/naics-jobs.aspx.
[37] Ibid.
[38] Howard County Economic Development Authority's Business Lists, *Howard County Largest Private Employers (2018)*, available at http://www.hceda.org/why-howard-county/business/business-lists/.

Power for the county is primarily provided by the Baltimore Gas & Electric Company and Constellation NewEnergy, Inc., both owned by Exelon. The majority of county residents are served by public water and sewerage service that is provided to the Planned Service Area. Other parts of the county have private water systems, individual wells and traditional septic systems. The county's wastewater system is comprised of 1 wastewater treatment plant, 32 wastewater pump stations, 30 miles of sewer force main, 951 miles of gravity sewer and 25 shared septic systems. The water system is comprised of 1,044.23 miles of water main, 15 water pumping stations, 12 pressure reducing valves and 11 elevated storage tanks.

Verizon Communications is the county's primary telecommunications carrier. Additionally, long-distance telecommunications services are also provided by AT&T, Comcast, MCI WorldCom, Sprint, and over 250 additional carriers and resellers of Wide Area Telephone Service (WATS) and cellular phone service. Additional communications utilities such as cable internet, ISDN switching, and fiber optics utilities are also offered to residents in the county.

Renewable utilities in the county include the Chimes West Friendship (Nixon Farms) Solar Farm. The plant is located in West Friendship near the intersection of US Route 70 and Maryland Route 32.[39]

2.10 Transportation

Howard County is accessible by multiple transportation networks. The County is bisected by Interstate 95, which is the Nation's main East Coast transportation artery. The 2017 Annual Average Daily Traffic numbers for the section of Interstate 95 that runs through Howard County ranges from 206,435 to 216,613.[40] Additionally, Interstate 70 connects the northern portion of Howard County with the City of Frederick and the Baltimore Beltway (Interstate 695,). US Route 1 and US Route 29 run parallel to Interstate 95. Whereas Route 1 runs to the east, Route 29 runs to the west. Both act as supplemental commuter routes to Baltimore and to the District of Columbia. Route 40, the Baltimore National Pike, connects northern Howard County with downtown Baltimore City. West of Ellicott City, Route 40 joins with Interstate 70 to link Howard County with Western Maryland. The State Route 32 and State Route 100 run east to west, connecting each of these major arteries with the Baltimore-Washington Parkway, another regional freeway between the District of Columbia and Baltimore.

Baltimore Washington International Thurgood Marshall Airport (BWI) is Maryland's primary airport and serves the Baltimore-Washington Metropolitan Area. It is located 15 miles east of Howard County, in Baltimore County. Today, it provides access to both domestic and international destinations and serves as a hub for Southwest Airlines.

Howard County offers a variety of public transit options. The local transit service, Regional Transportation Agency (RTA) of Central Maryland, provides residents with a fixed route bus service. The service provides fifteen fixed lines connecting major County locations, as well as the BWI in

[39] United States Energy Information Administration's Electricity Data Browser, *Chimes West Friendship (Nixon Farms), monthly*, available at https://www.eia.gov/electricity/data/browser/#/plant/59743.
[40] Maryland Department of Transportation's State Highway Administration *Traffic Volume Maps by County*, 2017, available at https://roads.maryland.gov/Traffic_Volume_Maps/Howard.pdf.

nearby Anne Arundel County[41]. RTA also offers specialized transit service, for individuals with disabilities or mobility challenges, and individuals aged 60+.

There are 12 Park and Ride lots located throughout the county[42]. The Maryland Transit Administration (MTA) provides commuter buses to both Baltimore City and the District of Columbia. The MTA also provides a light rail line for commuters in the area. The Maryland Area Regional Commuter (MARC) train has three stations in Howard County, Dorsey, Savage, and Jessup. These lines connect Union Station in DC to Camden Station in Baltimore.

Launched in 2017, the Howard County Bikeshare system offers electric-assist bicycles, as well as traditional options for residents and visitors to explore the region. Users have with a network of 7 stations and 70 bikes, and is perfect for errands, commuting, or recreation.[43]

In spite of these public transportation options, county residents rely heavily on personal automobile transportation. As such, the roadway system is a critical component of the County's infrastructure.

2.11 Educational/Institutional

The Howard County Public School System consists of a total of 73 public schools throughout the County. The number of schools are broken down as follows: 41 elementary schools; 20 middle schools; and 12 high schools. There are also 26 private schools in the County that are approved by The Maryland State Board of Education[44], which serve from pre-school to high school levels.

Additionally, the Maryland School for the Deaf (MSD) Columbia Campus opened in 1973 as part of the planned community of Columbia. The MSD Columbia offers an ASL and English bilingual educational program in the population center of the state, and today provides a nurturing and educational environment for 155 students.[45]

Howard County is also home to several institutions of higher learning. The Howard County Community College is the main higher education institution in the County. The college has roughly 14,220 credit students enrolled and 15,674 noncredit continuing education students enrolled in the 2017 Fiscal Year[46]. Located in Howard County, the Maryland University of Integrative Health offers graduate-level programs in wellness-based education, clinical care, research, and public policy.[47] The John Hopkins University Applied Physics Laboratory is located on Route 29 in the County. Additionally, Loyola College, the University of Maryland, and the University of Phoenix all have satellite campus locations in Howard County.

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[41] Central Maryland's Regional Transportation System's *System Map*, available at http://www.transitrta.com/wp-content/uploads/2018/07/system.pdf.
[42] Live Green Howard, *Transportation*, available at http://livegreenhoward.com/green/energy/transportation/.
[43] Howard County Bikeshare, System, available at https://howardcountybikeshare.com/system/.
[44] Maryland State Department of Education, *Nonpublic Schools Approved by the Maryland State Board of Education*, available at http://nonpublicschoolsdb.marylandpublicschools.org/nonpublic/nsab_directory/DisplayLocations.asp?County=Howard.
[45] Maryland School for the Deaf, Columbia Campus, available at https://www.msd.edu/apps/pages/index.jsp?uREC_ID=1114234&type=d&pREC_ID=1289154.
[46] Howard Community College, *HCC at a Glance*, available at http://www.howardcc.edu/about-us/hcc-at-a-glance/index.html.
[47] Maryland University of Integrated Health, *Academics*, available at https://www.muih.edu/academics.

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CHAPTER 3 - PLANNING PROCESS

3.1 IFR Requirements for the Planning Process

IFR §201.6(b): *In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:*

(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;

(2) An opportunity for neighbouring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and

(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

IFR §201.6(c)(1): *[The risk assessment shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

3.2 What is Hazard Mitigation?

The Federal Emergency Management Agency defines hazard mitigation as a sustained action taken to eliminate or reduce long-term risk to people and their property from various hazards. A hazard mitigation plan serves as a road map for a community's long-term strategy to reduce disaster losses and break the cycle of repeated destruction from natural disasters. The planning process used to

develop hazard mitigation plans involves risk-based decision-making to reduce damage to people, property, and infrastructure from future disasters.

3.3 Hazard Mitigation Plan Update Process

Local governments are required to develop and update their hazard mitigation plan in order to remain eligible for certain types of non-emergency disaster assistance from FEMA, including mitigation funding.

Howard County developed their first HMP in 2004. The 2004 plan was evaluated and updated again in 2012. This 2018 Update is being completed as part of the 5-year plan update cycle in order to maintain Howard County's eligibility for mitigation funds.

The 2012 HMP Update was undertaken by Howard County's Office of Emergency Management (OEM) in association with two local subject-matter experts and Vision Planning and Consulting. The update was developed between November 2010 and December 2012.

While the 2012 HMP update includes the standard sections required for hazard mitigation plans, it also includes the following:

- Re-evaluation of 2004 HMP's hazard profiles, risk assessment, mitigation goals, actions and priorities;
- Improved stakeholder coordination between county departments and involvement of outside agencies;
- Continued compliance with the National Flood Insurance Program;
- Integration of hazard mitigation principles with other planning processes (comprehensive plan, zoning ordinance, subdivision regulations, stormwater management plan, and recreation plan); and
- Incorporation of the County's Flood Mitigation Plan (FMP), which includes a detailed flood risk assessment and flood mitigation recommendations.

This 2018 HMP update will follow the 2012 format in incorporating the County's FMP as an annex to the HMP. Additionally, the Hazus model for this update will use the most recent release of the software and has tailored the critical facilities data to provide the most complete, up-to-date, and accurate information possible. General building stock data for the analysis is the default building data provided by Hazus.

The Plan Update planning process comprised four main steps as mandated by FEMA, namely:

- Step 1: Organize Resources
- Step 2: Assess Risks
- Step 3: Develop a Mitigation Plan
- Step 4: Implement Plan and Monitor Progress

These four steps are addressed in-depth below.

3.3.1 Organize Resources

During the plan update process, a number of entities at the local, state, and federal levels were involved. Each of these groups was entrusted with specific responsibilities so that the outreach efforts were comprehensive and far-reaching.

- Joint HMP/FMP Steering Committee (JSC) – attendance at meetings, review of plan sections and draft plan;
- Stakeholders – involvement of the NHMP's update progress via emails and through the county website;
- Public – plan input, and attendance at the Public Outreach Meetings;
- Maryland Emergency Management Agency (MEMA) – plan review and approval; and
- Federal Emergency Management Agency (FEMA) – project funding, plan review, and approval.

Joint HMP/FMP Steering Committee (JSC): The JSC (Table 3.1) convened four times during the HMP update process to review existing plans, update existing mitigation actions and goals, aid in developing new mitigation actions, and provide comments and feedback. The JSC comprised of representatives from several County departments.

Table 3.1 Joint Steering Committee Members

Name	Affiliation
Michael Hinson	Office of Emergency Management
Amanda Faul	Office of Emergency Management
Chris Meyer	Office of Emergency Management
Mark Richmond	Department of Public Works – Storm Water Management
Brian Cleary	Department of Public Works – Storm Water Management
Steve Hardesty	Department of Fire and Rescue Services
Rocco Sovero	Department of Fire and Rescue Services
David Keane	Howard County Recreation and Parks
Peter Conrad	Department of Planning and Zoning
Bill Sieger	Maryland Department of the Environment - Waterway Permits
Don Mock	Department of Inspections, Licenses and Permits
Lindsay DeMarzo	Office of Community Sustainability
Krishnakanth (Kris) Jagarapu	Department of Public Works - Highways
Philip Nichols	Howard County Administration
Sean Harbaugh	Columbia Association

Additionally, invitations to serve on the JSC were sent to select county businesses and community representatives such as: the Columbia Association; the Patapsco Heritage Greenway; and Wilkins-Rogers. Invitations were emailed to these representatives at least two weeks prior to each of the four JSC meetings.


Photo 1.1 - Steering Committee Meeting 1

Four HMP Steering Committee meetings were held during the plan update process. Meetings were held in conjunction with the Flood Mitigation Plan Update Process to maximize participation and provide an integrated and efficient planning process. The first meeting was held on December 7th, 2017 at the EOC Policy Room, in the Ligon Building, in Ellicott City (Photo 1.1). At this meeting, the various steps in the plan update process were discussed, the roles of the JSC, and the timeline for completion of the plan update was laid out. The meeting ended with a discussion and exercise on existing Goals and Objectives from the 2012 and 2010 HMP and FMP, respectively. Additionally, formats for public meetings and involvement were discussed.

The second Steering Committee meeting was held on February 6th, 2018 at the County EOC in Ellicott City. At this meeting, the data on the flood hazard identification, hazard vulnerability, and risk assessment was presented (Photo 1.2) and input on the flood risk was solicited. The meeting concluded with a review of the mitigation actions from the 2010 FMP. Additionally, mitigation actions from the previous plan were reviewed to determine current status (in progress, completed, deferred), relevance, and feasibility.

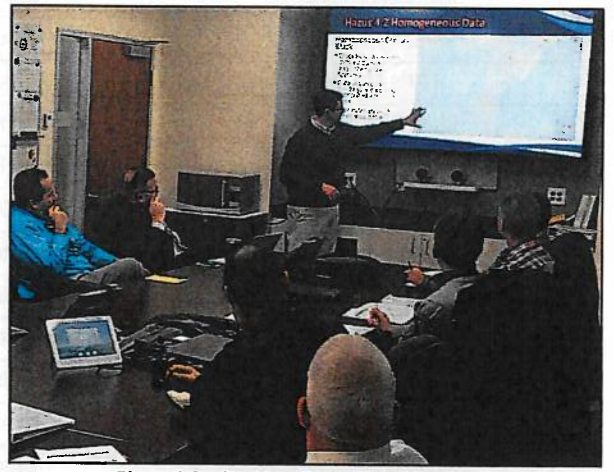


Photo 1.2 - Steering Committee Meeting 2

At the third Steering Committee meeting, held on April 3, 2018 at the County EOC, a range of mitigation actions were examined that addressed the Plan's updated goals and objectives. Additionally, the results of the hazard mitigation questionnaire were reviewed.. A brainstorming session was held with the Steering Committee to determine additional new mitigation actions, based on results of the public poll, and new mitigation actions were developed, and appropriate content and verbiage finalized.

The fourth and final Steering Committee (Photo 1.3) meeting was held on May 16, 2018 at the County EOC. An exercise to finalize and prioritize the list of mitigation actions for the FMP was held. An implementation plan was developed to determine Lead Agency, Timeline, Estimated cost and potential Funding Sources for each action item. Mitigation actions were also prioritized based on the prioritization rubric which utilizes criteria including Life/Safety, Technical/Administrative Difficulty, and Cost. A plan maintenance schedule was also developed at this meeting.

Copies of the agendas, sign-in sheets, and meeting summaries of all meetings are included in the Appendix.

Photo 1.3 - Steering Committee Meeting 4

Public Participation

Public input was solicited at two public meetings during the planning process. The first public meeting was held on February 15, 2018 at the North Laurel Community Center. At this meeting, the planning process and the results of the hazard identification were presented to the public to solicit comment. VPC explained how the implementation plan will lead to prioritizing actions based on social, administrative, economic, and other factors.

The second Public Meeting was held on May 17, 2018 at the Howard County Library in Elkridge. At this meeting, updated mitigation goals and objectives along with actions were presented for review and discussion. VPC discussed the integration of other county plans, as well as the Howard County 2017 HIRA, which was used to determine the hazard risk ranking for county.

Both meetings were published through the Howard County Public Information Office (PIO). All news releases go out to local media outlets (TV, radio and paper), as well as Howard County State Delegation. Additionally, the meeting notices were sent to fellow PIO's in the school system, Howard Community College, Howard County General Hospital, etc. The meeting was also posted on the County's main social media pages.

Online Hazards Survey

An online survey was developed to gather information from County residents on the frequency of various natural hazard events, as well as the kind of damages typically found by home and property owners. The results of the survey are reviewed in Appendix D.

Floodplain Coordinator Questionnaire

A capability questionnaire was sent to the Stormwater Management Division (SWMD). The purpose of the questionnaire was to solicit input on critical facilities, existing plans and ordinances, flood-related policies, and mitigation projects that have been implemented in the past as well as the county's technical and staffing capability.

3.3.2 Assess Risks

For this step, data on hazard events compiled in the 2017 Hazard Identification and Risk Assessment (HIRA) was reviewed. This formed the basis for Chapter 4 (*Hazard Identification and Profiling*) and Chapter 5 (*Vulnerability Assessment*) of the 2018 HMP. The hazard identification section summarizes past occurrences and the probability of future events. The vulnerability analysis section includes estimates of potential losses, types, and numbers of existing and future at-risk buildings, infrastructure, and critical facilities located in the identified hazard areas.

The HMP update also provides a general description of land uses and development trends in the County, so that mitigation options can be considered in future land use decisions. Chapter 6 (*Capability Assessment and Plan Integration*) includes a thorough review and analysis of the current County plans and ordinances in light of hazard mitigation principles. This interdisciplinary approach will enable Howard County to incorporate hazard mitigation principles into various Howard County planning documents going forward.

3.3.3 Develop a Mitigation Plan

In addition to the 2017 HIRA, the 2012 HMP, was examined and reviewed extensively.

Several actions were undertaken to protect the County from long-term vulnerability from identified hazards and to ensure community resiliency in the future. The JSC reviewed the 2012 HMP mitigation goals and departments were contacted in order to ascertain the status of the 52 mitigation actions. With the help from department representatives, the JSC was able to formulate new mitigation actions and projects to reduce the effects of hazards affecting the County.

The 2018 HMP explored actions in the following six categories:

- Preventative measures– e.g., zoning, floodplain, stormwater, and other ordinances;
- Structural projects – e.g., levees, dams, reservoirs and channel improvements;
- Property protection – e.g., relocation, floodproofing, and insurance;
- Emergency services – e.g., warning systems, sandbagging, evacuation routes;
- Natural resource protection – e.g., wetlands protection, sediment erosion control, and other best management practices; and
- Public outreach and education – e.g., outreach projects, environmental education and technical assistance.

3.3.4 Implement Plan and Monitor Progress

Plan implementation is discussed in-depth in Chapter 8, *Plan Monitoring and Maintenance*. Section 8.5.1-1 describes how the identified mitigation actions would be prioritized, implemented, funded, and administered by the County. This step also included a description of the method and schedule for monitoring, evaluating, and developing the next plan update.

MEMA and FEMA - Upon completion, the plan will be submitted to MEMA and FEMA for review and approval in Fall 2018. The HMP will also be formally adopted by the County Council in late-Fall 2018. Once the HMP is adopted by the County Council, it will be sent for review and approval by both MEMA and FEMA in late-Fall 2018.

CHAPTER 4 - HAZARD IDENTIFICATION AND PROFILING

4.1 IFR Requirement for Hazard Identification and Profiling

IFR §201.6(c)(2)(i): [The risk assessment shall include a] description of the location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

4.2 Hazard Identification

A Hazard Identification and Risk Assessment (HIRA) is a vital step in preparing a hazard mitigation plan and in identifying the appropriate mitigation actions. This HIRA includes the identification of all hazards affecting the County and its municipalities, profiling of hazards based on historical data, and assessing vulnerability.

While the 2012 Howard County HMP preserved some sections of the original 2004 plan, other sections were removed or heavily edited. As this plan is an update of the 2012 HMP, certain sections of that plan, such as the county background and geography, have been retained for continuity. Much of the historical information on each hazard has been retained from the 2012 plan, and several sections have been enhanced and updated to accurately reflect the conditions that have affected Howard County since the 2012 update. The list of hazards that were profiled in the 2012 plan have

been slightly modified for this update to reflect current conditions. Please refer to the 2017 HIRA document, developed by the Howard County OEM, for a detailed discussion regarding the list of hazards addressed in this 2018 HMP Update.

The 2017 HIRA document highlighted the following eight natural hazards:

- Floods
- Severe Winter Weather
- Wildfires
- Hurricanes & Tropical Storms
- Tornados & Wind Storms
- Lightning
- Earthquakes
- Drought (including Extreme Heat)

Some of these hazards are interrelated (i.e., hurricanes can cause flooding and tornadoes), and some consist of hazardous elements that are not listed separately (i.e., severe thunderstorms can cause hail; hurricanes can cause coastal erosion). It should also be noted that some hazards, such as severe winter storms, may impact a large area yet cause little damage, while other hazards, such as a tornado, may impact a small area yet cause extensive damage. This section provides a general description for each of the hazards listed above, along with their hazardous elements, written from a national perspective.

To summarize these natural hazards, as identified in the 2017 Howard County HIRA, Table 4.1 gives brief definitions of the eight natural hazards in which this plan update will focus on.

Table 4.1 – Descriptions of Natural Hazards

Hazard	Description
Flood	Flooding is defined as the accumulation of water that exceeds a physical barrier or collects in a low lying area that leads to the inundation of an area. A flood can develop slowly, over a period of several days, or it can develop within minutes, which is the case with flash floods. Flooding typically results from large scale weather systems that generate prolonged or or sudden, heavy rainfall. Other conditions such as winter snow thaws, over-saturated soil, ice jams, and urbanization can cause flooding as well.
Hurricane/Tropical Storm	Hurricanes and tropical storms are a type of storm known as a tropical cyclone, which are rotating, organized systems of clouds and thunderstorms that originate over tropical or subtropical waters. They can involve heavy rains and winds of 74 miles per hour or higher and, in some rare cases, reaching sustained wind speeds of 160 mph. Hurricanes can cause extensive wind damage, flash flooding and storm surge. The peak months for hurricanes are August and September; however, hurricane season extends from June 1st to November 30th each year.
Earthquake	An earthquake is a sudden release of energy from the earth's crust that creates seismic waves. These waves are sudden rolling or shaking events caused by the movement under the earth's surface. Earthquakes happen along cracks in the earth's surface, called fault lines, and can be felt over large areas, although they usually last less than one minute. The movement of tectonic plates creates strain at the fault line. When the strain becomes too great, the rocks give way, and the earthquake is felt at the surface.

Drought	A drought is the condition of having insufficient moisture, whether from groundwater or precipitiation, to sustain vegetation, animals, and humans over a large area. Although the term drought is usually reserved for a period of below-average rainfall, it can also be caused by the drying up of reservoirs or lakes or any other resource that provides liquid water for the area.
Severe Winter Weather	Winter storms occur when there is enough precipitation at a low enough temperature to turn rain into sleet, snow, or even ice. A winter storm can range from freezing rain and ice over the course of a few hours, to moderate snowfall, to blizzard conditions that can last for several days.
Wildfire	Wildfires are usually triggered by lightning, human carelessness, arson or even simple accidents. Wildfires are uncontrolled forest fires, grassland fires, or urban-interface fires, which consume the natural fuels found in the environment. These fires spread quickly from wildland or rural areas igniting bushes, ground cover, and trees and if not contained, can then move to homes and other structures in suburban or other populated areas.
Lightning	Lightning events are generated by atmospheric imbalance and turbulence due to a combination of conditions. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground.
Tornado/Wind Event	A tornado is a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground. Tornadoes can strike anywhere, at any time, and with little warning. Tornadoes generally occur near the trailing edge of a thunderstorm and are considered the most violent of all atmospheric storms. Windspeeds can reach 300 miles per hour and the damage paths can reach over one-mile-wide and over 50 miles long.

This chapter provides an overview of past natural hazard events that have occurred in Howard County and brief descriptions of the potential for future losses based upon the past experiences and future probability of an event occurring. Chapter 5, Vulnerability Assessment and Loss Estimation provides a more detailed analysis of past and potential future risks and subsequent expected losses based on the most significant hazards to potentially impact Howard County.

4.3 Overview of Howard County's Natural Hazards History

Howard County completed a comprehensive HIRA in February of 2017. This HMP update relies heavily on the findings of that HIRA. The HMP update uses best available data to identify, describe, and explain the potential severity and extent of impact of each hazard. While numerous government agencies maintain records regarding natural hazards losses, no single source provides a definitive account of losses due to natural hazards. Although the data between sources may not always align, this HMP update relies heavily on data from the National Oceanic Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC), the 2017 Howard County HIRA, and FEMA. By analyzing this data, we can paint a comprehensive picture of the extent, severity, and impact a natural hazard event may have on the County. According to the Howard County HIRA and the NCDC Database, Howard County has experienced or has been affected by the following events (Table 4.2), specifically from between 1950 and 2018.

Table 4.2– Hazard events in Howard County from 1950 to 2018

Type of Events	Number of Events
Hurricane/Tropical Storms	13
Winter Storms/Ice Storms	87
Droughts/Extensive Heat	8
Floods/Flash Floods	97
Tornado/Wind Event	228
Earthquakes	26
Wildfire	5
Lightning	6

*Past event search from 1950-2018, although some events did not begin recording until several years later.

The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (the Stafford Act) establishes a systematic way for a Presidential Disaster Declaration by the President to trigger financial and physical assistance for States and local jurisdictions. It is at the President's discretion to issue either a Major Disaster Declaration or an Emergency Declaration during an emergency. As part of the documentation process, FEMA maintains records of these types of declarations, along with federal expenditure records, on its website.

Howard County has received 15 Major Disaster Declarations since 1971, which are summarized in Table 4.3. Of the 15 Major Disaster Declarations between 1971 and 2018, six were snow events, four were flooding/severe storms-related events, and five were hurricanes/tropical storm events. These figures and events are discussed in more details in the hazard-specific subsections that follow.

Table 4.3 - Major Disaster Declarations in Howard County (1971 to 2018) [48]
Source: FEMA

Date	Event Type	Event Description
FEMA DR-127 3/12/1962	Severe storms/flooding	No information available
FEMA DR-309 8/17/1971	Severe storms/flooding	On August 17, 1971, storms caused flooding to the Baltimore and Washington, DC metropolitan regions. Declarations was made for local jurisdictions from Harford County to Prince George's County for FEMA Public Assistance (Category B – Emergency Protective Measures).
FEMA DR-341 6/23/1972	Tropical Storm Agnes	Hurricane Agnes made landfall on the Florida Panhandle and traveled northwestward, bringing with it strong winds and heavy rains. The Patuxent, Little Patuxent and Patapsco Rivers all exceeded their 100-year flood levels. Eight people were killed and 700 families were left homeless.
FEMA DR-489 10/4/1975	Heavy rains/flooding	On October 4, 1975, heavy rains caused flooding. Fourteen counties were declared for FEMA Public Assistance (Category B - Emergency Protective Measures).

[48] FEMA, Disasters, available at https://www.fema.gov/disasters.

Date	Event Type	Event Description
FEMA DR-1081 1/11/1996	Blizzard	A winter storm known as the "Blizzard of '96" crippled most of Maryland during the first weekend of January 1996. In general, snow totals were as follows: 20 inches in lower Southern Maryland, 20 to 26 inches in Central Maryland to include Howard County, and 26 to 36 inches over the northern tier.
FEMA DR-1324 4/10/2000	Winter storm	A low-pressure system off of Cape Hatteras rapidly intensified on January 24, 2000. The storm soon developed into a nor'easter and began to track northward along the Eastern shoreline. On January 25th, the storm brought snowfall totals ranging from 1 inch to 20 inches across the state. The higher amounts of snow occurred around the Chesapeake Bay. A total of 11.5 inches of snow fell in Columbia, Maryland.
FEMA DR-1492 9/19/2003	Hurricane Isabel	On September 18, 2003, Hurricane Isabel made landfall on the North Carolina coast. Isabel raced inland, bringing rain and wind. There was no major flooding caused by the storm. However, many trees were toppled from the wind combined with the saturated ground. At one point, over 50% of the County was without power. Five homes suffered major damage and another eight suffered minor damage.
FEMA DR-1875 2/19/2010	Winter storm	This was the first of two major blizzards that occurred during the 2009-2010 winter. On December 18, 2009, two low pressure systems merged to form a strong low-pressure system over the Mid-Atlantic. The new low was able to gather moisture from the Gulf of Mexico and the Atlantic Ocean, while the high-pressure system to the north kept the cold air in place. From December 18th to December 20, 2009, between 14 and 17 inches of snow fell across the County.
FEMA DR-1910 5/6/2010	Winter storms	DR-1910 was issued in response to the February 5th to February 11, 2010 blizzards. The first blizzard caused snow accumulations between 12 to 38.3 inches. The second blizzard added an average of 12 to 21.5 inches across the County. As the low pressure intensified, strong winds caused blowing and drifting snow that led to whiteout conditions. All Maryland counties, with the exception of Somerset and Worcester Counties, were declared for FEMA Public Assistance (Category B – Emergency Protective Measures).
FEMA DR – 4034 9/16/2011	Hurricane Irene	In Maryland, the hurricane left more than 700,000 people without power. Damages were estimated at approximately $16 million, with the most severe damages occurring in the Eastern and Southern portion of the state. A Presidential Disaster Declaration (FEMA-DR-4034) was declared for 13 of the 24 counties in Southern and Eastern Maryland. Also, all Maryland jurisdictions were eligible for Hazard Mitigation Grant Program.
FEMA DR – 4038 10/05/2011	Remnants of Tropical Storm Lee	Following TS Lee, assessments show Howard County suffered approximately 2 million dollars' worth of damage. Main Street in Historic Ellicott City was severely flooded, where sixteen homes in the area sustained flood damage of various degrees. The Presidential Disaster Declaration (FEMA-DR-4038) was declared for the following counties: Anne Arundel, Baltimore County, Cecil County, Charles County, Harford County, Howard County, and Prince George's County.

Date	Event Type	Event Description
FEMA DR-4091	Hurricane Sandy	A power outage at a water treatment plant resulted in the release of wastewater. Water contamination became a significant threat to health and the environment for those downstream from the plant. Water mains feeding Howard County from the City of Baltimore failed, and the drinking water supply was limited for a period of 1-2 weeks. On November 20, 2012, President Obama declared that a major disaster exists in the State of Maryland. The Presidential Disaster Declaration (FEMA-DR-4038) was declared for the following counties: Allegany, Calvert, Caroline, Charles, Dorchester, Frederick, Garrett, Harford, Howard, Kent, Queen Anne's, Somerset, St. Mary's, Talbot, Washington, Wicomico, and Worcester Counties and the Independent City of Baltimore.
FEMA DR-4170	Maryland Snow Storm	On April 10, 2014, President Obama declared that a major disaster exists in the State of Maryland. This declaration made emergency protective measures (Category B), including snow assistance under the Public Assistance program available to state and eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work due to the snowstorm. The Presidential Disaster Declaration (FEMA-DR-4038) was declared for the following counties: Baltimore, Carroll, and Howard Counties.
FEMA DR-4261	Maryland Severe Winter Storm and Snowstorm	On March 4, 2016, President Obama declared that a major disaster exists in the State of Maryland. The Presidential Disaster Declaration (FEMA-DR-4038) was declared for the following counties: Allegany, Anne Arundel, Baltimore, Calvert, Caroline, Carroll, Cecil, Charles, Frederick, Garrett, Harford, Howard, Kent, Montgomery, Prince George's, Queen Anne's, Washington, and Worcester Counties and the Independent City of Baltimore. This declaration also authorized snow assistance for a period of 48 hours for the counties of Allegany, Anne Arundel, Baltimore, Calvert, Caroline, Carroll, Cecil, Charles, Frederick, Garrett, Harford, Howard, Kent, Montgomery, Prince George's, Queen Anne's, and Washington and the Independent City of Baltimore.
FEMA DR-4279	Maryland Severe Storm and Flooding	A significant flooding event occurred on July 30, 2016, when a strong storm dropped 6 inches of rain over Ellicott City over a span of two hours. Massive flooding caused extensive damage to businesses and homes on Main Street in Old Town, Ellicott City. The July 2016 storm took two lives and caused at least $22.4 million in estimated damages and caused extensive damage to 90 businesses and 107 homes. On September 16, 2016, President Obama declared that a major disaster exists in the State of Maryland.
FEMA DR-4376	Maryland Severe Storm and Flooding	A flash flooding event occurred on May 27, 2018, when a strong storm dropped 8-10 inches of rain over Ellicott City in a span of five hours. The rapid floodwaters took one life and caused extensive damage to businesses and homes on Main Street in Old Town, Ellicott City.

Table 4.4 provides a summary of the past Emergency Declarations for the County, in which two have been winter storm-related, and 3 have been hurricane/tropical storm-related.

Table 4.4 - Emergency Declarations in Howard County (1993 to 2012) [49]
Sources: FEMA

Date	Event Type	Event Description
FEMA EM-3100 3/16/1993	Winter storm	From March 13th to March 17, 1993, a snow storm hit the State of Maryland. All counties in Maryland were declared for FEMA Public Assistance (Category B – Emergency Protective Measures).
FEMA EM-3179 3/14/2003	Winter storm	From February 14th to February 18, 2003, a storm bought three waves of wintery precipitation. Snowfall totals ranged from 20 to 32 inches across Northern and Central Maryland and the Baltimore Metropolitan area. This was the heaviest snowfall event in the Baltimore region since records began in 1870 (the record will not be broken until the 2010 snowstorms).
FEMA EM-3251 9/13/2005	Hurricane Katrina Evacuation	Between August 29, 2005 and October 1, 2005, an Emergency was declared for the State of Maryland. This Emergency declaration provided federal aid to State and local response efforts to assist evacuees after Hurricane Katrina.
FEMA DR-3335 8/27/2011	Hurricane Irene	DR-3335 was issued as a response to Hurricane Irene making landfall on the East Coast, which brought tropical storm force winds and torrential rains to the region. While no individual assistance is available, almost all Maryland counties except Garrett County, were declared eligible for FEMA Public Assistance (Category B – Emergency Protective Measures).
FEMA EM-3349 8/28/2012	Hurricane Sandy	From October 26, 2012 to November 08, 2012 an Emergency was declared for the State of Maryland. A power outage at a water treatment plant in Howard County resulted in the release of wastewater. Water contamination became a significant threat to health and the environment for those downstream from the plant. Water mains feeding Howard County from the City of Baltimore failed, and the drinking water supply was limited for a period of 1-2 weeks.

4.4 Natural Hazard Related Deaths, Injuries and Property Damage

According to the NCDC database, Howard County has experienced 4 deaths and 6 injuries from natural hazards from 1950 to 2018. [50] Property damage from these natural hazards is estimated at slightly more than $50 million totaled, with no accounting for inflation. Crop damage during the same period is estimated to be roughly $12,000. [51] During the 2012 HMP development the dataset had significantly higher numbers, particularly for injuries and deaths. The current numbers for Howard County in the NCDC were analyzed as part of this plan development and found to be an accurate account for Howard County. It is unknown what resulted in the changes to the dataset.

4.5 Losses Due to Major Disasters

As discussed above, there is no definitive record that exists for all losses due to natural disasters in Howard County. In the United States, estimates for public and private costs of natural hazards range from $2 billion to over $9 billion per event. [52] In most declared disasters, the federal government

[49] FEMA, Disasters, available at https://www.fema.gov/disasters .
[50] NCDC's Storm Events Database, Howard County, MD, available at https://www.ncdc.noaa.gov/stormevents/.
[51] Ibid.
[52] NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2018), available at https://www.ncdc.noaa.gov/billions/.

reimburses 75% of the cleanup and recovery costs, while the remaining 25% is covered by the state and affected local jurisdictions.

As of 2018, Howard County had been part of twelve Presidential Disaster Declarations. The estimated damages for these disasters are summarized below in Table 4.5.

Table 4.5 - Estimated Damages for Federally Declared Disasters In Howard County, Maryland (1965 to 2018) [53]
Source: FEMA

FEMA Disaster	Event/Declaration Date	Event Type	Total Assistance Obligated*
FEMA DR-127	3/12/1962	Severe storms/flooding	No information available
FEMA DR-309	8/17/1971	Severe storms/flooding	$14,925,339
FEMA DR-341	6/23/1972	Tropical Storm Agnes	$117,161,571
FEMA DR-489	10/4/1975	Heavy rains/flooding	$6,112,771
FEMA DR-1081	1/11/1996	Blizzard	No information available
FEMA DR-1324	4/10/2000	Winter storm	$16,744,243
FEMA DR-1492	9/19/2003	Hurricane Isabel	No information available
FEMA DR-1875	2/19/2005	Winter storm	No information available
FEMA DR-1910	2/5/2010 to 2/11/2010	Winter storms	$38,565,855
FEMA DR-4034	9/16/2011	Hurricane Irene	$18,290,538
FEMA DR-4038	10/05/2011	Remnants of Hurricane Irene	$25,302,710
FEMA DR-4091	11/20/2012,	Hurricane Sandy	$32,974,192.47
FEMA DR-4170	4/10/2014	Maryland Snow Storm	$8,701,290.63
FEMA DR-4261	3/4/2016	Maryland Severe Winter Storm and Snowstorm	$69,605,697.91
FEMA DR-4279	7/30/2016	Maryland Severe Storm and Flooding	$7,079,614.80
FEMA DR-4376	5/27/2018	Maryland Severe Storm and Flooding	$22,000,000.00

Note: Total Assistance Obligated is for the entire declared disaster area, not for individual counties or jurisdictions affected and may only represent initial estimates, and not modified or up to date obligations.

4.6 Risk Analysis

In this section the following information is discussed for each hazard: a hazard description; location (i.e. floods in floodplains); severity or extent; impact on life and property; previous occurrences; and the probability of the hazard occurring in Howard County sometime in the future. In analyzing the natural hazards, the future probability of its occurrence is broken down into high, medium or low probability. Table 4.6 breaks down the definition of high, medium, and low probability, in terms of future probability of a hazard occurrence.

[53] FEMA, Disasters, available at https://www.fema.gov/disasters.

Table 4.6 - Definition of High, Medium, and Low Probability of Occurrence

Probability	Definition
High	Event is likely to occur more than once every 5 years.
Medium	Event is likely to occur less than once every 5 years, but more often than once every 30 years.
Low	Event is likely occur less than once every 30 years.

4.6.1 Floods

Description of the Flood Hazard

In the United States, hundreds of floods occur each year, making flooding the most common and widespread of all weather-related natural disasters.[54] Up to 90 percent[55] of the natural hazard disasters across the United States include some degree of flooding. In the United States alone, floods are responsible for more deaths each year than hurricanes, lightning[56], or even tornadoes. Flooding occurs when rivers, creeks, streams, ditches, or other bodies of water receive more water than they can handle. The excess water flows over adjacent banks into the adjacent floodplain. Flooding typically results from large-scale weather systems that generate either prolonged rainfall or short duration heavy rainfall. Other conditions, such as winter snow thaws, over-saturated soil, ice jams, and urbanization, can cause flooding and/or make the flooding situation more severe. In Howard County, flooding will typically occur follow weather events, including, but not limited to: tropical cyclones (either hurricanes or tropical storms), thunderstorms (convectional and frontal), heavy rain events, winter storms, spring thaws, or any combination of these events.

Flooding is a natural event for rivers and streams, and Howard County can be impacted by several different, and potentially interrelated, types of flooding:

- Riverine flooding
- Flash flooding
- Urban flooding

Past flood events in Howard County have shown that many of the streams in the County carry both riverine and flash flood threats. Riverine flooding occurs when rivers, creeks, streams, reservoirs or channels receive too much water, which leads to the excess flow of water over its banks and onto the adjacent floodplain. This type of flooding is often referred to as "overbank" flooding.

Riverine flooding generally occurs over a period of days or weeks. This type of flooding is what is generally referred to as the 100-year flood. Flash floods fall under the riverine flooding category and involve a rapid rise in water level, high water velocity, and can include large amounts of debris that gets caught in the flow. These types of floods can cause significant damage, including the tearing out of trees, the scouring or undermining of buildings or infrastructure foundations, and can lead to the failure of steep slopes and landslides, and can cause injuries or death. The intensity of flash flooding is a function of the amount and duration of rainfall, the steepness/topographic nature of the watershed, stream gradients, presence or absence of watershed vegetation, natural and artificial flood storage areas, and the configuration of the streambed and floodplain. Dam failure and ice jams may also lead to flash flooding.

[54] NOAA's National Severe Storms Laboratory, available at https://www.nssl.noaa.gov/education/svrwx101/floods/
[55] FBIIC's Fact Sheet, available at https://www.fbiic.gov/public/2010/mar/FloodingHistoryandCausesFS.PDF.
[56] NOAA's National Severe Storms Laboratory, available at https://www.nssl.noaa.gov/education/svrwx101/floods/.

Urban flooding is caused by a combination of excessive rainfall or snow melt events that over saturate soils and clog drainage areas. The results of urban flooding are commonly referred to as nuisance, ponding, or overland flooding. In ponding events, water temporarily accumulates in an area until normal drainage allows it to flow away. In extreme cases, overland floods can rise to depths of more than a foot at relatively high velocities. [57]

Location of the Flood Hazard

Howard County's two major rivers (and their tributaries) are often the origin of riverine flooding in the County. These rivers are the Patuxent, which borders Prince George's and Montgomery Counties to the southwest, and the Patapsco, which borders Carroll and Baltimore Counties to the north and northeast. Both rivers are tributaries to the Chesapeake Bay. In Howard County, the Patuxent River watershed includes the main Patuxent River and two branches, the Middle Patuxent and Little Patuxent. Approximately three-quarters of Howard County's land area lies within the Patuxent watershed. The main Patuxent River branch begins at the most western point of Howard County. This river acts as a political boundary between Howard and Montgomery Counties and a source of drinking water for the National Capital Region. The river feeds into two reservoirs, the Rocky Gorge and the Triadelphia Reservoir. The Brighton and Howard Duckett Dams preserve these reservoirs. The Middle Patuxent and the Little Patuxent are two of the three major tributaries of the Patuxent River. The Middle Patuxent starts just south of Interstate 70 and runs through the middle of the County. The Little Patuxent runs southeast through Columbia and joins the Middle Patuxent in Savage.

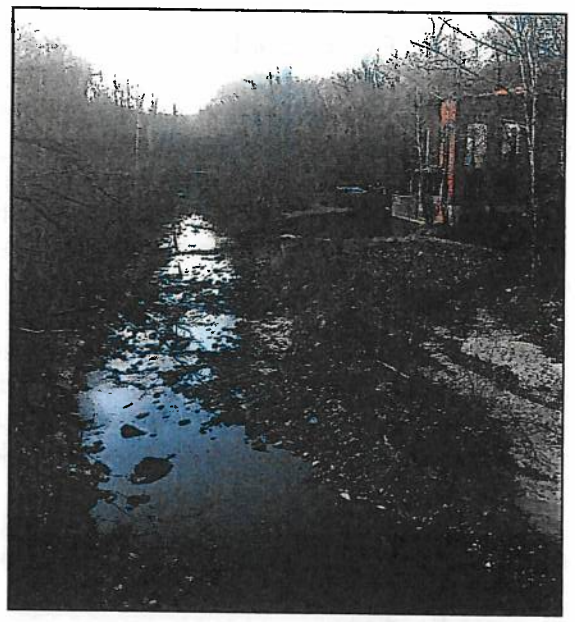


Photo 4.1 Middle Patuxent at Savage Mills

The Patapsco River watershed makes up the remaining quarter of the County's land area. The watershed is located to the extreme north and northwest of the County. The main portion of the Patapsco River acts as a political boundary for the northeast part of Howard County. The river splits into two branches, which serve as the borders for Carroll, Baltimore and Howard Counties.

The Patuxent, Middle Patuxent, Little Patuxent and Patapsco River watersheds can be divided even further to include Cattail Creek, Deep Run, Dorsey Run, and Hammond Branch watersheds. In addition, the County has several other smaller tributaries. These include: Bonnie Branch, Clyde's Branch, Guilford Branch, Plumtree Branch and the Tiber-Hudson Branch. All of these tributaries are susceptible to riverine flooding.

Flood Insurance Rate Maps

[57] NOAA's River Gauges, available at https://water.weather.gov/ahps/.

FEMA prepares and provides public access to the Flood Insurance Rate Maps (FIRMs), which provide an overview of the flood risk and identifies County land that is vulnerable to flooding. FIRMs are used to regulate new development and control the substantial improvement or repair of heavily damaged buildings. Flood Insurance Studies (FIS), often developed in conjunction with FIRMs, contain a narrative of the flood history of a community and discuss the engineering methods used to develop the FIRMs.

The studies also contain flood profiles for studied flooding sources and can be used to determine Base Flood Elevations (BFE) for some areas. The most recent Howard County FIS is dated November 6, 2013[58], and compiles previous flood information and data on drainage areas and discharge estimates for numerous waterways throughout the county.

The Howard County FIRM includes the following flood zone designations identified in Table 4.7 for the County.

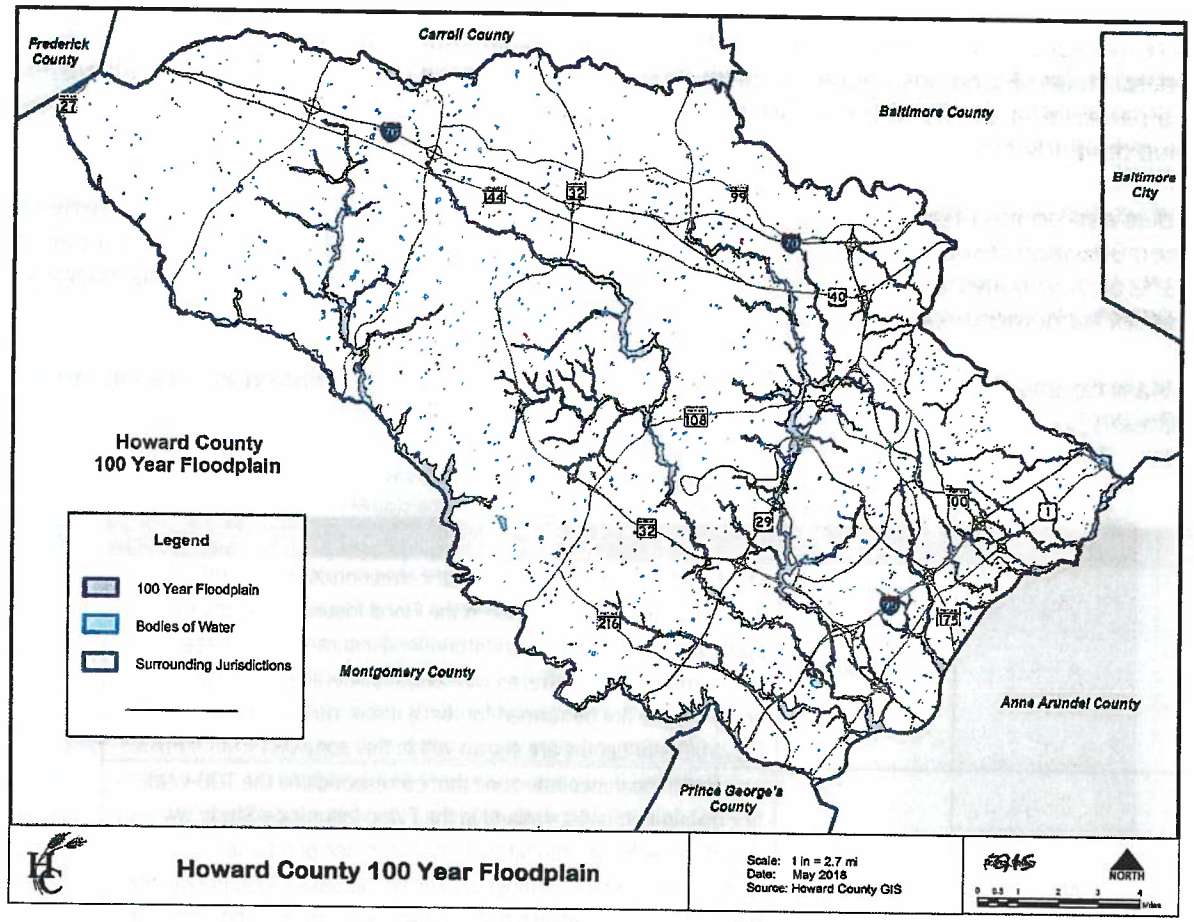
Table 4.7 - Comparison of Flood Hazard Zones
Source: Howard County Stormwater Management Division[59]

Effective Flood Zones	Description	Requirements
A	High flood risk	The flood insurance rate zone that corresponds to the 100-year floodplain that is determined in the Flood Insurance Study by approximate methods. Mandatory flood insurance purchase requirements apply here, as well. Because detailed hydraulic analyses are not performed for these areas, no Base Flood Elevations or depths are shown within this zone on FEMA's FIRMs.
AE	High flood risk	The flood insurance rate zone that corresponds to the 100-year floodplain that is determined in the Flood Insurance Study by detailed methods. Mandatory flood insurance purchase requirements apply. In most instances, the Base Flood Elevations derived from the detailed hydraulic analyses at selected intervals within this zone (the cross sections) are shown on FEMA's Flood Insurance Rate Maps (FIRMs).
X (shaded)	Moderate flood risk	The areas of 0.2% annual chance flood (the 500-year floodplain); areas of 1% chance of flood with average depths of less than 1 foot; or with drainage areas less than 1 square mile and areas protected by levees from 1% annual chance flood. Mandatory flood insurance purchase requirements do not apply here. County development restrictions apply.

Figure 4.1 identifies the most current version of the 100-year floodplain for Howard County based on the FIRM. The majority of the flood-prone areas are located in the eastern, and more urbanized, portion of the County. The Howard County FMP states that 5.5% of the County's land area is located within the 100-year floodplain and are susceptible to riverine, flash, and urban flooding

[58] FEMA, Howard County, Maryland and Incorporated Areas Flood Insurance Study 2013, available at https://www.howardcountymd.gov/LinkClick.aspx?fileticket=fZKU_TK7Z-g%3d&portalid=0
[59] Howard County Government, available at https://data.howardcountymd.gov/gdfirm/Floodplain%20Website%20Updates%20-%20flood%20zones_v3.pdf

Figure 4.1 - Howard County, 100-year Floodplain
Source: Howard County Department of Technology and Communication Services, GIS Division



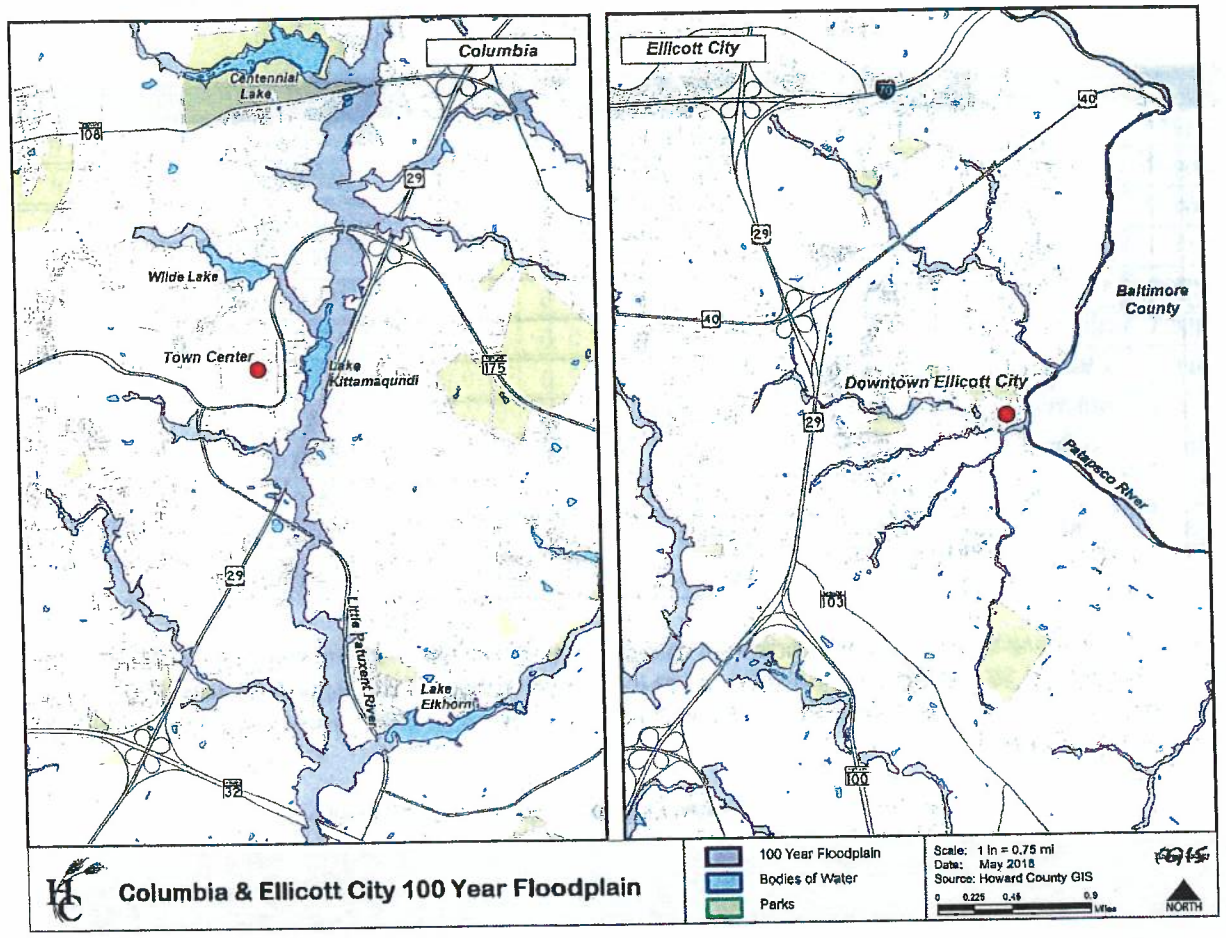
Ellicott City and Columbia are two areas in the region that are highly susceptible to flood damage due to urbanization.[60] Two FIRM maps (one of Columbia, and another of Ellicott City) are included below (Figure 4.2).

Severity (or Extent) of the Flood Hazard

Flood severity is measured in various ways, including frequency, depth, velocity, duration, contamination, and other factors. In Howard County, the severity of the flood hazard depends on the part of the County considered, but severity issues are generally correlated with frequency of occurrence.

[60] FEMA, Howard County, Maryland and Incorporated Areas Flood Insurance Study 2013, available at https://www.howardcountymd.gov/LinkClick.aspx?fileticket=fZKU_TK7Z-g%3d&portalid=0

Figure 4.2 - Columbia and Ellicott City, Maryland: 100-year Floodplain (preliminary DFIRM, May 22, 2012)
Source: Howard County Department of Technology and Communication Services, GIS Division



Flooding along the three major rivers of the County usually occurs during the summer and early fall, mainly as a result of tropical cyclones. Tropical cyclones, thunderstorms, heavy rains, and frontal storms may also force smaller tributaries of the County to overflow and flood. Significant flood events occurred in 1858, 1868, 1894, 1923, 1952, 1971, 1972, 1975, 2003, 2011, 2016, and 2018. The events of the 2016 Ellicott City Flood caused over $22 million dollars in damages and claimed two lives. Although the majority of these flood events were a result of tropical cyclonic-related events, intense local thunderstorms in the spring and summer have been known to cause flooding, particularly flash and urban flooding such as was seen in July of 2016 and May of 2018 as discussed below.

Impact on Life and Property

Much of the potential impact on life and property by flooding has been dramatically reduced by the implementation of strong mitigation practices by the County. After Tropical Storm Agnes in 1972, the County did not rebuild infrastructure or issue building permits in flooded areas.

According to the 2017 Howard County HIRA, there have been 88 flooding events from 1996 to 2016. Only 11 of the 88 flood events resulted in reported property damage. Since the 2017 HIRA

was completed, an additional flood event occur that caused one death and an estimated $22 million in property damage. These 12 flood events are listed below in Table 4.8.

Table 4.8 – Flood Events and Losses in Howard County
Source: Howard County HIRA 2017, NCDC

Event ID	Location	Date	Event Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
5541344	ALL	1/19/1996	Flash Flood	0	0	$5,000	0
5560608	NW PORTION	6/19/1996	Flash Flood	0	0	$20,000	0
5560609	NE PORTION	6/19/1996	Flash Flood	0	0	$10,000	0
5561173	NW PORTION	6/19/1996	Flash Flood	0	0	$30,000	0
5568228	ELKRIDGE	7/30/1996	Flash Flood	0	0	$10,000	0
5572206	COUNTYWIDE	9/6/1996	Flash Flood	0	0	$25,000	0
5569892	W PORTION	12/13/1996	Flash Flood	0	0	$10,000	0
5515118	COUNTYWIDE	6/25/2006	Flash Flood	0	0	$150,000	0
575659	SAVAGE	5/19/2015	Flood	1	0	$10,000	0
593720	SAVAGE	7/6/2015	Flash Flood	0	0	$5,000	0
651633	ELLICOTT CITY	7/30/2016	Flash Flood	2	0	$22,400,000	0
--	ELLICOTT CITY	5/27/2018	Flash Flood	1	--	~$22,000,000	--

The 2018 Howard County FMP indicates that 234 structures are vulnerable to a 100-year flood event. Of these 234 structures, half are located in just three communities; Columbia, Elkridge, and Ellicott City. Table 4.9 shows the number and estimated damages to structures located within the 100-year floodplain.

Table 4.9 - 100-year Estimated Building Exposure and Damage Count
Source: 2018 Howard County Flood Mitigation Plan Update

Study Area	Exposed Structures	Damaged Buildings	Damaged Residential Buildings	Damaged Commercial Buildings
Columbia	38	0	0	0
Elkridge	33	1	0	1
Ellicott City	49	27	9	0
County Total	234	29	9	1

The 2018 Howard County FMP uses FEMA's lost estimation software Hazus 4.2 to assess the County's vulnerability to flooding. The results of the analysis indicated that 30 buildings faced the possibility of sustaining severe damage of greater than 50% in the event of a 100-year flood. Section 7, Vulnerability Assessment and Loss Estimation, includes a detailed discussion of the potential flood impacts on the County.

Occurrences of the Flood Hazard

The NCDC indicates there have been 97 flooding events in Howard County from 1996 to 2018. The majority of these events were labeled as flash floods, and, with the exception of the Ellicott City flood in 2016, caused limited or no property damage, injuries or fatalities. The 2018 Ellicott City flood is not yet included in the NCDC Database, but it is anticipated that it will be added in the near future.

Howard County has had numerous flooding incidents, including major events such as Tropical Storm Agnes in 1972, Hurricane Eloise in 1975, Hurricane Floyd in 1999, Tropical Storm Lee in 2011, Hurricane Sandy in 2012, and most recently the Ellicott City floods of 2016 and 2018. Most incidents are the result of tropical systems, nor'easters or flash flooding from sudden, short-lived rainstorms. To develop the following flood history narratives, information was culled from FIS for Howard County and the NCDC database.

As mentioned previously, the most notorious and destructive flooding events in Howard County were caused by the 2016 and 2018 Historic Ellicott City flash floods. In 2016, a strong storm dropped 6 inches of rain over Ellicott City over a span of two hours. Massive flooding caused extensive damage to businesses and homes on Main Street in Old Town, Ellicott City. The July 2016 storm took two lives and caused at least $22.4 million in estimated damages. The storm caused extensive damage to 90 businesses and 107 homes. More recently, on Sunday, May 27th, 2018, just 22 months after the last flash flooding incident, an unexpected second flash flood occurred in Historic Main Street Ellicott City, Maryland. The flood left in its path one person dead, destroyed businesses, residences, infrastructure, vehicles, debris, and an estimated $22 million in property damage. The topography of Ellicott City is one of the primary contributors to the repetitive flooding and flash flooding issues. The community sits at the bottom of a topographical funnel, at the confluence of several streams feeding into the Patapsco River, which during the 2018 flood, rose more than 18-feet to hit record-level heights.

Tropical Storm Agnes occurred on June 21 – 23, 1972. The Howard County Flood Insurance Study (FIS) estimates the total property damage from the storm to be as high as $41.2 million.[61] The majority of the damage occurred along the Patapsco River in Ellicott City and Elkridge areas. The total damage along the Patapsco River was estimated to be approximately $36 million, the property damage along the Little Patuxent River totaled about $2.4 million, and damage along the Patuxent and Middle Patuxent totaled roughly $512,000.[62] An estimated $1.1 million[63] worth of damages occurred to roads and bridges throughout the County. This massive flood caused at least three fatalities.

Other significant flooding events that have impacted Howard County are summarized below. Major hurricanes/tropical storm events that resulted in flooding is discussed in the Hurricanes/Tropical Storms section later in this chapter.

- **July 24, 1868:** 18 inches of rain fell on Howard County, causing the Patapsco River to overflow. Witnesses noted that the river rose approximately 30 feet in 30 minutes. The flood resulted in 37 fatalities and caused an estimated $4 million[64] in damage.
- **May 1894:** The Patapsco River flooded, causing extensive property damage. The flood resulted in approximately $149,228[65] in damage.

[61] Howard County Flood Insurance Study
[62] Ibid.
[63] Ibid.
[64] Ibid.
[65] Ibid.

- **September 1952:** On Labor Day weekend, Hurricane Abel's heavy rains swept through Howard County. A destructive flash flood caused a log jam in the mouth of the Tiber River and resulted in approximately $4.06[66] million dollars' worth of damage.
- **August 1 – 4, 1971:** Heavy rain flooding caused numerous road closures and damaged several homes. The Patuxent River rose 25 feet in 30 minutes and mud slides damaged roads and bridges. Roads that were flooded and/or damaged included: Owen Brown Road, Morgan Road, Carroll's Mill Road, River Road, Mullinix Mill Road, Howard Chapel Road, Furnace Avenue, Mink Hollow Road, Route 108, Route 32, Centennial Lane, Bethany Lane, and Old Annapolis Road. An estimated $585,400[67] in County property damage was reported.
- **September 22 – 26, 1975:** The remnants of Hurricane Eloise, coupled with snow from a previous storm, resulted in over 12 inches of rain in four days and caused both the Patuxent and Patapsco Rivers to overflow up to 24 feet above normal. Much of Ellicott City and Elkridge were again flooded, as some businesses had just reopened after recovering from the extensive damage caused by Hurricane Agnes. Mud and debris covered the landscape, and homes and businesses were declared unsafe.
- **June 19, 1996:** Storms poured 5.5 inches of rain into Howard County and flooded roads, bridges, and properties. Seneca Creek and Bennett Creek overflowed their banks, causing several roads to be temporarily closed. Two fatalities occurred when a couple rafting in the Patapsco River was swept over a dam in the raging current. $82,500[68] in property damage was reported.
- **September 6, 1996:** The remnants of Hurricane Fran left up to 5 inches of rain in parts of the County and caused physical damage to the County with 40 mph sustained winds. Minor flooding occurred, 36,300 residents of Howard County lost power, and $34,300[69] of property damage was recorded.
- **September 9, 1999:** Thunderstorms moved through the County, producing damaging winds and heavy rainfall across the area. Flooding occurred in Ellicott City, Dorsey, Columbia, and Elkridge. Portions of Route 1 were flooded and cars were trapped by the surrounding water. Water infiltrated homes near Columbia and Dorsey. Precipitation measurements showed 7.39 inches of rain near Columbia and 5.98 inches near Elkridge.
- **September 16, 1999:** The remnants of Hurricane Floyd produced high winds and heavy rains that closed 200 roads and streets countywide. Businesses were threatened by the raging waters of the Patapsco River as its banks overflowed in Ellicott City. Rainfall measurements of 2 to 5 inches were reported throughout the day. County officials reported 17 homes were damaged, 350 basements were flooded, 2 people were rescued, and the Howard Country Fair was shut down for the first time in its 47-year history.
- **Floods of 2003:** Howard County experienced several floods in 2003. First, on February 22nd, widespread flooding was caused by both melting snow from the snowstorm of February 14 – 18th combined with 1.5 to 3 inches of rain. Several roads were closed, including Route 108, Race Road, Furnace Avenue, Triadelphia Mill Road, and Toll House Road. 30 basements were flooded. A few months later, on June 7th – 20th, precipitation systems moved across the region, causing roads and waterways to flood off and on for nearly two weeks. River and stream levels remained high throughout this period, fed by up to 5 inches of rain a day. Several roads were closed multiple times including Furnace Avenue, South Entrance Road,

[66] Ibid.
[67] Ibid.
[68] Ibid.
[69] Ibid.

Carris Mill Road, Warfield Road, Route 108, and Lime Kiln Road. On September 23rd, a few days after Hurricane Isabel brought rain to the region, a heavy rain storm brought 2.5 inches of rain in one day and flooded parts of the County. On November 19th, a strong line of thunderstorms brought 2 to 4 inches of rainfall, which resulted in the closure of several roads. Finally, on December 11th, a heavy overnight rainfall averaging 2 to 3 inches fell on snow-covered grounds, melting the snow. This led to the heightening of rivers and streams as well as the closure of several roads due to rising water.

- **October 8, 2005:** Remnants of Tropical Strom Tammy caused prolonged heavy rainfall that measured 7 inches in 2 days. 10 roads in the County were flooded, 2 homes were damaged by the influx of mud, and a water rescue was conducted in Ellicott City.
- **June 23 – 26, 2006:** A storm system from the south caused torrential rain that continued for 4 days. The ground was saturated and low-lying areas flooded as the area accumulated more than 10 inches of rain. A 2 to 3 feet storm surge, coupled with flood water, washed away part of Vollmerhausen Road Bridge and forced the closing of minor roads. Main Street in Ellicott City flooded, which broke a sewer line.
- **July 23, 2008:** A slow moving cold front produced waves of heavy showers in the afternoon and evening. Flash flooding occurred, closing several roads including I-95, the nation's main thoroughfare on the East Coast, near Elkridge.
- **May 19, 2015:** A cold front was located to the north of the Mid-Atlantic and warm and humid conditions persisted through the evening hours. A bay breeze formed across North-Central Maryland and led to multiple rounds of showers and thunderstorms in this area. Heavy showers also moved into the region from West Virginia and led to heavy rain across north-central Maryland. A pickup truck was swept off a road by flood waters in Savage resulting in the death of the driver.
- **July 30, 2016:** A strong storm dropped 6 inches of rain over Ellicott City over a span of two hours. Massive flooding caused extensive damage to businesses and homes on Main Street in Old Town, Ellicott City. The flash flood caused $22.4M worth of damage, including extensive damage to 90 businesses and 107 homes, and left two people dead.
- **May 27th, 2018:** The second flash flood within a 22-month timeframe occurred along Historic Main Street Ellicott City. A strong storm dropped approximately 8-10 inches of rain over Ellicott City in a span of five hours, and leaving in its path, destroyed businesses, residences, infrastructure, vehicles, and debris, one person dead, and extensive property damage.

Future Flood Probability for Howard County

NCDC identifies a total of 97 flooding events between 1996 and 2018, this means that Howard County experiences, on average, 4.4 flooding events per year. As with most areas of its size, there is virtually 100% annual probability that a flood of some magnitude will occur within the County in the future. With significant flood events occurring in 2003, 2005, 2006, 2008, 2011, 2012, 2016, and 2018, this pattern also emphasizes a high probability of future floods occurring in Howard County.

Chapter 5, Vulnerability Assessment and Loss Estimation, includes detailed probability-based estimates of potential future flood losses for the County and several communities.

4.6.2 Severe Winter Storm

Description of the Winter Storm Hazard
A winter storm is a weather event that produces various forms of precipitation caused by cold temperatures, such as snow, sleet, ice, and freezing rain. The accumulation of these forms of precipitation can immobilize an entire region, leaving roads impassable, triggering utility outages, creating ice jams which cause flooding, and prolonged cold temperatures, which may lead to the loss of lives. These impacts may be enhanced with the presence of windy conditions, which can lead to blizzards, whiteout conditions, and drifting of snow. [70]

Location of the Winter Storm Hazard
Severe winter weather, including snow storms, ice storms, and extreme cold, may affect any part of Howard County during winter. The average winter temperature is 32.4 degrees and the average annual snowfall for the County is 24 inches [71]. Snowfall amounts vary across the State, with western Maryland counties experiencing significantly more annual snowfall, while counties closer to the Atlantic Ocean generally have a smaller annual snowfall total.

Generally, the winter storm season for the eastern portion of Maryland runs from November to mid-March, while the western counties experience longer winters. Severe winter weather has occurred as early as October and as late as May in eastern portions of the State. Within Howard County, the risk to people and property from winter weather cannot be distinguished by area, as the hazard is not spatially constrained and has an equal probability of occurrence anywhere within the County. Although different parts of the County may be impacted in different ways when a severe winter weather event strikes, generally all people and assets are considered to have the same degree of exposure.

Severity (and extent) of the Winter Storm Hazard
Typically, Howard County remains cool during the winter months. Heavy snow events can be common during certain years, with snow fall totals surpassing 12 to 18 inches. During other years, snowfall events could be considerably less. Generally, January is the coldest month, with an average temperature slightly above freezing at 33.3 degrees Fahrenheit. February commonly has the highest snow fall, with 9.61 inches of average snow fall.

It is possible for an occasional ice storm, freezing rain event, or sleet to impact the County. Winter storms along the Atlantic Coast can bring a wintery mix of precipitation - where the event may start out as rain and switch over to snow (or vice versa). A wintery mix event may cause more sustained damage than a single-precipitation winter event. For example, if a wintery mix started as snow and then switches over to rain, the weight of the fallen snow may bring down trees and electrical lines. Another possible characteristic of severe winter storms is extreme cold temperatures, where single digit temperatures and wind chills below zero are possible.

Snow events such as winter storms, heavy snow fall, ice, wind, and cold temperatures have the potential to create hazardous situations. Over the years, Howard County has sustained varying

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[70] NOAA's *Hydrometeorological Prediction Center*, https://www.wpc.ncep.noaa.gov/wwd/winter_wx.shtml. See also *Winter Weather Basics*, http://www.nssl.noaa.gov/primer/winter/ww_basics.html
[71] Howard County Economic Development Authority, Climate and Geography, available at http://www.hceda.org/why-howard-county/living/climate-geography/.

degrees of damages from winter storm events. These storms have affected the entire County by restricting travel, downing trees, interrupting electrical power, and causing water main breakage. The 2009-2010 winter season had the highest recorded snowfall on record, with 77 inches of snow falling across the area. Several other snow events brought over 12 inches of snow to the County during that period. These smaller snow events, along with sleet, freezing rain, and cold temperatures, caused physical damage to the environment.

Impact on Life and Property

Winter storms are prevalent on a yearly basis for the County, but significant improvements to building codes, maintenance to structures, and weather forecasting has dramatically decreased the threat to people and property. Even with these improvements, a risk of injury or death to individuals during a winter event may still exist, particularly with elderly persons, small children and infants and/or the chronically ill. These groups may be more susceptible and vulnerable to injury or death if they are exposed to the winter event or if they do not have adequate heating in their homes. Also, heavy snow loads may cause possible structural damage or even failure to buildings and infrastructure.

Severe winter storms could also result in increased traffic accidents, impassable roads, and loss of business or income. On the roadways, snow and ice can reduce visibility and affect automobile traction as bridges can freeze before the majority of the roadways. Disruption of the roadways and other transportation methods is a threat to the County's economic well-being, for individuals will not be able to travel to work and the shipment of goods could come to a standstill.

County residents may also be affected physically by severe winter storms. People may injure themselves while walking on ice and snow, or suffer heart attacks as a result from overexertion from shoveling snow. Although rare, carbon monoxide poisoning may occur during winter events when heaters, automobile mufflers or generators are not vented properly.[72] Frostbite and hypothermia may also lead to death or injury.

Occurrences of the Winter Storm Hazard

The NCDC database reports Howard County has experienced 137 severe winter weather events between 1969 and 2016 (severe winter weather events include any Avalanches, Blizzards, Cold/Wind Chill events, Extreme Cold/Wind Chill events, Freezing Fog, Frost/Freeze events, Heavy Snow events, Ice Storms, Lake-Effect Snow events, Sleet events, Winter Storms, or Winter Weather events to occur in the jurisdiction). Although the query results start in 1969, the first reported severe winter event was in 1993. Of the severe winter events, only seven resulted in property damage. Table 4.10 lists the seven winter weather events that resulted in deaths, injuries, property damage, or crop damage for Howard County between 1995 and 2016. Data from the NOAA/NCDC database is derived from a number of sources but may not be the most exhaustive resource for consequence figures. At the time of the search, the NOAA/NCDC database only contained data through the end of 2014. Although not indicated in the NCDC database, the severe winter storms in December 2009 and February 2010 also resulted in property damage.

[72] *Two Improving in Ellicott City Carbon Monoxide Poisoning that Left One Dead*, available at http://www.baltimoresun.com/explore/howard/news/ph-ho-cf-co-poisoning-0901-20110830,0,3266348.story.

Table 4.10 - Winter Weather Events that Resulted in Deaths, Injuries, Property Damage, or Crop Damage for Howard County (1995-2016)
Source: Howard County HIRA 2017, NCDC

Event ID	County	Date	Event Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
5541132	HOWARD	1/7/1996	Blizzard	0	0	$10,000	$0
5600186	HOWARD	4/10/1997	Frost/Freeze	0	0	$0	$50,000
5633246	HOWARD	3/11/1998	Cold/Wind Chill	0	0	$0	$2,500
5680092	HOWARD	1/14/1999	Ice Storm	0	0	$40,000	$0
5344135	HOWARD	2/14/2003	Winter Storm	0	0	$543,000	$0
5491961	HOWARD	2/11/2006	Heavy Snow	0	0	$40,000	$0
215216	HOWARD	2/5/2010	Winter Storm	0	0	$5,000	$0

The NCDC database indicates that one of the most severe winter storms resulting in property damage and loss of life occurred on February 14, 2003 and lasted until February 18, 2003. The system brought three waves of wintery precipitation to the region. The first line of precipitation started to fall on the evening of the 14th as a mix of light to moderate snow or rain. The next round, on the 16th and 17th, took the form of heavy wet snow and sleet. The event ended with snow showers tapering off on the 18th. When the winter storm ended, snowfall totals ranged from 20 to 32 inches across the Baltimore Metropolitan area. Estimated regional property damages from the storm were $6.1 million. In Howard County, a stable, a warehouse, a store awning, a tennis bubble dome, a greenhouse, and a shed collapsed under the weight of the snow. [73]

More recently, the 2009-2010 winter season brought the highest snowfall on record in the region. Several waves of severe snow events dropped over a foot each of snow in the County. The first low pressure system arrived on the night of December 18, 2009. The system strengthened on the 19th, as moisture from the South pushed northward while the cold air remained in place. Snowfall totals ranged from 14 to 17 inches across the County. As a result of this event, a Presidential Disaster Declaration (DR-1875) was issued for the State of Maryland on February 19, 2010 for the December storms. Before the Presidential Disaster Declaration was even issued for the December storms, the State was hammered yet again by a line of severe winter storms from February 5th to February 11th, 2010 and produced a snowfall of 10 to 20 inches across the County. Certain parts of the County had even higher localized amounts. As a result of this event, another statewide Presidential Disaster Declaration (FEMA DR-1910) was declared on May 6, 2010 for the February storms.

Other significant winter storm events that have impacted Howard County are summarized below.

- **February 1899:** Also known as the "Great Eastern Blizzard of 1899," this February 1899 storm is one of the earliest documented severe winter storm events in the area. The storm produced approximately 20 inches of snow across the region.
- **January 5, 1912 – February 12, 1912:** Known as the "Great Cold Wave" of January 1912, extreme cold was recorded across the region. In Howard County, reports showed that temperatures fell close to 20 degrees below zero.

[73] *NCDC Storm Events Database*, available at https://www.ncdc.noaa.gov/stormevents/.

- **January 27, 1922 – January 28, 1922:** Known as the "Knickerbocker Storm," the nor'easter brought 30 to 32 inches of snow across the County. The high winds also brought blizzard and whiteout conditions across the region.
- **March 29, 1942 – March 30, 1942:** The "Palm Sunday Snowstorm" was the heaviest March snowstorm on record in Maryland. The storm dropped over 20 inches of heavy, wet snow in Howard County.
- **February 18, 1979**: The "Presidents' Day Storm" brought snow of up to 20 inches over the Northern Virginia and Maryland region. At times, snow was falling 2 to 3 inches an hour, and temperatures fell to the single digits.
- **February 11, 1983 – February 12, 1983:** The "Blizzard of 1983" brought over two feet of snow covered the County. During certain periods, snow fell at a rate of 3.5 inches per hour.
- **January 7, 1996 – January 13, 1996:** The "Blizzard of '96'" brought between 18 and 30 inches of snow to Howard County on January 8th. On the 9th, an "Alberta Clipper" left an additional 3 to 5 inches of snow throughout the region. A third storm brought another 4 to 6 inches of snow. The County had 2 to 3 feet of snow by the end of the week.
- **January 14, 1999:** An arctic cold front moved over Central Maryland and brought snow to the region. The snow turned to rain while the ground remained below freezing, which created hazardous conditions. Ice accumulations ranged from ¼ to ½ inch. With wind gusting over 40 mph, fallen trees and power outages occurred across the County. As many as 39,000 households were without power. The Governor declared a State of Emergency for Howard County and the surrounding counties.
- **December 11, 2002:** A low pressure system produced between 1 and 2 inches of rain. However, the rain turned to ice as temperatures dropped below freezing. In some locations, ice accumulated to ¼ of an inch thick. In Howard County, 22 people were treated for slip and fall injures related to the ice accumulation.
- **February 14-19, 2003:** A high pressure system held a low, definite Nor'easter in place during Presidents' Day weekend of 2003, resulting in one of the most severe snowstorms to affect the East Coast in recorded history. The Baltimore region received 28.2 inches of snow. As a result of this storm, all three airports in the region were closed, and schools were closed for a week.
- **February 11, 2006 – February 12, 2006:** Storm totals ranged from 14 to 22.5 inches across the Baltimore/DC Metropolitan area with Howard County suffering a direct hit. The highest snowfall total occurred in Columbia Hills, located in the north-east part of the County, with up to 22.5 inches recorded. There were numerous reports of downed trees and power outages in the County. NCDC estimated property damage to be $248,000 for the event.
- **February 12, 2008:** A wintery mix of snow and ice produced roughly an inch of snow and between $^{1}/_{10}$ to $^{3}/_{10}$ of an inch of ice. The central and eastern portions of Maryland saw a quick change from snow to ice, which froze just before the evening commute. As road conditions deteriorated, a number of accidents were reported across the region.
- **January 26, 2011 – January 27, 2011:** A snowfall event produced between 8 to 13 inches of snow across the County. The heavy, wet snow brought trees and power lines down and left thousands without power. Unfortunately, the storm coincided with the evening commute and led to numerous car accidents and roadway shutdowns. There were several reports of tractor trailers jackknifing due the slick road conditions.
- **January 22, 2016 – January 24, 2016:** A coastal low pressure rapidly intensified as it tracked up the Mid-Atlantic coast. The strong low-pressure system dropped heavy amounts of snow and produced blizzard-like conditions throughout the county and across central and

southern Maryland. In Howard County, up to 28.8 inches of snow were observed in Columbia and a report of 27.5 inches was received near Ellicott City. [74]

With a total of 137 severe winter weather events between 1993 and 2016, Howard County experiences on average 5.9 winter storm events a year. With 6 winter storms occurring per year, there is a 100% annual probability of a winter storm event occurring in Howard County in the future.

4.6.3 Wildfire

Description of the Wildfire Hazard

Wildfires are uncontrolled forest fires, grassland fires, rangeland, or urban-interface fires which consume natural fuels and spread in response to the environment. [75] Wildfires can be either a natural phenomenon, caused by drought or lightning, or human-caused, whether accidentally or deliberately. An estimated 97% [76] of wildfires are caused by people. Wildfires can play a positive or destructive role in the evolution of an ecosystem depending on the duration and extent of the event. Forest and grassland fires can occur throughout the year. In Maryland, the greatest threat of wildfires occurs during the spring season, in the months of March and April. The length and severity of the burning season largely depends on weather conditions. During the spring, the region experiences low humidity, high winds, below-normal precipitation, and high temperatures, which all contribute to high fire danger. Wildfires can also occur in late fall. Depending on weather conditions, the month of November also generally has a high rate of wildfires.

Location of the Wildfire Hazard

Although the U.S. Forest Service's (USFS) Fire Modeling Institute [77] places Howard County in the "very low" category for potential wildfire hazards (Figure 4.3), wildland-urban interface (WUI) fires are becoming increasingly problematic in Maryland. As people continue to live and work near wildland areas, the threat to private property from wildfires increases. This phenomenon is growing in Howard County as suburbanization and population growth continues in the County. Although urban interface fires have the greatest possibility to cause property damage, the potential for wildfires exists throughout the entire planning area.

The greatest risk for significant wildfires to occur would be in large, forested areas such as the Patapsco State Park and the Hugh Thomas Wildlife Management Area to the north. The Patapsco River Valley, where Patapsco State Park is located, is characterized by steep slopes exceeding 20% grade. In addition, dense vegetation and hardwoods provide ample fuel for fire. In the southern portion of the County, the Rocky Gorge Reservoir Park and the Patuxent Wildland Area are also areas at risk for potential wildfires. The Patuxent Wildland Area is a State-designated wildland, which restricts the ability to reduce fuels or create ingress routes. In addition, the characteristics of the Patuxent Wildland Area are similar to the Patapsco State Park, where dense vegetation and hardwoods provide high fuel loads.

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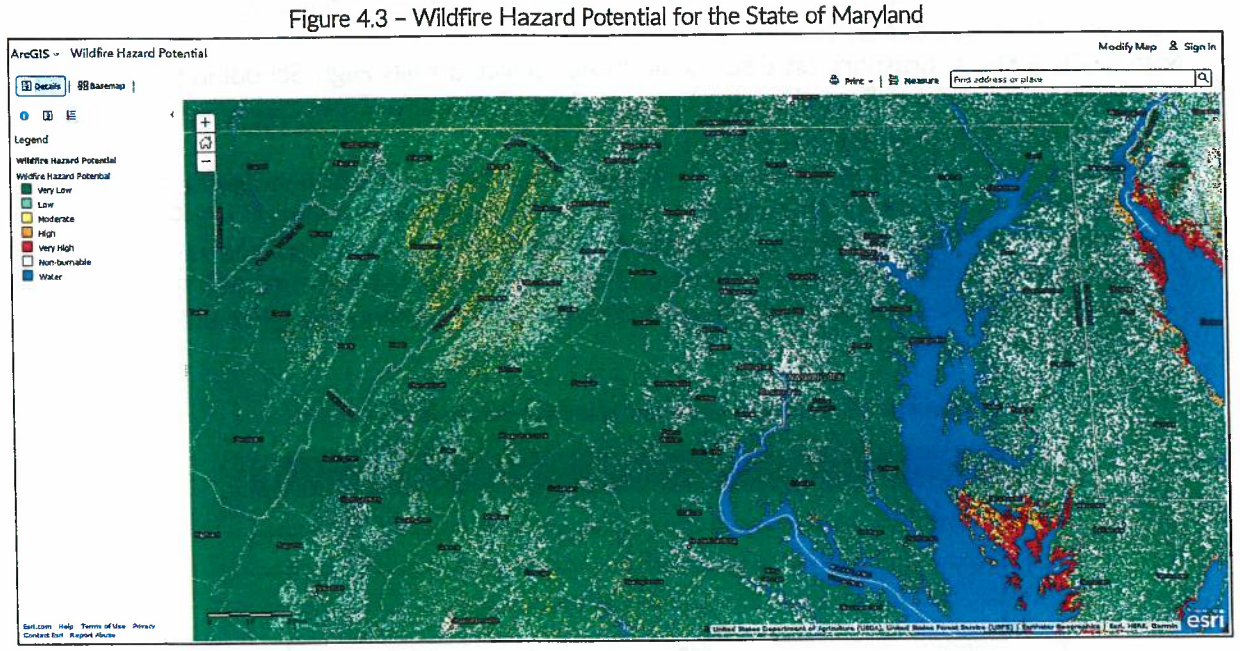
[74] NCDC Storm Events Database, available at https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=609846.
[75] NWCG Glossary of Wildland Fire Terminology, http://www.nwcg.gov/pms/pubs/glossary/w.htm#Wildfire.
[76] Maryland Department of Natural Resources, Wildland Fire in Maryland, available at http://dnr.maryland.gov/forests/Pages/wfm.aspx.
[77] Wildfire Hazard Potential, available at http://www.arcgis.com/home/item.html?id=fc0ccb504be142b59eb16a7ef44669a3.

Figure 4.3 – Wildfire Hazard Potential for the State of Maryland



Severity of the Wildfire Hazard

The frequency and severity of wildfires depends on many factors. The three that control wildfire behavior the most are; the availability of fuels, the weather, and the areas topography. The speed and intensity of a fire will usually increase as the slope and wind increases, and the humidity decreases[78]. The severity in Howard County has been historically very low, and the duration of wildfires has ranged from a matter of hours to several days.

Impact on Life and Property

As previously mentioned, the populated areas considered most at-risk from wildfires are located in the large forested areas, such as Patapsco State Park and the Hugh Thomas Wildlife Management Area in the north. There have been no reported deaths or injuries from wildfires in the planning area.

Occurrences of the Wildfire Hazard

Wildfires incident data shows fires in Maryland occur relatively frequently. The Maryland Department of Natural Resources indicates that the State as a whole averaged 419 natural cover fires per year from 2004-2015. Table 4.11 summarizes the total number of fires and acres for the State of Maryland between 2004 and 2015.

Although NCDC indicates zero wildfire events (as they may not have met the threshold for inclusion), the following notable wildfire events to have occurred in the County are described below.

- **March 30, 1999:** A 10-acre brushfire raged for four hours in the Patapsco Valley State Park. Firefighters were then called to a 5-acre brushfire within an hour after extinguishing the park

[78] Maryland Department of Natural Resources, available at http://dnr.maryland.gov/forests/Pages/wfm.aspx

fire. Firefighters responded to four other fires within eight miles of one another. The high number of fires was due to drought-like conditions.

- **March 23, 2004:** A brushfire on County land near Oakland Mills High School in Columbia burned 10 acres of land. Fueled by dead corn stalks and trees, the fire raced across an open field before firefighters contained it an hour later. [79]
- **February 19, 2011.** High winds with gusts up to 45 mph, high temperatures, and low humidity contributed to the start of eight brushfires, which eventually burned down 20 acres. One of the largest fires occurred near the 3800 block of Manor Lane in Ellicott City. A wildfire was also located on Interstate 95 in the Laurel area between MD 198 and the Capital Beltway closing down both northbound and southbound lanes until the fire was brought under control.

Table 4.11 - Fires and Acres Burned in Maryland from 2004 - 2015 [80]
Source: Maryland Department of Natural Resources

Year	Total Number of Fires	Total Acres Burned
2004	253	3,149
2005	441	4,344
2006	753	6,074
2007	622	5,102
2008	583	2,339
2009	408	4,853
2010	170	1,503
2011	825	8310
2012	159	837
2013	122	160
2014	118	1,720
2015	158	1,077

Although wildfire incidents are expected to occur more frequently due to increased human activity in forested areas, no acceptable mechanism exists to assign probability to fire occurrences. As noted, wildfire incidents are directly related to weather patterns and other conditions, and thus the probability of occurrences are dynamic.

4.6.4 Hurricane/Tropical Cyclones

Description of the Hurricane/Tropical Cyclones Hazard

Hurricanes and tropical storms are collectively known as tropical cyclones. NOAA defines a tropical cyclone as a "warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center. Once formed, a tropical cyclone is maintained by the extraction of heat energy from the ocean at high temperature and heat export at the low temperatures of the upper troposphere." [81]

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[79] Sentementes, Gus, *Brush Fire Scorches About 10 Acres*, Baltimore Sun, March 24, 2004, available at http://articles.baltimoresun.com/2004-03-24/news/0403240194_1_firefighters-oakland-mills-corn-stalks.
[80] Maryland Department of Natural Resources, available at http://dnr.maryland.gov/forests/Pages/fire/index.aspx.
[81] *Glossary of National Hurricane Center Terms*, available at http://www.nhc.noaa.gov/aboutgloss.shtml#TROPCYC.

Tropical cyclones are among the most devastating naturally occurring hazards in the United States. Hurricanes are the strongest type of tropical cyclones, and can generate additional hazards that can cause extensive damage such as high winds, heavy rainfall, storm surge, and even tornadoes. While there is potential for hurricane force winds to occur in Howard County, its inland location away from the Atlantic coastline prohibits it from seeing the traditional storm surge associated with a hurricane making landfall. However, this location makes the County more vulnerable to tropical storms and tropical depressions which bring wind and precipitation.

As a tropical cyclone strengthens, it can be become a tropical depression with wind speeds below 38 mph. As a storm intensifies, it becomes a tropical storm with maximum sustained wind speeds ranging from 39 to 73 mph. A storm of that magnitude is given a name once it reaches tropical storm intensity. Further development can produce a hurricane, which can be described as a well-defined low-pressure system with circulation around the "eye" or center of the storm. [82] Table 4.12 provides a concise explanation of each category of tropical cyclones. Table 4.13 provides the wind speeds for designated hurricane categories.

Table 4.12 – Tropical Cyclone - Wind Speeds Categories
Source: NOAA

Category	Wind Speed	Definition
Tropical Depression	< 38 mph	An organized system of strong thunderstorms with a defined surface circulation and maximum sustained winds of 38 mph or less.
Tropical Storm	39 -73 mph	An organized system of strong thunderstorms with a defined surface circulation and a wind speed range from 39 to 73 mph.
Hurricane	74+ mph	An intense tropical low-pressure system of strong thunderstorms with a well-defined surface circulation and a sustained wind speed of 74 mph or more. The term hurricane is used for Northern Hemisphere tropical cyclones east of the International Dateline to the Greenwich Meridian.

Table 4.13 – Saffir-Simpson Wind Scale
Source: NOAA

Category	Maximum Sustained Wind Speed (mph)
1	74-95 mph
2	96-110 mph
3	111-129 mph
4	130-156 mph
5	157 mph or higher

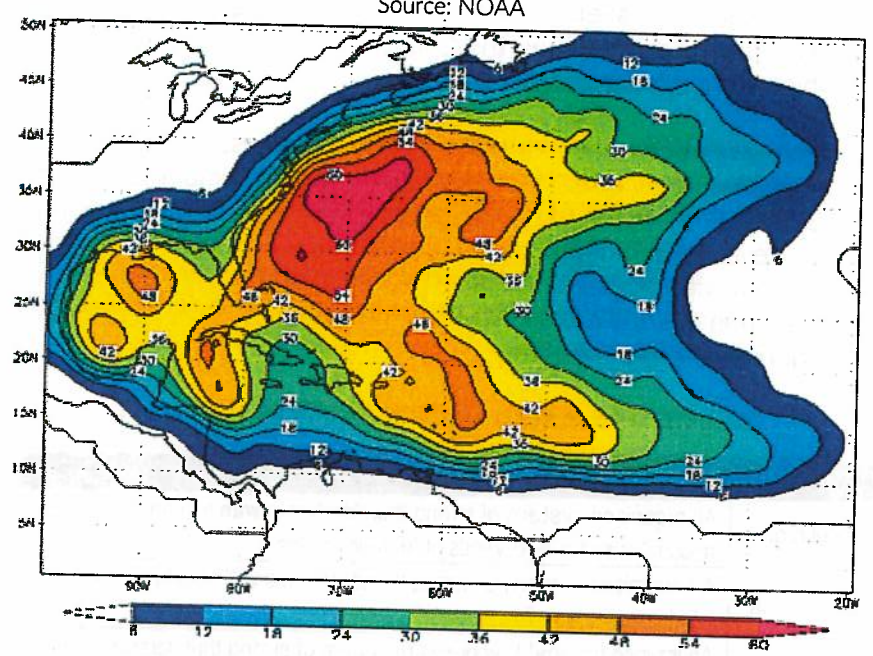
Location of the Hurricane/Tropical Cyclones Hazard

Tropical cyclone risk in the United States extends along the entire East Coast (from Florida to Maine), the Gulf Coast, and Hawaii. Based on historical storm tracks, the Southeastern United States and the Gulf Coast are at greater risk than the mid-Atlantic. As one moves further inland and north along the Atlantic Coast where colder ocean waters are prevalent, the threat of powerful hurricanes diminishes. However, the threat of tropical storms and hurricane remnants still exist, as was the case with Hurricane Sandy. The greatest threat for the occurrence of a tropical cyclone is during the

[82] *NOAA FAQ*, available at http://www.aoml.noaa.gov/hrd/tcfaq/tcfaqHED.html.

Atlantic Ocean/Gulf Hurricane season, which runs from June 1 to November 30 each year. The hurricane/tropical cyclone hazard affects the entire planning area for the County.

Figure 4.4 – Empirical Probability of a Named Storm
Source: NOAA



Severity and Extent of the Hurricane/Tropical Cyclones Hazard

The severity of hurricanes and tropical storms is measured primarily by wind velocity, surface pressure, and storm surge. Hurricane severity is measured by the Saffir-Simpson Scale, which classifies hurricanes on a number scale of 1 to 5, based on factors such as wind speed, storm surge height, and potential damage. The higher the number, the more severe the storm.

Table 4.14 depicts the potential effects of wind damage during a hurricane event.

Table 4.14 – Hurricane Damage Classification
Source: National Hurricane Center

Category	Damage Level	Description
1	MINIMAL	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	MODERATE	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.

Category	Damage Level	Description
3	EXTENSIVE	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4	EXTREME	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	CATASTROPHIC	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Impact on Life and Property

Past tropical storms have had moderate impact on life and property in Howard County. According to Howard County's 2017 HIRA, there have been 13 named tropical cyclones, with only one storm reaching hurricane strength that passed within 65 miles of Howard County between 1950 and 2018. Each of these storms were downgraded to either tropical storms or tropical depressions by the time they reached the Mid-Atlantic region, which is typical for this region. Although not all of these storms brought significant damage, most brought heavy rain and increased high winds across Howard County.

Occurrences of the Tropical Storms and Tropical Cyclones Hazard

Below is a list of notable tropical cyclonic events since 1950 that have significantly impacted Howard County.

- **September 1, 1952 – Tropical Storm Able:** On the night of August 30, 1952, Hurricane Able made landfall over Beaufort, South Carolina. As the storm moved northward across the Carolinas, and Virginia, Able was downgraded to a tropical storm. On September 1st, the center of Tropical Storm Able moved over the western portion of Howard County and brought winds of 35 to 40 mph with 50 mph gusts. The rain associated with the storm caused isolated flooding, while the wind brought down trees and branches and caused power outages to the region. [83]
- **October 15, 1954 – Hurricane Hazel:** Hurricane Hazel was listed as a Category 3 storm when it made landfall 250 miles south of Wilmington, North Carolina. Hazel maintained its hurricane force winds as it rapidly progressed up north. From Southern Virginia to Central Pennsylvania, Hazel produced Category 1 hurricane force winds. The storm passed Washington, DC to the west and then near Hagerstown, Maryland. There were reports of peak gusts in an excess of 130 mph in Howard County.
- **August 15, 1955 – Tropical Storm Connie:** On August 12th, Connie made landfall over the Outer Banks of North Carolina as a Category 1 Hurricane. Hurricane Connie then moved northward across North Carolina. By the time Connie reached Maryland's Eastern Shore on

[83] *Monthly Weather Review*, August 1952. Available at ftp://ftp.library.noaa.gov/docs.lib/htdocs/rescue/mwr/080/mwr-080-08-0134.pdf.

the 13th, it had weakened to a tropical storm. Tropical Storm Connie then moved northwest across the Chesapeake and towards north of Baltimore City; bringing with it 50 mph winds and a substantial amount of rain to the region.

- **August 18, 1955 – Tropical Storm Diane:** Only five days after Connie made landfall, on August 17th, Category 1 Hurricane Diane made landfall near Wilmington, North Carolina. Hurricane Diane was quickly downgraded to a tropical storm as it moved inland. The tropical storm then moved northwest across North Carolina and Virginia before shifting to the northeast over North-Central Virginia. On August 18th, the center of Tropical Storm Diane went through the eastern portion of Frederick County, Maryland, producing winds between 50 and 60 mph. Due to its proximity, Tropical Storm Diane brought a significant amount of rain and flooding to Howard County.
- **June 21, 1972 – Tropical Storm Agnes:** The Howard County FIS estimates the total property damage from the storm to be as high as $41.2 million. The majority of the damage occurred along the Patapsco River in Ellicott City and Elkridge areas. The total damage along the Patapsco River was estimated to be approximately $36 million. Property damages along the Little Patuxent River totaled about $2.4 million and damages along the Patuxent and Middle Patuxent totaled roughly $512,000. An estimated $1.1 million worth of damages occurred to roads and bridges throughout the County. This massive flood caused at least 3 fatalities.
- **September 22, 1975 – Hurricane Eloise:** The remnants of Hurricane Eloise, coupled with snow from a previous storm, resulted in over 12 inches of rain in four days and caused both the Patuxent and Patapsco Rivers to overflow up to 24 feet above normal. Much of Ellicott City and Elkridge were again flooded, as some businesses had just reopened after recovering from the extensive damage caused by Hurricane Agnes. Mud and debris covered the landscape, and homes and businesses were declared unsafe.
- **September 7, 1999 – Tropical Storm Dennis:** The remnants of Hurricane Dennis tracked across Western Maryland on September 7th. The hurricane brought heavy rains and flooding throughout the County. Strong winds also caused power outages throughout the region.
- **September 16, 1999 – Hurricane Floyd:** The remnants of Hurricane Floyd produced high winds and heavy rains that closed 200 roads and streets countywide. Businesses were threatened by the raging waters of the Patapsco River as its banks overflowed in Ellicott City. Rainfall measurements of 2 to 5 inches were reported throughout the day. County officials reported 17 homes were damaged, 350 basements were flooded, 2 people were rescued, and the Howard Country Fair was shut down for the first time in its 47-year history.
- **September 19, 2003 – Hurricane Isabel:** Hurricane Isabel made landfall on September 18th as a Category 2 hurricane. As the storm moved across Southern Virginia, it weakened to tropical storm status. The rain associated with Hurricane Isabel caused isolated flooding, while strong wind brought down power lines and left more than 65,000 homes without power. At one point, 80-90 roads were deemed impassable due to fallen trees. In the end, Hurricane Isabel spared Howard County, but left other Maryland communities suffering substantial damage, particularly areas near the Chesapeake Bay and the Atlantic Ocean.[84]
- **September 3, 2006 – Tropical Storm Ernesto:** Tropical Storm Ernesto made landfall on September 1st in North Carolina. The storm maintained its strength as it tracked northward from North Carolina to Virginia, and then into Southern Maryland. Ernesto's center passed

[84] *NOAA National Hurricane Center's Tropical Cyclone Report; Hurricane Isabel*. Available at https://www.nhc.noaa.gov/data/tcr/AL132003_Isabel.pdf.

just east of Howard County, bringing upwards of five inches of rain and wind guests over 50 mph. Ernesto's winds caused over 44,000 residents in the region to lose power. [85]

- **August 30, 2011 – Tropical Storm Irene:** In Howard County, tens of thousands were left without power in the wake of Hurricane Irene. Initial estimates indicated damage of about $1.9 million in Howard County, where the storm severely damaged two homes and caused significant damage to four others in the Ellicott City area. A total of sixteen homes sustained varying degrees of water damage. The highest rainfall totals in Howard County were around 4-5 inches along the eastern part of the County.
- **September 7, 2011 – Tropical Storm Lee:** On September 7, 2011, the remnants of the storm reached the Maryland area. That afternoon, the combination of a warm front moving across the area and the moisture from the remnants of Tropical Storm Lee produced heavy storms and flooding. With two to three inches of rain falling on already saturated soils, the heavy rains caused flash flooding throughout Maryland. Specific to Howard County, flash flood warnings were issued after heavy rains caused numerous rivers and creeks to rise. According the National Weather Service (NWS), the Little Patuxent River near Savage rose to 13.6 feet on September 7th, its highest level in five years.
- **October 29, 2012 – Hurricane Sandy:** Hurricane Sandy makes landfall to the north of Maryland, but the size of the storm brings heavy rain and high winds to Howard County. A power outage at a water treatment plant resulted in the release of wastewater. Water contamination became a significant threat to health and the environment for those downstream from the plant. Water mains feeding Howard County from the City of Baltimore failed, and the drinking water supply was limited for a period of 1-2 weeks.

In late August and early September 2011, Howard County was affected by a downgraded Hurricane Irene, which became a tropical storm by the time it reached Central Maryland. Hurricane Irene originally made landfall on August 27, 2011 as a Category 1 hurricane near Cape Lookout, North Carolina, with maximum sustained winds of 85 mph. The storm followed the Atlantic coastline as a Category 1 storm, which then made a second landfall as a hurricane near Little Egg Inlet, New Jersey the following morning.

In Maryland, Hurricane Irene caused tropical storm force winds and torrential rains. More than 700,000 people were left without power across the State. Total damage in Maryland was estimated at approximately $16 million, with the most severe damages occurring on the Eastern and Southern portion of the State. A Presidential Disaster Declaration (FEMA-DR-4034) was declared for 13 of the 24 counties in Southern and Eastern Maryland as a result of this storm.

In Howard County, tens of thousands were left without power in the wake of Hurricane Irene. Initial estimates indicated damage of about $1.9 million in Howard County, where the storm severely damaged two homes and caused significant damage to four others in the Ellicott City area. A total of sixteen homes sustained varying degrees of water damage. [86]

Rainfall totals in Howard County were around two inches in the western part of the County, with the rainfall total increasing as one moves eastward. The highest rainfall totals in Howard County were around 4-5 inches along the eastern part of the County. Wind speeds across the majority of

[85] Desmon, Stephanie and Gadi Dechte, *Ernesto's Wind Gusts Punched Away at Maryland*, Baltimore Sun, September 3, 2006, available at http://articles.baltimoresun.com/2006-09-03/news/0609030063_1_arundel-county-rain-anne-arundel.
[86] *Maryland Officials Tally Hurricane Irene Losses*, September 2, 2011, WBALTV, available at https://archive.org/details/WBAL_20110902_210000_11_News_at_5.

Howard County averaged 40-45 mph during the storm. Hurricane Irene also caused widespread power outages throughout the Northeast region.

Tropical Storm Lee made landfall on September 4, 2011 along the Gulf Coast near South-Central Louisiana as a slow-moving storm with heavy rains and winds of 45 mph. The storm slowly moved inland, bringing torrential rain and flooding to the Gulf Coast region. The storm continued inland, tracking towards the Mid-Atlantic and Northeast.

On September 7, 2011, the remnants of the storm reached the Maryland area. That afternoon, the combination of a warm front moving across the area and the moisture from the remnants of Tropical Storm Lee produced heavy storms and flooding. With two to three inches of rain falling on already saturated soils, the heavy rains caused flash flooding throughout Maryland. Specific to Howard County, flash flood warnings were issued after heavy rains caused numerous rivers and creeks to rise. According the National Weather Service (NWS), the Little Patuxent River near Savage rose to 13.6 feet on September 7th, its highest level in five years. [87]

The storms and flooding also resulted in numerous road closures. More than 40 road closures were reported in Howard County, including portions of Route 1 and Route 29. Columbia's South Entrance Road, which connects Little Patuxent Parkway to Route 29 Southbound, was closed in the early afternoon of September 7th.

The most significant flooding from Tropical Storm Lee occurred along Main Street in Historic Ellicott City, an area prone to flooding in the past. The swollen Patapsco River and Tiber Creek River both flooded parts of Main Street. Portions of the road on Main Street were covered in rushing water, causing pockets of water that were several feet deep. Several shops closest to the river and creek were flooded, with up to six feet of floodwater in their basements. [88] As a result of the flooding, the Howard County Department of Fire and Rescue Services (DFRS) evacuated the area from the County line to Cocoa Lane (the 8200 through 8500 blocks). Figures 6.4.4-8 through 6.4.4-10 show flooding along Main Street, as well as behind a municipal parking lot adjacent to Main Street.

As a result of the flooding, a Presidential Disaster Declaration (FEMA DR-4038) was declared on October 5, 2011 for Howard County and several other Maryland counties.

The most recent event was Hurricane Sandy, which occurred in late October 2012. Hurricane Sandy, later known as Superstorm Sandy, drenched Howard County an estimated 10 inches of rain [89] and caused power outages, downed trees, and rivers throughout the county to crest. Business owners in Historic Ellicott City sandbagged their businesses. Windspeeds were estimated between 35 and 45 mph. A power outage at the water treatment plant caused raw sewage to spill into nearby tributaries at a rate of 2 million gallons per hour. Over 365,700 people were reported without power

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[87] Lindsey McPherson, *Heavy Rains Batter County; Flood Warning Extended to Thursday Morning*, Baltimore Sun, September 7, 2001, available at http://www.baltimoresun.com/explore/howard/news/community/ph-ho-cf-flooding-0915-20110907,0,3036295.story.
[88] *Maryland Historical District: Ellicott City Flooding From Tropical Storm Lee*, http://www.mdhistoricdistrict.com/ellicott-city-flooding-from-tropical-storm-lee/ (last accessed March 24, 2012).
[89] http://www.baltimoresun.com/news/weather/weather-blog/bal-wx-maryland-saw-heaviest-superstorm-sandy-rainfall-according-to-official-report-20130212-story.html

statewide, and as of November 2, there were 11 reported fatalities[90], none of which occurred in Howard County, according the NCDC.

With a total of 13 named tropical cyclones between 1950 and 2012, Howard County experiences a tropical cyclone on average approximately every 5 years. These 13 events occurred over a period of approximately 60 years which, upon tabulation, equates to an expected 20% annual probability of future tropical cyclone occurrences in Howard County. While clearly it is possible for multiple tropical cyclones to occur in any given year, this result shows that these types of events have a medium probability of occurrence in Howard County.

4.6.5 Tornadoes and Wind Storms

Description of the Tornado and Wind Storms Hazard

A tornado is " a violently rotating column of air touching the ground, usually attached to the base of a thunderstorm[91]." The windspeed of a tornado can reach over 300 miles per hour. They can leave a path of destruction over one mile wide and 50 miles long. The most destructive tornadoes are formed in the most powerful thunderstorms, known as supercells, which have a well-defined radar circulation showing a "large rotating updraft that occurs inside the supercell[92]", which is called a mesocyclone. Strong downburst (such as straight-line) winds may also occur due to the same thunderstorm. Hail is very commonly found very close to the tornadoes[93].

Tornadoes can form at any time, however the season of greatest activity for the country runs from March to August. The majority of tornadic activity usually occurs between April and June, however peak activity for the mid-Atlantic region is in July[94]. Tornadoes can occur at any time of the day, although they are more likely to occur between 3 p.m. and 9p.m[95]. Figure 4.5 shows the average number of annual tornado activity in the United States.

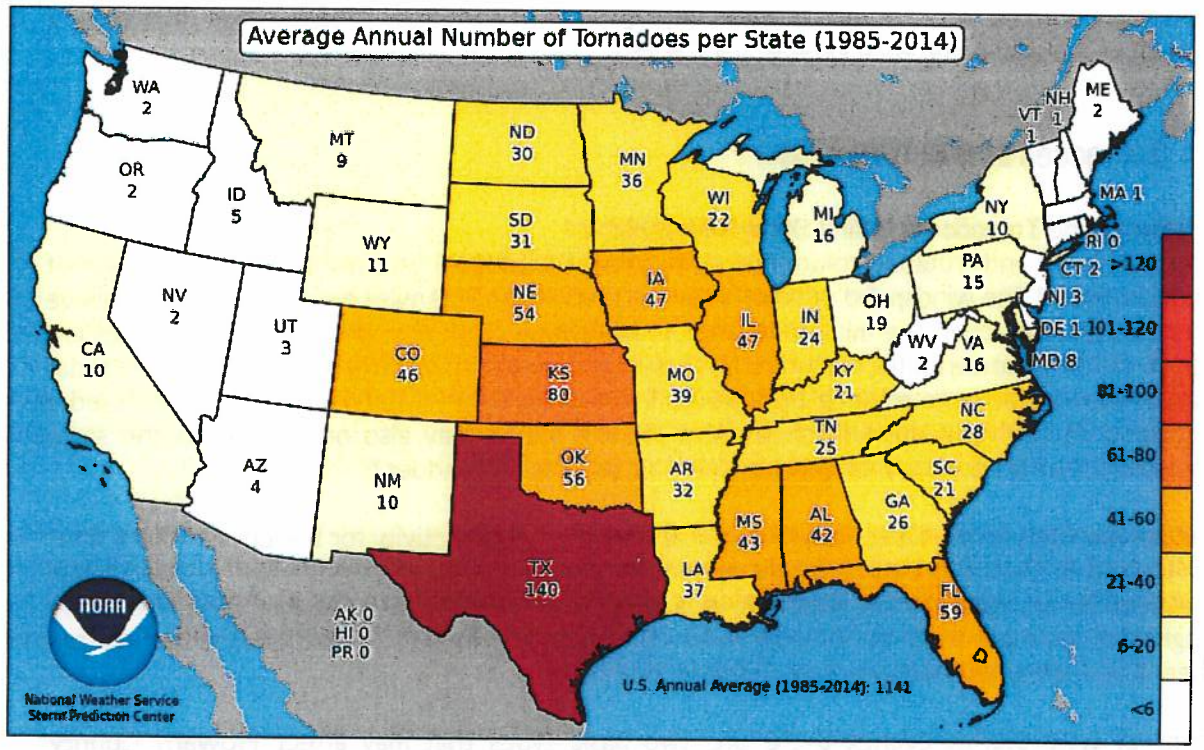
In terms of wind storms events, there are two basic types that may affect Howard County: Mesoscale and Microscale winds. Either type of wind storm events may result in property damage and loss of life. Mesoscale winds are high winds that are long-lasting and occur over a large area. They are typically associated with a cold frontal passage or a Nor'easter. Microscale winds last a short time period and are confided to a small area. Microscale winds are commonly associated with thunderstorms. When a thunderstorm produces winds over 50 knots (roughly 58 mph), that thunderstorm is considered severe.

A downburst, or a sub-set of thunderstorms, is a type of Microscale wind. [96] Downbursts result from a sudden descent of cold air hitting the ground and spreading outward, thus creating a high wind

[90] https://www.washingtonpost.com/blogs/capital-weather-gang/post/hurricane-sandy-and-washington-dc-detailed-storm-timeline-maps-and-frequent-questions/2012/10/28/2c24af1a-2127-11e2-ac85-e669876c6a24_blog.html?noredirect=on&utm_term=.5e4b91eb4d1d
[91] National Weather Service, Tornado Definition, available at http://www.weather.gov/phi/TornadoDefinition.
[92] NOAA's National Severe Storm's Laboratory, Severe Weather 101 – Tornadoes, available at https://www.nssl.noaa.gov/education/svrwx101/tornadoes/detection/
[93] National Weather Service, Tornado Definition, available at http://www.weather.gov/phi/TornadoDefinition.
[94] U.S. Tornadoes, Monthly Tornado Averages by State and Region, available at http://www.ustornadoes.com/2013/03/19/monthly-tornado-averages-by-state-and-region/#mid_atlantic.
[95] Department of Homeland Security, available at https://www.ready.gov/tornadoes.
[96] National Weather Service's Downburst, available at https://www.weather.gov/cae/downburst.html.

event. A downburst can have devastating effects. According to NOAA, there are two types of downbursts, a microburst and a macroburst. A microburst is a small downburst that brings damaging winds up to 168 mph, over an area of 2 ½ miles, and lasts 5 to 15 minutes. A macroburst is a large downburst that causes tornado-like damage, where winds can reach 134 mph, over an area of 2 ½ miles, and lasts 5 to 20 minutes. [97]

Figure 4.5 Tornado Activity in the United States
Source: NOAA



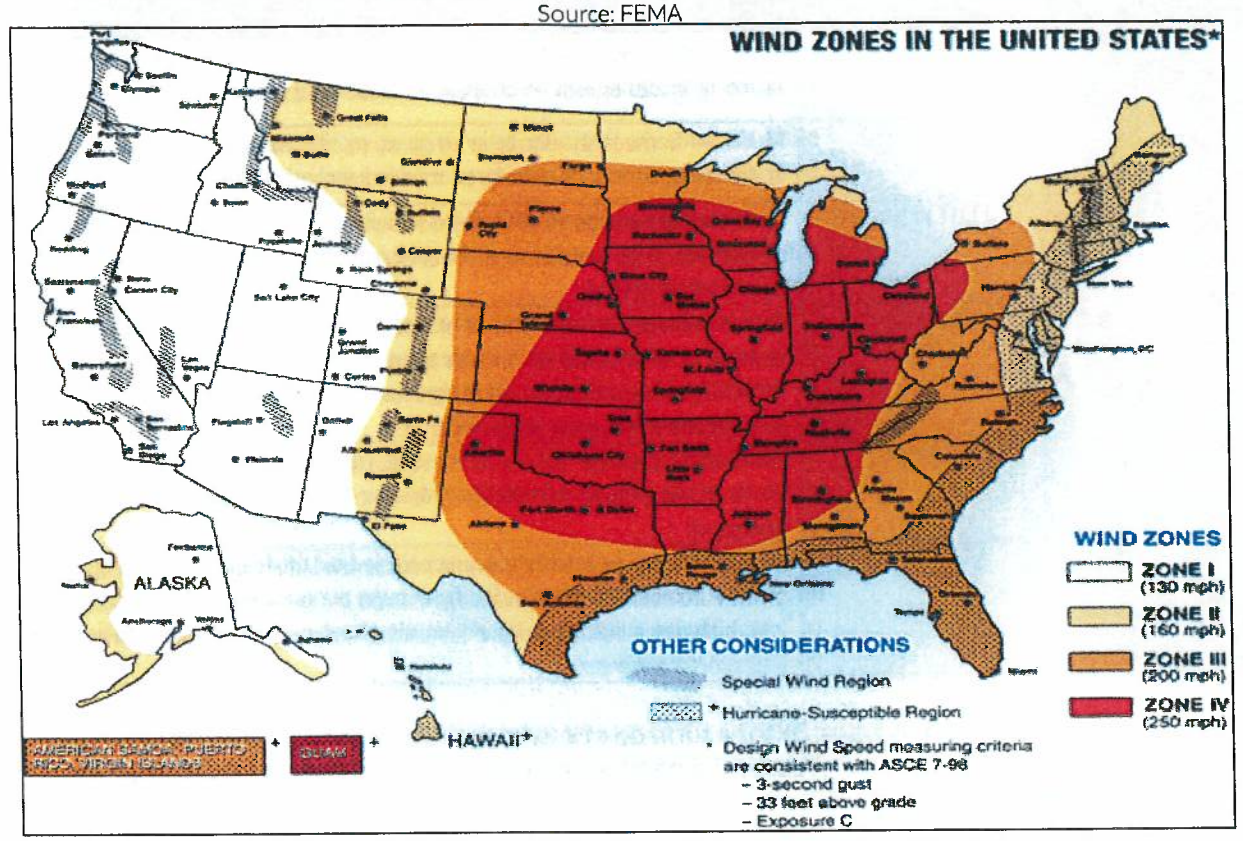
Location of the Tornado Hazard and Wind Storms

Compared to the Central United States, the risk of a tornado occurring in Howard County is present but very low. From 1950 to 2018, the NCDC indicates that Maryland has experienced 410 tornadoes, an average of about six per year. Tornadoes can occur at any time, however statistically show the greatest frequency from late spring to the early summer months, and from late afternoon to early evening. Within Howard County, the risk to people and property from tornadoes cannot be distinguished by area; as with winter storms, the hazard has a uniform probability of occurrence anywhere within the County. Although the impact of a tornado event will be different in different parts of the County, all people and assets are considered to have the same degree of exposure.

Figure 4.6 shows how the frequency and strength of extreme windstorms can vary across the United States. This map is based on a combination of all past occurrences and shows that Central Maryland and Howard County falls within Wind Zone II, where wind speeds can reach as high as 160 mph.

[97] NOAA's Severe Weather, available at https://forecast.weather.gov/glossary.php?word=MACROBURST.

Figure 4.6 - Wind Zones in the United States
Source: FEMA



Severity (or Extent) of the Tornado Hazard and Wind Storm Events

Tornado damage severity is measured by the Enhanced Fujita Tornado Scale (EF-Scale), named after Dr. T. Theodore Fujita, who introduced the scale in 1971. The original Fujita Scale (F-Scale) assigned numerical values based on wind speeds and the categorized tornadoes from 0 to 5, with the letter "F" often preceding the numerical value. The scale was based on tornado damage, correlated to the fastest ¼ mile wind speed at the height of a damaged structure. The miscalculation of two tornadoes in the 1990s revealed a problem of the F-Scale, namely the wind estimates in the F-scale were too high. As a result, a committee of meteorologist and engineers searched for a more accurate method of assessing the magnitude of tornadoes and then recalibrated the F-Scale by developing the Enhanced F-Scale.

The Enhanced F-Scale is a set of wind estimates based on observed damages after a tornado. It uses three-second gusts estimated at the point of damage. It is also based on a judgment of eight levels of damage and 28 indicators that include various commercial and residential building types, transmission towers, poles, and trees. Similar to the original scale, the new Enhanced F-Scale includes five classes ranging from EF0 to EF5. The wind speeds from the Fujita Scale were used as the basis for development of the Enhanced F-Scale. Table 4.15 displays the wind speed ranges for the original Fujita Scale, the derived wind speeds (Enhanced F-Scale), and the new Enhanced F-Scale currently in use since February 2007. [98]

[98] Storm Prediction Center, The Enhanced Fujita Scale, available at http://www.spc.noaa.gov/efscale/

Table 4.15 - Enhanced Fujita Scale for Tornadoes
Source: NOAA, NWS, SPC

EF-Scale Number	3 Second Gust (mph)	Type of Damage Done
EF0	65-85	Light Damage: Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	Moderate Damage: Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	Considerable Damage: Roofs torn off well-constructed houses; mobile homes demolished; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	Severe Damage: Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	Devastating Damage: Whole frame houses, well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	Incredible Damage: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100m (109 yd.); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Within the planning area, it is possible for a tornado of any magnitude to occur, with the probability decreasing as the intensity scale increases. Tornadoes can impact all parts of Howard County equally and uniformly. Although the NCDC indicates the strongest historical tornado in Howard County was rated F2 on the Fujita scale[99], the potential for extreme atmospheric instability allows for the possibility that tornadoes in the planning area could reach EF-4 or EF-5 severity. For example, on April 28, 2002, an F4 tornado struck La Plata in Charles County, which killed three, injured 122 people, and caused over $138.5 million in damages. Charles County's climate conditions are fairly similar to Howard County, and its proximity suggests that a similar tornado may occur within the County. A tornado of similar magnitude could potentially cause catastrophic damages to the affected area in Howard County.

Impact on Life and Property

Tornadoes pose a significant threat to life and safety in Howard County. When a tornado is on the ground, all citizens in its path are potentially in danger of injury or death. Infrastructure is also at risk from tornadoes. Historically, lightly constructed residential structures (such as manufactured housing like mobile homes) located within the planning area are most vulnerable to a tornado hazard. The NCDC database reports there have been two injures from tornadoes in Howard County.[100] The 14 tornadoes that have impacted Howard County have cumulatively caused an estimated $3.99 million in property damage.[101] Most of the damage was limited to downed trees, blown shingles off roofs, and disabled power lines.

[99] NCDC Storm Events, available at https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=24%2CMARYLAND.
[100] Ibid.
[101] Ibid.

Thunderstorm wind events have injured four and caused over $1.3 million in property damage in Howard County, according to the NCDC database.

Occurrences of the Tornado Hazard and Wind Storms

The NCDC database reports that 14 tornadoes have occurred in Howard County between 1950 and 2017. The database indicates there were eight F0s, four F1s, and two F2s tornadoes. Table 4.16 summarizes the tornadoes that have occurred within Howard County between 1975 and 2017

Table 4.16 – Tornado Events in Howard County
Source: NOAA, NCDC

Event ID	Location	Date	Event Type	Fujita Scale	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
10040461	N/A	7/3/1975	Tornado	F0	0	0	0	0
10042106	N/A	7/31/1978	Tornado	F2	0	0	250000	0
10038193	N/A	8/28/1992	Tornado	F1	0	2	2500000	0
10038195	N/A	8/28/1992	Tornado	F0	0	0	2500	0
10329525	West Friendship	7/6/1995	Tornado	F0	0	0	75000	0
5567912	Columbia	8/27/1996	Tornado	F0	0	0	15000	0
5165078	Savage	7/10/2000	Tornado	F1	0	0	50000	0
5270225	North Laurel	9/24/2001	Tornado	F2	0	0	1000000	0
189029	Alpha	7/31/2009	Tornado	EF1	0	0	0	0
391766	Watersville Jct.	6/1/2012	Tornado	EF1	0	0	5000	0
391769	Scaggsville	6/1/2012	Tornado	EF0	0	0	100000	0
546054	Savage	10/15/2014	Tornado	EF0	0	0	0	0
599519	Savage	9/29/2015	Tornado	EF0	0	0	0	0
645695	Florence	6/21/2016	Tornado	EF0	0	0	0	0

Howard County has experienced two F2 tornadoes since 1975. The July 31, 1978 tornado was estimated to be 40 yards wide and travelled for a length of $^{8}/_{10}$ of a mile, causing $826,000 in damage. The tornado of September 24, 2001 originated in Prince George's County as an F3 and travelled north-northeast from Hyattsville, through College Park, and into Laurel. Along its destructive path, the tornado killed two and injured 55. Just before the tornado crossed into Howard County, it weakened from a F3 to an F2 tornado. In Howard County, the tornado caused severe damage to several townhomes in Settler's Landing, a subdivision in North Laurel. As the tornado continued northward, it slowly dissipated and ended one mile east-southeast of Columbia. The tornado traveled a total distance of six miles in Howard County and had a width of 100 yards. Along its destructive path, the tornado uprooted trees, blew off rooftops, and blew out car windows. Many homes were deemed unsafe for a period of time, and one was severely damaged. Property damage in Howard County was estimated at $123.4 million. The tornado caused no fatalities or injures.

Additional significant tornado events that have impacted Howard County are described below.

- **June 30, 2016 (F0 Tornado)**: The tornado traveled nearly 13 miles through western Howard County. There were no injuries or deaths associated, hundreds of trees were knocked down

and several homes had serious damage from falling debris. The path of debris was over 500 yards wide at some points.

- **July 10, 2000 (F1 Tornado):** The tornado touched down three miles southeast of Savage. It brought down several trees and power lines. It also blew over two trailers and three semi-tractor trailers. In Howard County, the tornado was 100 yards wide and traveled 6/10 of a mile before moving into Anne Arundel County. The tornado resulted in $62,600 in property damage.
- **August 27, 1996 (F0 Tornado):** A small tornado caused damage to several subdivisions along Frederick Road north of Columbia. A total of four trees were knocked down, including two trees that were blown into a home on Pine Bluffs Drive. The NCDC database estimates that there was $20,600 in property damages.
- **July 6, 1996 (F0 Tornado):** A small tornado briefly touched down in a wooded area, just south of Interstate 70 near the Marriottsville Road Exit. The tornado was only 20 yards wide and traveled 1/10 of a mile. One house between Marriottsville and Ellicott City was heavily damaged by a falling tree. In total, an estimated $103,100 in property damage occurred.

With a total of 14 tornado events between 1975 and 2016, Howard County experiences, on average, one tornado every three years. Based on this information, it is possible to infer an approximate 34% annual probability of occurrence countywide. Depending on atmospheric conditions, it is possible for any number of tornadoes to occur in any given year. Based on the history of tornadoes in Howard County, there is a high probability of future tornadoes occurring sometime in the future in Howard County, and a low-to-medium probability of a tornado occurring within any given year (Figure 4.7).

Howard County has experienced over 207 thunderstorm wind events since 1969, and 4 high wind events from 1950 to 2017, based on the NCDC database. Of the 207 events, 30 included winds of 60 knots (69 mph) or greater and causing damages of over $810,000 dollars.

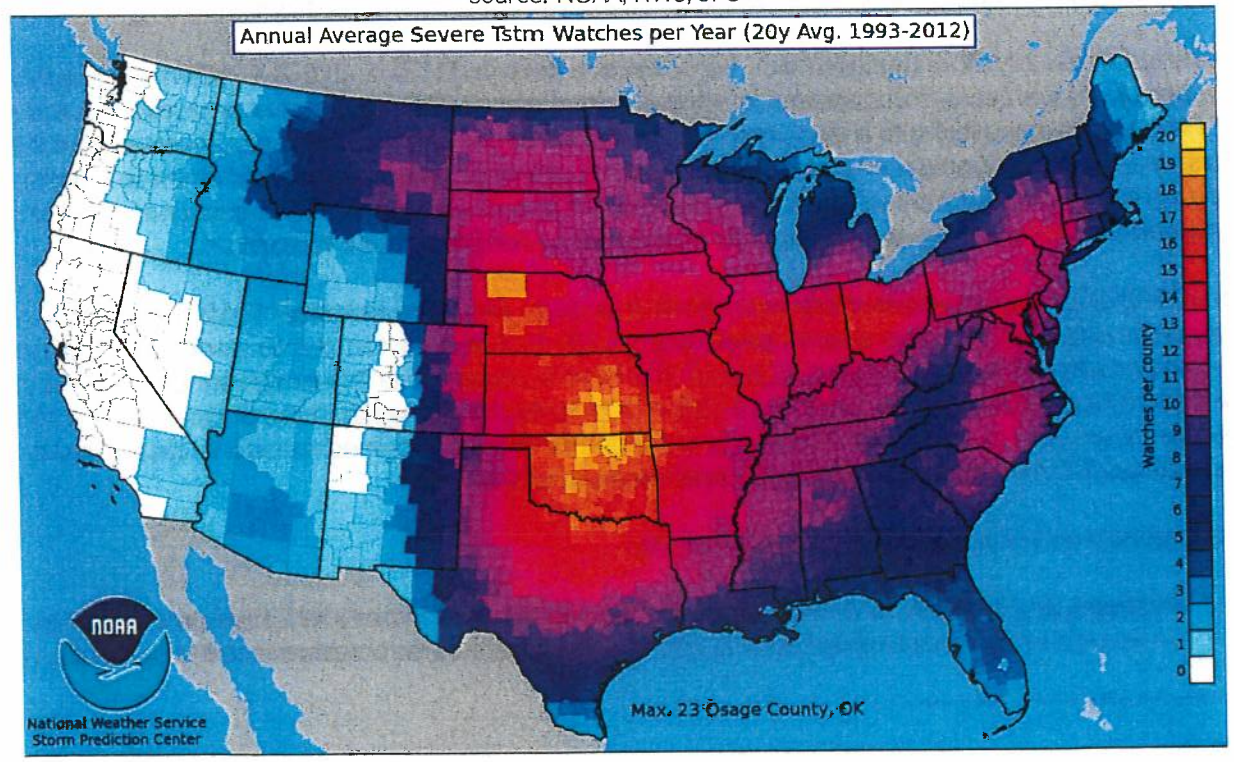
Table 4.17 summarizes the 30 high wind events in Howard County producing greater than 60 knot winds.

Table 4.17 High wind events in Howard County
Source: NOAA, NCDC

Location	Date	Event Type	(Windspeed in knots)	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
Howard Co.	06/29/1978	Thunderstorm Wind	70 kts.	0	0	0.00K	0.00K
Ellicott City	05/13/2002	Thunderstorm Wind	65 kts. E	0	0	150.00K	0.00K
Elk Ridge	05/25/2004	Thunderstorm Wind	60 kts. EG	0	0	1.00K	0.00K
Ellicott City	06/01/2004	Thunderstorm Wind	60 kts. EG	0	0	3.00K	0.00K
Alpha	07/31/2009	Thunderstorm Wind	65 kts. EG	0	0	0.00K	0.00K
Ilchester	07/03/2011	Thunderstorm Wind	61 kts. EG	0	0	5.00K	0.00K
Glenelg	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
Glenelg	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	50.00K	0.00K
Glenwood	06/29/2012	Thunderstorm Wind	66 kts. EG	0	0	100.00K	0.00K
Fulton	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
West Friendship	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
Highland	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
Fulton	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K

Location	Date	Event Type	(Windspeed in knots)	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
Simpsonville	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	50.00K	0.00K
East Lioak	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
East Lioak	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	50.00K	0.00K
Simpsonville	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
Simpsonville	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
East Lioak	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
Pine Orchard	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
Waterloo	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	5.00K	0.00K
Waterloo	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
Ilchester	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
Waterloo	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	50.00K	0.00K
Dorsey	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
Dorsey	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	1.00K	0.00K
Marriotsville	06/29/2012	Thunderstorm Wind	61 kts. EG	0	0	25.00K	0.00K
East Lioak	06/23/2015	Thunderstorm Wind	61 kts. EG	0	0	3.00K	0.00K
Cooksville	02/24/2016	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
Lisbon	03/01/2017	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K

Figure 4.7 - Annual Average Number of Thunder Events based on 20 Year Average
Source: NOAA, NWS, SPC



The database indicates that there were two thunderstorm wind events that caused over $100,000 in damages. On May 13, 2002, a thunderstorm, with winds estimated at 75 knots, damaged several homes and knocked down numerous trees in the Ellicott City area. The total impact was estimated

to be $150,000 in property damages. On June 29th, 2012, a strong upper-level disturbance passed through the region. Extremely hot and humid conditions caused high amounts of instability. The upper-level disturbance triggered a line of thunderstorms that moved through the area. Due to the high instability, thunderstorms caused widespread wind damage. Numerous trees were brought down and the downburst caused widespread power outages. Many homes were heavily damaged by downed trees. The estimated total property damage for the downburst was $100,000.

Additional significant thunderstorm wind events that have impacted Howard County are described below.

- **July 30, 1996:** A severe thunderstorm moved from east to west across the County. The storm brought down trees and power lines, and caused an estimated $20,600 in property damage and another $2,700 in crop damage. [102]
- **August 26, 2003:** A line of severe thunderstorms with winds up to 78 mph moved across the County during the afternoon hours. There were numerous reports of downed trees and power lines throughout the County and caused an estimated $17,700 [103] in property damage.
- **June 1, 2006:** A low pressure trough, combined with upper level moisture and atmospheric instability, caused strong severe thunderstorms to ravage the area. The winds from these storms caused $27,000 [104] in damage.
- **September 28, 2006:** As a cold front moved into the region during the afternoon, it spawned several thunderstorms. The most intense thunderstorm occurred along the Interstate 95 Corridor. In total, the storms caused an estimated $37,800 [105] in property damage.

With a total of 207 thunderstorm wind events between 1950 and 2017, Howard County experiences on average 3 thunderstorm wind events per year. With 3 storms per year, there is a 100% annual probability of a thunderstorm wind event occurring in Howard County. Based on the history of past thunderstorm and high wind events, there is a high probability of these events occurring in Howard County in the future. Although the probability is high, the impact on life and property in the planning area will probably be minimal as compared to other hazards.

The NCDC database reports there have been four high wind events between 1950 and 2017, however results only show events beginning in 2015. The reason for this underreporting is unknown. According to the Howard County 2017 HIRA, the most destructive high wind event in Howard County occurred on January 14, 2006. Not only did strong winds bring down trees and power lines which left tens of thousands without power for an extended period, it caused an estimated $1.7 [106] million in property damages throughout the region.

Additional high wind events in the region include:

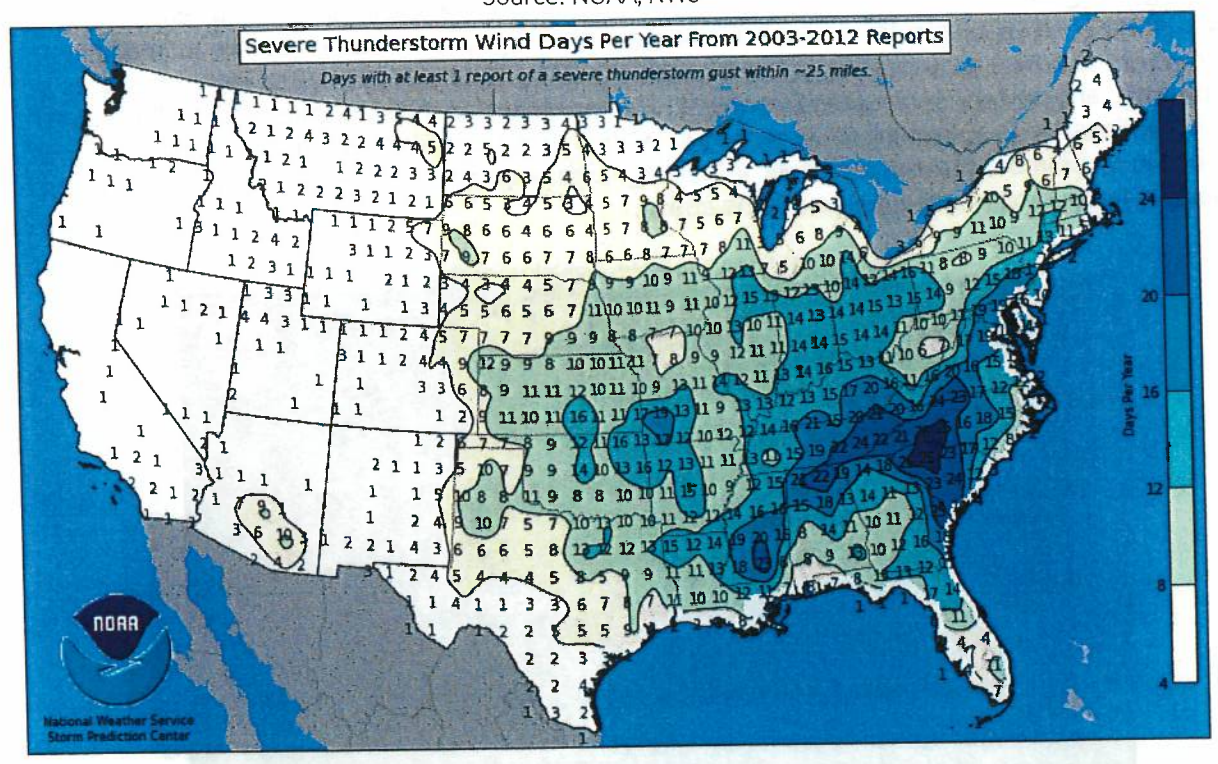
- **February 24, 1996:** With a storm over the Canadian Maritimes and a high-pressure ridge over the Southeast United States, a strong wind gradient was created in the Mid-Atlantic. A

[102] Ibid.
[103] Ibid.
[104] Ibid.
[105] Ibid.
[106] Ibid.

steady wind of 25 to 35 mph, with gust up to 60 mph, was felt throughout the region. Over 22,000 homes were left without power.

- **March 19, 1996:** A low pressure system over the Ohio Valley produced gusts as high as 58 mph. The winds caused an estimated $103,100[107] in property damage and injured six individuals across the region.
- **February 10, 2008:** A strong cold front brought wind gusts in excess of 60 mph, with some areas in the region reporting gusts in excess of 40 mph for several hours. In Howard County, the winds caused an estimated $10,100[108] in property damage.
- **March 2, 2018:** Howard County experienced a high wind event starting on the night of Friday, March 2nd. During the event the County experienced 60-70 mph gusts with sustained winds of 20-40 mph. Winds remained elevated (40+ mph gust) through Saturday, March 3rd. Due to the winds the County experienced large numbers of downed trees, traffic issues, and at the peak had over 25,000 power outages.

Figure 4.8 – Severe Thunderstorm Wind Days
Source: NOAA, NWS



According to the Howard County 2017 HIRA, Howard County experiences on average 1.5 high wind events per year (Figure 4.8). This calculation is based on a total of 11 high wind events between 1993 and 2011. From this information, it is possible to infer an approximate 64% annual probability of occurrence. Also, the past history shows there is a high probability of future high wind events occurring in Howard County.

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[107] Ibid.
[108] Ibid.

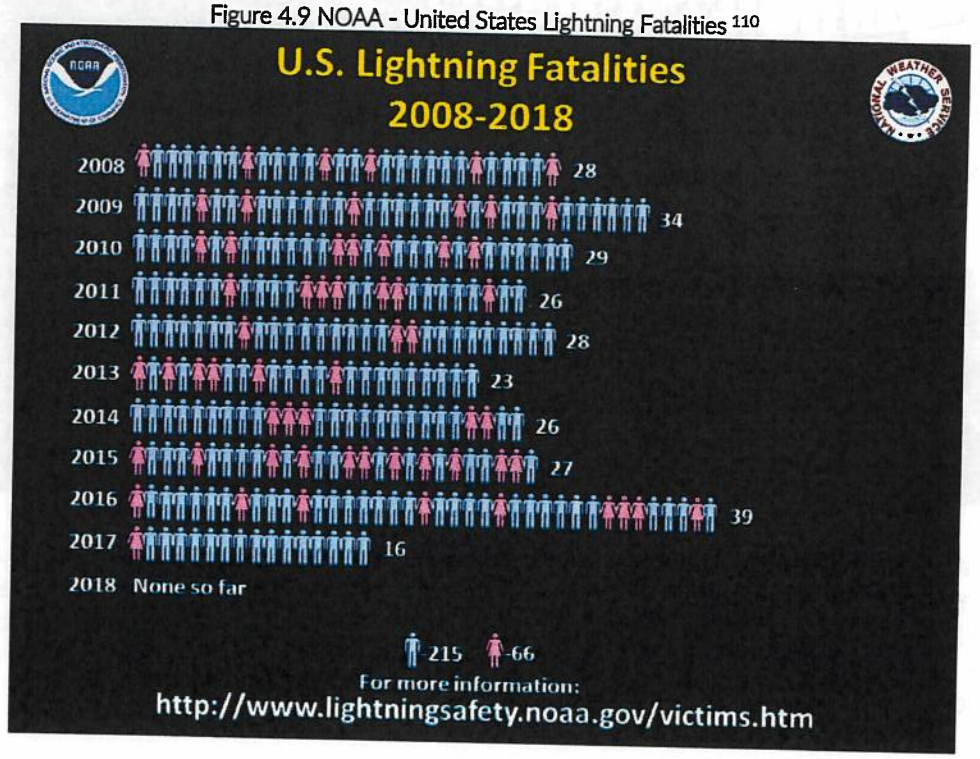
4.6.6 Lightning

Description of the Lightning Hazard
Lightning events are generated by atmospheric imbalance and turbulence due to a combination of conditions. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air in the channel of a lightning strike reaches temperatures over 18,000 degrees Fahrenheit. [109]

Location and Extent of the Lightning Hazard
Individual lightning strikes typically affect a relatively small geographic area. As lightning is not geographically constrained, lightning affects the entire County equally, particularly during the warmer months of the year.

Severity of the Hazard
Severe lightning events can occur anywhere within the planning area. The lightning current can branch off to strike a person from a tree, fence, pole, building, or other tall object. In addition, electrical current may be conducted through the ground to a person after lightning strikes a nearby tree, antenna, or other tall object. The current also may travel through power lines, telephone lines, or plumbing pipes to a person who is in contact with an electric appliance, telephone, or plumbing fixture inside of a building. Lightning may damage property and can cause fires using similar processes as outline above.

Figure 4.9 NOAA - United States Lightning Fatalities [110]



[109] NOAA's *Severe Weather*, available at https://www.nssl.noaa.gov/education/svrwx101/lightning/.
[110] Ibid.

Impact on Life and Property

People and property are exposed to damage, injury, and loss of life from lightning in virtually the entire United States (Figure 4.9). According to NOAA, lightning kills an average of 47[111] people per year. Most lightning-related deaths and injuries occurred when people were outdoors during summer afternoons and evenings.

Occurrences of the Lightning Hazard

The NCDC database identified six lightning events in Howard County between 1950 and 2016. Like other hazards, the list appears to only account for events from 1950 onwards. The six events in the database listed occurred between 1996 and 2006, and caused $935,000 in damage. This indicates additional events outside this period are unlikely captured in the database. Although many more lightning events may have occurred, they were not reported to the NCDC.

Table 4.18 below summarizes the significant lighting events that have occurred in Howard County between 1994 and 2006.

Table 4.18 – Lightning Events in Howard County
Source: NOAA, NCDC

Event ID	Location	Date	Event Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
5568044	COLUMBIA	7/8/1996	Lightning	0	0	75000	0
5173739	COLUMBIA	8/7/2000	Lightning	0	0	100000	0
5265439	CLARKSVILLE	8/11/2001	Lightning	0	0	100000	0
5314399	CLARKSVILLE	8/3/2002	Lightning	0	0	500000	0
5421712	HANOVER	8/10/2004	Lightning	0	0	55000	0
5515110	ELLICOTT CITY	6/1/2006	Lightning	0	0	100000	0

The event causing the most property damage occurred on August 3, 2002, when a lightning strike destroyed a home in Clarksville along Talon Court. This event caused approximately $602,000 in property damage.

Howard County experiences a significant lightning event approximately once every two years. Averaging these seven events over a period of 17 years equates to a 43% annual probability of future lightning occurrences. The probability of lightning impacting Howard County is presumed to be about the same as it has been in the past. Based on historical data, the future probability of lightning strikes is reasonably high with a severe strike impacting the planning area every couple of years. However, the damage associated with these events is usually minor and not widespread.

4.6.7 Earthquake

Description of the Earthquake Hazard

An earthquake is a "sudden, rapid shaking of the earth, caused by the breaking and shifting of subterranean rock as it releases strain that has accumulated over a long time[112]." At the Earth's surface, earthquakes may present as a shaking or displacement of the ground. This can cause:

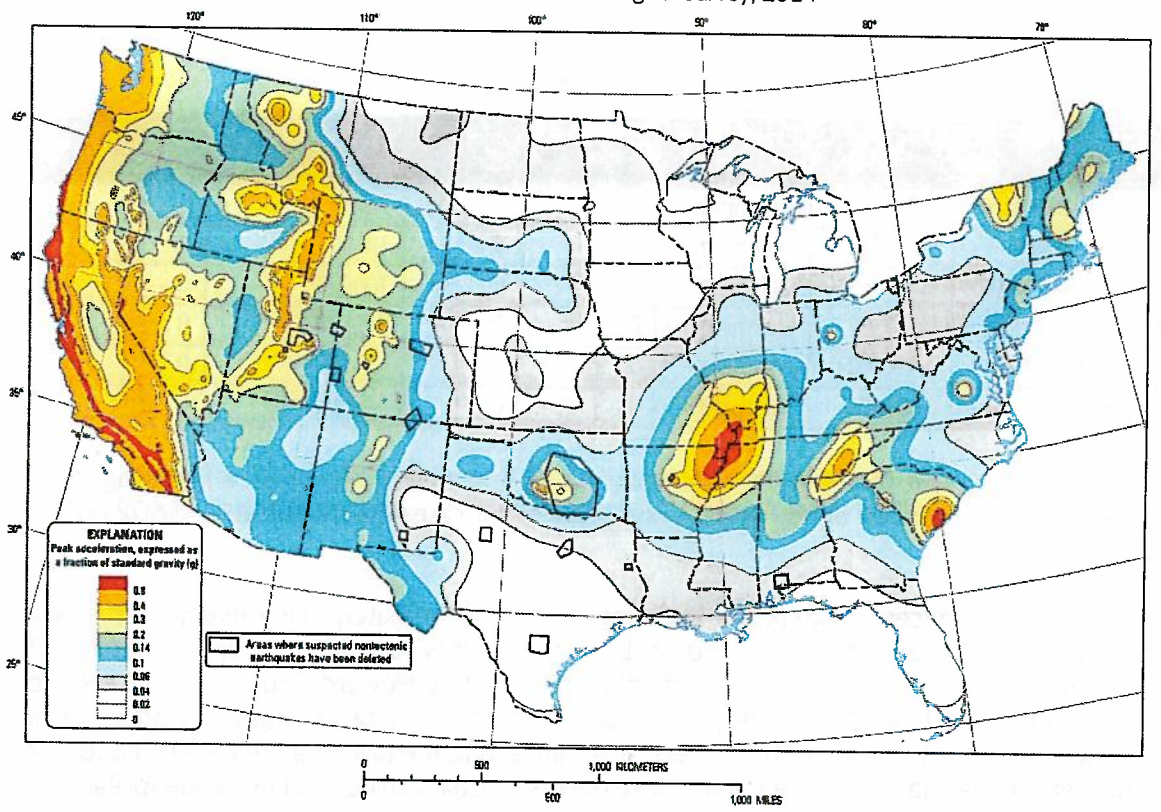
[111] NOAA's National Weather Service, Lightning Safety Tips and Resources, available at http://www.lightningsafety.noaa.gov/
[112] Department of Homeland Security, Earthquakes, available at https://www.ready.gov/earthquakes.

everyday objects or household items to become dangerous projectiles; buildings to shift from their foundations or even collapse; damaged utilities, roads and infrastructure including bridges, levees, and dams; or even cause fires and explosions from disruption of power or fuel transmission. Earthquakes can trigger landslides, avalanches, and even tsunamis. These hazards can lead to loss of life and destruction of property.

Location of the Earthquake Hazard

The entire planning area is susceptible to the effects of earthquakes. The map shows peak ground acceleration (PGA) with a 10% chance of being exceeded over 50 years. The map shows a 1% to 2%*g* (the acceleration of gravity) range across most of Central Maryland, including Howard County. The *FEMA How-To Guidance* [113] suggests an earthquake hazard should be profiled if the PGA is greater than 3%*g*. Figure 4.10 displays the United States Geological Survey (USGS) earthquake hazard map produced in 2014.

Figure 4.10: 2% Probability of Exceedance in 50 Years Map of Peak Ground Acceleration
Source: United States Geological Survey, 2014



Severity of the Earthquake Hazard

The size of an earthquake is expressed quantitatively as magnitude (Table 4.19), while local strength of shaking is expressed as intensity. The severity of an earthquake is influenced by several factors, including the depth of the earthquake, the geology of the affected area, and the soil composition. The severity of soil liquefaction is dependent on the soils grain size, thickness, compaction, and degree of saturation. Small earthquakes are possible almost anywhere, and all regions face serious effects from very large and distant earthquakes.

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[113] FEMA 386-2, *FEMA How-To Guidance; Understanding Your Risks*, p 1-7 (2001).

Earthquakes with epicenters in Central Maryland are rare. Most past earthquakes in Maryland have been of low magnitude. However, it is possible for earthquakes to occur in this region of the State. The probability of a severe earthquake in the area is relatively low. However, Howard County could be affected by very large and distant quakes. Based on past earthquake occurrences in Howard County, an earthquake in the magnitude 2 to 3 range could be possible in the planning area.

Table 4.19 - Richter Scale

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally not felt, but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0-7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Impact on Life and Property

There are no known deaths or injuries from earthquakes in Howard County. Because of the nature of the built environment, the effects on life and property in the planning area could be significant if a large earthquake were to occur. The County is home to many structures that were built long before the advent of building codes, and many of these structures are made of unreinforced masonry, which is particularly susceptible to damage during earthquakes. Given the relatively low probability of earthquakes of significant magnitude affecting the area, the potential impacts are relatively minor. Table 4.20 describes the effects of each scale of earthquake.

Table 4.20 - Modified Mercalli Intensity Scale for Earthquakes
Source: North Carolina Division of Emergency Management

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	
II	Feeble	Some people feel it	<4.2
III	Slight	Felt by people resting; like a truck rumbling by	
IV	Moderate	Felt by people walking	
V	Slightly Strong	Sleepers awake; church bells ring	<4.8
VI	Strong	Trees sway; suspended objects swing, objects fall off shelves	<5.4
VII	Very Strong	Mild Alarm; walls crack; plaster falls	<6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	<6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	<7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards	<8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	>8.1

Source: North Carolina Division of Emergency Management

Occurrences of the Earthquake Hazard

Historically, there has been no record of earthquakes with an epicenter in Howard County, except for a cluster of small earthquakes in 1993 in Allview Estates in Columbia, MD. But the County has experienced minor shaking from earthquakes located outside of the region. Maryland's USGS earthquake history was reviewed to identify past earthquake occurrences that have impacted Howard County. The data indicated that from March through December 1993, a series of two dozen small tremors occurred near Columbia, Maryland, ranging in magnitude from >1 to 2.7 on the Richter Scale. The State's earthquake history shows there have been seven significant earthquakes felt within the State between 1900 and 2014, most notably the August 2011 earthquake which had an epicenter in Central Virginia. Of these seven events, the USGS's earthquake descriptions indicate that while several of these events were felt in Howard County, there were none that had a significant impact on the County nor were any damages or injuries reported.

The USGS shows the earliest recorded earthquake with its epicenter in Maryland occurred in Annapolis on April 24, 1758. The shock lasted 30 seconds and could be felt as far away as Pennsylvania. In recent years, moderate-sized earthquakes in nearby states have been felt in Maryland with only minimal effects. On November 19, 1969, a 4.3 magnitude earthquake near Elgood, West Virginia was felt in Central Maryland, including Howard County. On February 28, 1973, residents throughout the Mid-Atlantic region were jolted awake by shock waves from a minor earthquake near the Delaware/New Jersey/Pennsylvania border. Numerous points in Northeastern Maryland reported this earthquake.

Data from the Maryland Geological Survey (MGS) indicates there have been 64 earthquakes with epicenters in Maryland (Figure 4.11). Of these 64 earthquakes, 26 affected localities within Howard County. Review of the events with epicenters in Howard County indicates these were all minor events, ranging in magnitude between 1.0 and 2.7 [114].

On August 23, 2011, Maryland experienced the effects of a nearby earthquake when a 5.8 magnitude quake centered in Virginia impacted much of the East Coast. Tremors were felt as far south as North Carolina, as far north as Buffalo and Boston, and as far west as Detroit. The epicenter of the earthquake was about 3.5 miles beneath Mineral, Virginia, which is 35 miles northwest of Richmond. The USGS indicated the earthquake was one of the strongest ever to occur in Virginia and the strongest felt in Maryland. After the ground shook for several seconds, buildings were evacuated and some businesses and agencies shut down for the afternoon. Rail travel was interrupted, and many commuters faced an early, congested rush hour. [115] Damage inspections after the earthquake found structural damage was limited, although in some areas there were significant localized damages. In Howard County, many residents were startled by the earthquake but there was no significant damage or injuries reported. [116]

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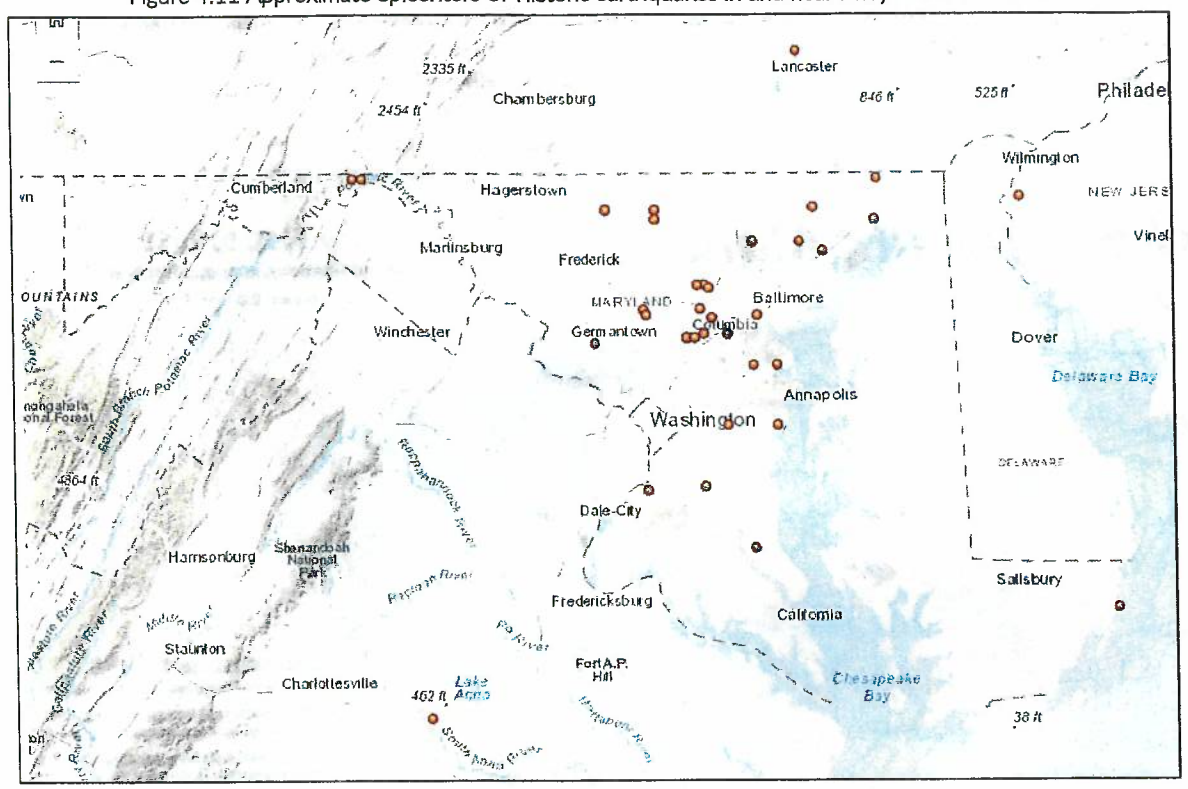
[114] Maryland Geological Survey, available at http://www.mgs.md.gov/geology/geohazards/earthquakes_and_maryland.html.
[115] Calvert, Scott and Childs Walker, *Earthquake in Virginia Rattles Baltimore and the East Coast*, Baltimore Sun, August 23, 2011, available at http://articles.baltimoresun.com/2011-08-23/news/bs-md-earthquake-20110823_1_maryland-geological-survey-earthquake-smaller-temblors.
[116] Howard County Administration, *Howard County Earthquake Update*, August 23, 2011.

Figure 4.11 Approximate epicenters of historic earthquakes in and near Maryland since 1758



The likelihood of significant earthquake damage in Howard County is low since the probability of the area being stricken by an earthquake is relatively low as compared to other parts of the country. Even though earthquakes do occur occasionally, the County is located in an area of very low seismic activity. Because of the very low risk associated with this hazard, a simple risk assessment was completed for earthquakes.

4.6.8 Drought and Extreme Heat

Description of the Drought Hazard

A drought is a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and humans over a sizeable area." [117] It usually refers to a period of below-normal rainfall, but can also be caused by drying bores or lakes, or anything that reduces the amount of liquid water available. Drought is a recurring feature of nearly all the world's climatic regions. [118]

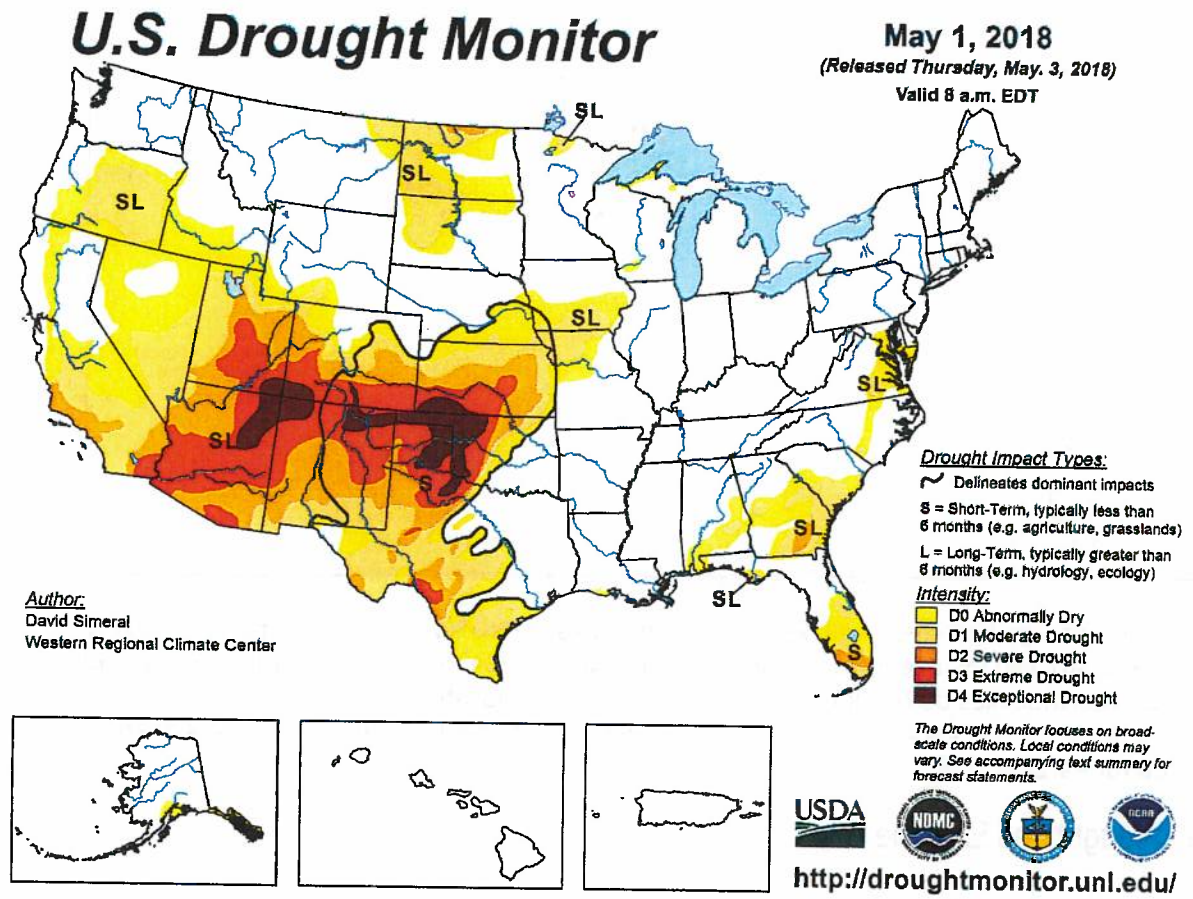
Location of the Drought Hazard

Droughts may occur anywhere in the United States. Different regions may be affected by drought conditions differently (Figure 4.12), depending on normal meteorological conditions (such as precipitation and temperature) and geological conditions (such as soil type and subsurface water levels).

[117] United States Geological Service, *Definition of Drought*, available at http://md.water.usgs.gov/drought/define.html.
[118] National Integrated Drought Information System (NIDIS), available at www.drought.gov.

Drought is possible throughout the entire planning area, and in the Central Maryland region in general. As there is no defined geographic boundary for this hazard, and as such all properties within Howard County are considered equally exposed. The probability of a drought occurring in any specific region depends on atmospheric and climatic conditions.

Figure 4.12 - U.S. Drought Monitor
Source: United States Drought Monitor, University of Nebraska-Lincoln, 2018



Duration and frequency can be used as indicators of potential severity. Variation in drought risks to people and property cannot be distinguished by area. The hazard has a uniform probability of occurrence across the entire County.

Severity and Extent of the Drought Hazard

A drought's severity depends on numerous factors, including duration, intensity, and geographic extent as well as regional water supply demands by humans and vegetation. The severity of drought can be aggravated by other factors, such as high temperatures, high winds and low humidity. This can also increase the risk of wildfire. Due to its multi-dimensional nature, drought is difficult to define in exact terms, which makes comprehensive risk assessments difficult.

One method used by scientists to calculate the severity and duration of a drought is the Palmer Drought Severity Index (PDSI). The PDSI "uses readily available temperature and precipitation data

to estimate relative dryness." [119] The PDSI is an important climatological tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. [120]

The equation for the PDSI was empirically derived from the monthly temperature and precipitation scenarios of 13 instances of extreme drought in Western Kansas and Central Iowa and by assigning an index value of -4 for these cases. Conversely, a +4 represents extremely wet conditions. From these values, seven categories of wet and dry conditions can be defined. Table 4.21 identifies the values used to define the PDSI. [121]

Table 4.21 - Palmer Drought Severity Index
Source: NOAA, NWS - Climate Prediction Center [122]

Palmer Drought Severity Index
-4.0 or less (Extreme Drought)
-3.0 or -3.9 (Severe Drought)
-2.0 or -2.9 (Moderate Drought)
-1.9 to +1.9 (Near Normal)
+2.0 or +2.9 (Unusual Moist Spell)
+3.0 or +3.9 (Very Moist Spell)
+4.0 or above (Extremely Moist)

Impact on Life and Property

Droughts have the ability to impact many sectors of the economy, and can have far-reaching effects beyond the area experiencing the actual drought. The impacts droughts may have on a community are commonly categorized as either "direct" or "indirect." Reduced crop productivity, increased fire hazard, reduced water levels, and damage to wildlife and fish habitat are a few examples of direct impacts. Drought can cause extensive damage to commercial and residential structure foundations, framing and walls, levees, roads, bridges, pipelines, and other integral infrastructure. Indirect impacts of drought include increased prices for food, unemployment, and reduced tax revenues due to reduced supplies of agriculture products dependent upon rainfall.

All residents of Howard County can potentially be affected by drought conditions, which could include limitations on water supplies or even create health threats. Summer droughts are generally associated with increased temperatures, as such elderly persons, small children, infants, and chronically ill persons who do not have adequate cooling units in their homes may be more vulnerable to illness, injury, and/or death.

The NCDC indicates zero (0) drought events have occurred in the planning area. The drought hazard affects all residential and commercial building types equally within the planning area.

Occurrences of the Drought Hazard

According to the 2017 Howard County HIRA, Howard County has experienced 13 drought events from 1950 to 2011. All 13 events occurred between 1995 and 2007. Also note that the events are

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[119] https://climatedataguide.ucar.edu/climate-data/palmer-drought-severity-index-pdsi
[120] *National Weather Service's Climate Prediction Center: Explanation,* http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/cdus/palmer_drought/wpdanote.shtml (last accessed April 9, 2012).
[121] NOAA. NWS. Climate Prediction Center. Drought Indices – Explanation.
[122] http://www.droughtmanagement.info/palmer-drought-severity-index-pdsi/

listed by months. If a drought lasted several continuous months, it is listed as separate events. If the continuous months are combined into single events, the number of events is reduced from 13 to 7 events.

With a total of seven significant drought events between 1995 and 2011, Howard County experiences a severe drought event, on average, approximately once every two years. The seven events have occurred over a period of 16 years, which equates to approximately a 46% annual probability of future drought occurrences. Based on previous occurrences, it is reasonable to assume that droughts will continue to occur in Howard County. It is also equally reasonable to assume that the impact will be reasonable with no projected injuries, deaths, or property damage.

Description of the Extreme Heat Hazard

Temperatures that are significantly above normal for the time period are considered extreme temperatures. Additionally, "local governments, weather stations, medical providers, or others may have systems for issuing heat alerts through the television, radio, newspapers, phone calls, social media, texts, emails, or the internet" [123] Furthermore, the heat index, calculated by combining the effects of temperature and humidity, can lead to additional alerts as condition may feel hotter than the actual air temperature.

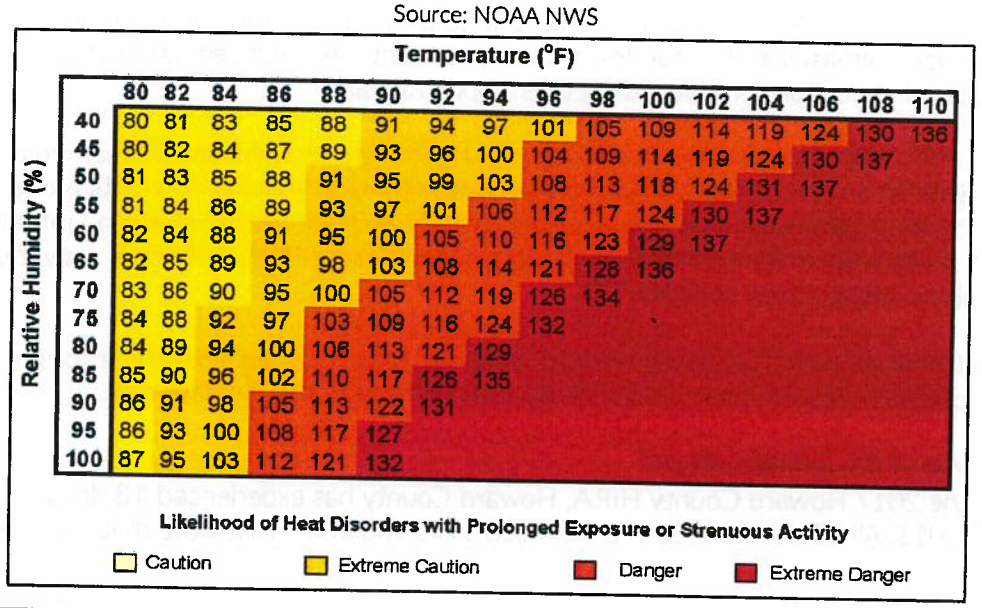
Location of the Extreme Heat Hazard

The entire planning area is subject to the hazards associated with extreme temperatures from high heat as there is no geographic boundary for this hazard.

Severity of Extreme Heat

The severity of extreme temperature events is measured by temperature, duration, and humidity. Most events last for less than a week on average. In Northeastern United States, periods of warmer

Figure 4.13 NOAA Heat Index
Source: NOAA NWS



[123] Environmental Protection Agency, Climate Change and Extreme Heat – What You Can Do to Prepare, available at https://www.epa.gov/sites/production/files/2016-10/documents/extreme-heat-guidebook.pdf.

than normal temperatures typically occur several times over a single summer. Extreme heat waves may occur about once every five years. The passing of a cold front usually moderates temperatures after a few days to a week. However, it is expected that the duration and frequency of such events will increase in the coming years due to climate change and overall warming trends [124].

Impact on Life and Property

The extreme heat hazard can be moderately disruptive to life in the planning area. Vulnerable populations such as seniors, children, and people with existing health conditions are most at risk. Although damages from extreme heat hazards are generally seen by individuals, there may be relatively minor effects on infrastructure, such as overloads on electrical grids.

Occurrences of Extreme Heat Hazard

The NCDC database indicates there have been seven recorded extreme temperature events related to high heat in Howard County during the period of 1950 to February of 2017. Although the query results begin in 1950, the first reported event was in 2016. There are undoubtedly additional extreme heat events prior to 2017 that are not captured in the NCDC database. The database provides no indication as to why there are no events prior to 2016. Table 4.22 lists the seven extreme heat events from the NCDC for Howard County.

Table 4.22 - Reported Extreme Temperature Events, Howard County 1950 – 2017
Source: NOAA, NCDC

Location	Date	Type	Deaths	Injuries	Property Damages ($)	Crop Damages ($)
Central and Southeast Howard	07/25/2016	Heat	0	0	0.00K	0.00K
Northwest Howard (Zone)	07/25/2016	Heat	0	0	0.00K	0.00K
Central and Southeast Howard	08/12/2016	Heat	0	0	0.00K	0.00K
Northwest Howard (Zone)	08/13/2016	Heat	0	0	0.00K	0.00K
Central and Southeast Howard	08/13/2016	Excessive Heat	0	0	0.00K	0.00K
Central and Southeast Howard	07/14/2017	Heat	0	0	0.00K	0.00K
Central and Southeast Howard	08/18/2017	Heat	0	0	0.00K	0.00K

Based on the seven events between 1950 through 2017, on average, an extreme heat event occurs one or two times per year. Without additional information regarding past events between 1950 and 2016, it is difficult to develop probability estimates. However, based on the limited NCDC historical data, extreme heat events will continue to occur in the County at least annually, but with relatively minor impacts on life and property.

4.7 Methodology for Identifying Hazards of Concern

The Interim Final Rule (IFR) requires all potential hazards that affect Howard County to be profiled in this section of the HMP. Since this is a County-level hazard mitigation plan, it may be useful to concentrate on hazards that have a greater impact on the region. Various National, Regional, and Local sources were used to identify and classify different hazards for Howard County. The criteria used were:

[124] Ibid.

1. **History –** incorporating historical accounts and records that the hazard has affected the County often in the past, and that the hazard has occurred often and/or with widespread or severe consequences.

2. **Potential for mitigation** – acknowledging that there are ways to address the hazard and that the methods are technically feasible and have the potential to be cost-effective (i.e. mitigation measures that are available at a reasonable cost, and damages to property, lives, and/or community functions would be reduced or eliminated).

3. **Presence of susceptible areas or vulnerability** – indicating that Howard County has numerous facilities, operations, or populations that may be subjected to damage from the hazard.

4. **Data availability** – demonstrating that sufficient quality data is available to permit an accurate and comprehensive risk assessment.

5. **Federal disaster declarations and local emergency declarations** – noting that Howard County has received numerous disaster declarations for the particular hazard.

Table 4.23 through Table 4.26 list the hazards, describes the rationale for identifying (or not identifying) hazards as significant, shows the sources of information that were consulted in this determination, and the disposition of the hazard for this HMP. Hazard Impact Scores and Hazard Risk Scores were determined for each hazard, for likely and worse-case scenarios. The hazard impact tables account for impacts to property damage, health and safety, critical facilities, response capacity, and the environmental and economic impacts. The impact score is then used, along with the likelihood, warning time, and duration, to determine the total risk Scores for each hazard. The Total Risk Score for a likely hazard scenario is the basis for the county's hazard ranking.

However, it is important to note that many hazards and risks are site-specific. Thus, without further detailed risk assessments, this process and the resulting table should only be viewed as a guide.

Table 4.23 Hazard Impact Scores (Likely Scenario)
Source: Howard County HIRA 2017

	Impact Ranking	Total Impact Score	Property Damage	Health & Safety	Critical Facilities	Response Capacity	Environmental Impact	Economic Impact
Hurricane / Tropical Storm	1	1.25	1	2	1	1	1	1
Severe Winter Weather	1	1.25	1	2	1	1	1	1
Drought	1	1.25	1	2	1	1	1	1
Flood	4	1	1	1	1	1	1	1
Earthquake	4	1	1	1	1	1	1	1
Tornado / Wind Storm	4	1	1	1	1	1	1	1
Lightning	4	1	1	1	2	1	1	1
Wildfire	4	1	1	1	1	1	1	1

Table 4.24 Hazard Impact Scores (Worst-Case Scenario)

Source: Howard County HIRA 2017

	Impact Ranking	Total Impact Score	Property Damage	Health & Safety	Critical Facilities	Response Capacity	Environmental Impact	Economic Impact
Earthquake	1	3.5	3	4	3	4	2	4
Hurricane / Tropical Storm	2	2.75	2	4	3	3	1	1
Drought	3	2.25	1	3	1	2	2	1
Severe Winter Weather	3	2.25	2	3	1	3	1	2
Tornado / Wind Storm	3	2.25	2	4	2	2	2	3
Flood	6	2	2	2	4	3	2	3
Lightning	6	2	1	3	3	2	1	1
Wildfire	8	1.5	1	3	1	3	1	2

Table 4.25 Hazard Risk Scores (Likely Scenario)
Source: Howard County HIRA 2017

	Risk Ranking	Risk Score	Likelihood	Impact	Warning Time	Duration
Flood	1	2.65	4	1	4	1
Severe Winter Weather	2	2.6	4	1.25	1	1
Hurricane / Tropical Storm	3	2.29	3.375	1.25	1	1
Drought	4	2.25	3	1.25	1	1
Lightning	5	2.09	2.875	1	4	1
Tornado / Wind Storm	5	2.09	2.875	1	4	1
Earthquake	7	2.03	2.75	1	4	1
Wildfire	8	1.78	2.25	1	4	1

Table 4.26 Hazard Risk Scores (Worst-Case Scenario)
Source: Howard County HIRA 2017

	Risk Ranking	Total Risk Score	Likelihood	Impact	Warning Time	Duration
Drought	6	2.65	3	2.25	1	4
Earthquake	3	3.03	2.75	3.5	4	1
Flood	2	3.15	4	2	4	3
Hurricane / Tropical Storm	4	2.97	3.375	2.83	1	2
Lightning	7	2.49	2.875	2	4	1
Severe Winter Weather	1	3.25	4	2.25	1	3
Tornado / Wind Storm	5	2.69	2.875	2.5	4	1
Wildfire	8	2.03	2.25	1.5	4	2

These scores were determined using the Risk Tool developed for the 2017 HIRA. The Tool is defined below in Figure 4.14, while Table 4.27 provides the County's qualitative hazard ranking.

Figure 4.14 Howard County Risk Tool

Source: Howard County HIRA 2017

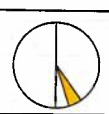
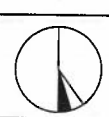
LIKELIHOOD FACTORS			
LIKELIHOOD *Estimated chance of a single hazard event occurring in a given year based on historical incidence and trend forecasting.*			
UNLIKELY (1)	INFREQUENT (2)	LIKELY (3)	VERY LIKELY (4)
No documented occurrence. Less than 1% chance of annual occurrence.	1-10% chance of annual occurrence.	11-30% chance of annual occurrence.	30+% chance of occurrence annually.
CONSEQUENCE FACTORS			
IMPACT *Estimated effect of a single hazard event on property, health & safety, critical facility functioning, response capacity, the environment, the economy, and standard of living.*			
LIMITED (1)	SIGNIFICANT (2)	CRITICAL (3)	CATASTROPHIC (4)
▪ Property damage is less than 5% of critical and non-critical infrastructure. ▪ Injuries are manageable with existing resources, no fatalities. ▪ Shutdown of critical facilities for less than 24 hours. ▪ Local resources are adequate to support the response. ▪ Little to no environmental impact. ▪ Little to no economic impact. ▪ Standard of living is only minimally disrupted.	▪ Property damage is 5-25% of critical and non- critical infrastructure. ▪ Injuries are manageable, may include at least one death. ▪ Critical facilities are down for 1-7 days. ▪ Local and mutual aid resources are adequate to perform response, with limited or no state assistance. ▪ Moderate environmental impact. ▪ Moderate economic impact. ▪ Standard of living is moderately affected.	▪ Property damage is between 26-50% of critical and non-critical infrastructure. ▪ Multiple deaths and serious injuries are probable. ▪ Shut down of critical facilities 1-4 weeks. ▪ Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government. ▪ Serious environmental impact. ▪ Serious economic impact. ▪ Standard of living is seriously affected.	▪ Property damage is severe, greater than 50% of critical and non-critical infrastructure affected. ▪ Multiple deaths and serious injuries exceed jurisdiction response capacity. ▪ Shut down of critical facilities will be more than one month. ▪ Response capacity is overwhelmed and requires significant and long lasting state and federal government support. ▪ Severe environmental impact. ▪ Severe economic impact. ▪ Standard of living is extremely impacted and may not be fully recoverable.
WARNING TIME *Estimated time of awareness prior to the onset of the hazard event.*			
VERY LONG (1)	LONG (2)	MODERATE (3)	SHORT (4)
More than 24 hours	12-24 hours	6-12 hours	Less than six hours
DURATION *Estimated time from onset to conclusion of the hazard event.*			
SHORT (1)	MODERATE (2)	LONG (3)	VERY LONG (4)
Less than six hours	6-24 hours	Less than one week	More than one week
RISK SCORE WEIGHTING			
LIKELIHOOD	IMPACT	WARNING TIME	DURATION
[50%]	[40%]	[5%]	[5%]
			
RISK = LIKELIHOOD + CONSEQUENCE			

Table 4.27 Howard County Qualitative Hazard Ranking

Hazard	Rationale	Disposition
Floods	High probability, significant impacts, long history of occurrences in the County, significant annual damages	Profile and risk assessment
Hurricanes/Tropical Storm/High Winds	Relatively high annual probability with moderate to severe impacts, potential for widespread losses, history of occurrences in the County	Profile and risk assessment, with emphasis on wind hazard
Severe Winter Storms	High annual probability with the potential for widespread impacts	Profile and risk assessment
Tornado/Wind Event	Moderate probability, widespread impacts, losses generally limited except in most extreme events.	Profile and risk assessment
Wildfires	Moderate annual probability of site-specific events, with limited impacts	Profiled, but not part of detailed risk assessment
Lightning	Moderate annual probability, site-specific impacts, losses considered moderate except in most extreme events	Profiled, but not part of detailed risk assessment
Earthquakes	Low annual probability, but potential for significant consequences	Profiled, but not part of detailed risk assessment
Drought (and Extreme Heat)	High annual probability, but impacts generally limited	Profiled, but not part of detailed risk assessment

Based on the qualitative ranking above, and utilizing the Impact and Risk Rankings from the County's 2017 HIRA, Howard County's JSC recommended further analysis of the following four natural hazards in Chapter 5, Vulnerability Assessment and Loss Mitigation:

- Floods
- Hurricanes and Tropical Storm Winds
- Severe Winter Storms
- Tornadoes & Wind Events

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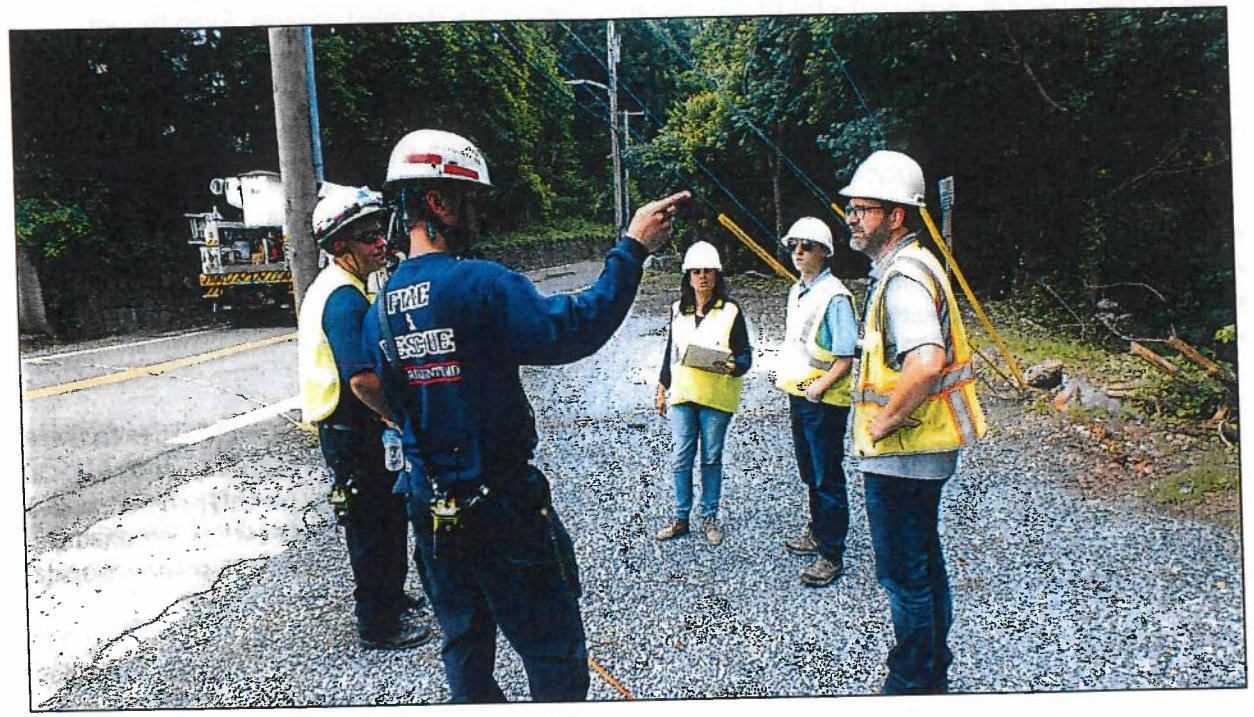
CHAPTER 5: VULNERABILITY ASSESSMENT AND LOSS ESTIMATION



5.1 IFR Requirement for Risk Assessments

IFR §201.6(c)(2): *The NHMP shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

IFR §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

IFR §201.6(c)(2)(ii): *[The risk assessment] must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

IFR §201.6(c)(2)(ii)(B): *[The NHMP **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate.*

IFR §201.6(c)(2)(ii)(C): *[The NHMP **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

5.2 Overview and Analysis of Howard County's Vulnerability to Hazards

Chapter 4, *Hazard Identification and Profiling,* describes the process by which the County reduced the eight possible natural hazards to a list of four hazards selected for detailed analysis. Even though Howard County is exposed to various types of hazards, the probability of some of these hazards striking the County is so low that they do not pose a significant risk to the jurisdiction. Like most inland counties in the Mid-Atlantic region, Howard County is not considered particularly vulnerable to most natural hazards. The following four hazards pose the most risk to people, assets, and operations within Howard County:

- Floods
- Hurricanes and Tropical Storm Winds
- Severe Winter Storms
- Tornadoes & Wind Events

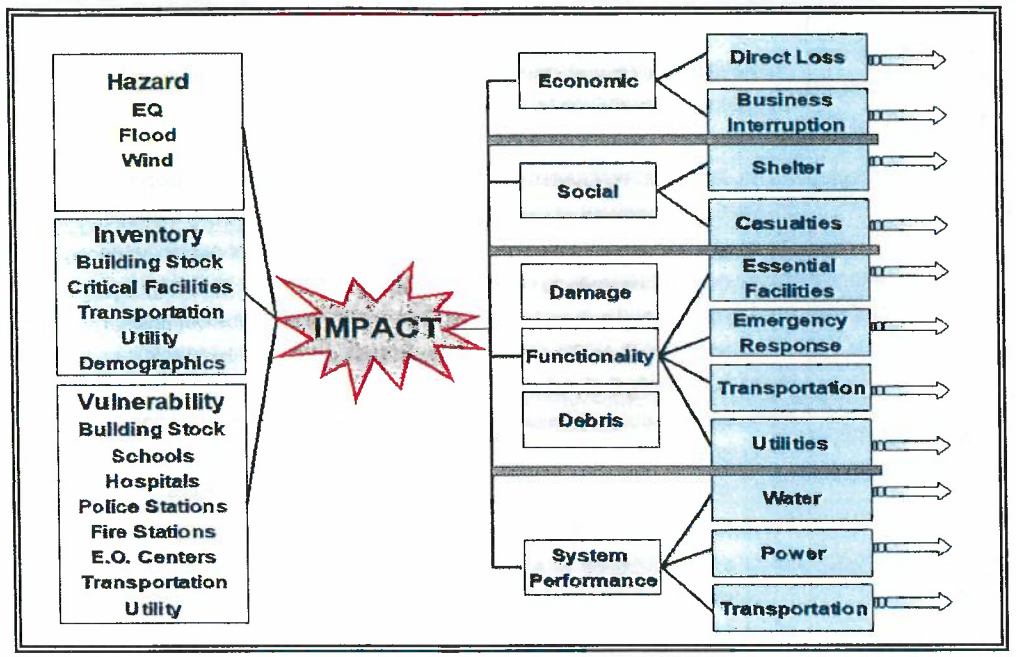
In accordance with FEMA requirements, this section addresses the County's vulnerabilities to these hazards and estimates the expected losses from their occurrences. Flooding and tropical storm/hurricane-related winds are the most common hazards affecting the County. There exists a wealth of information to sufficiently complete meaningful assessments of these events. For example, floodplain maps and flood data are available for flood hazard calculation. Similarly, hurricane/tropical storm-related wind damages can be determined using databases and historical records.

The County is also somewhat vulnerable to the effects of winter storms and tornadoes. Unfortunately, there is little reliable information available to assess quantitative loss estimates for snowstorms properly. This chapter uses currently available data to surmise a reasonable estimate of damages from a snowstorm. It is important to note that the risk assessments for the County are based on best available data and represent a base-level assessment for the planning area. Additional work will be needed on an ongoing basis to enhance, expand and further improve the accuracy of the baseline established here.

5.3 Explanation of Hazus 4.2 Risk Assessment Methodology

Hazus is FEMA's standardized loss estimation software program, built upon an integrated geographic information system (GIS) platform (Figure 5.1). This risk assessment applied Hazus to produce estimated losses for three of the eight hazards addressed in this section: flood, hurricane winds and earthquake.

Figure 5.1 Conceptual Model of HAZUS-MH Methodology



5.4 Hazard Vulnerability

5.4.1 General Discussion of Flood Vulnerabilities

Flooding can result from various weather events such as hurricanes, thunderstorms, and runoff from winter storms. When hurricanes reach inland, they often weaken and become tropical storms. This frequently brings torrential rain to the region. Likewise, winter storms can cause flooding, as temperatures rise causing rapid snowmelt. The NOAA's National Climatic Data Center (NCDC) reports 97 flood or flash flood events (excluding hurricane/tropical storm events) took place in Howard County from 1996 to 2016. Although the NCDC did not return flood information prior to 1996, historical data shows numerous instances of flooding.

The County is concurrently developing the 2018Flood Mitigation Plan (FMP) update, along with this HMP update, to ensure plan integration and maximize county, stakeholder, and public participation. To avoid repetition and to maintain consistency, the 2018 FMP update is incorporated by reference into this HMP update. Additionally, Appendix E lists all flood related mitigation actions identified in the FMP.

The Joint HMP/FMP Steering Committee (JSC) reviewed various materials while preparing the flood assessment to help inform the most effective and coordinated mitigation strategy. Table 5.1 identifies the flood risk-related documents that were reviewed, a brief description, and the year in which the effort was completed.

Table 5.1 – Local Flood-Related Planning Documents Reviewed

Document	Description	Year
Ellicott City Flood Recovery Community Advisory Group (CAG): Final Report	Provides recommendations on the recovery process as well as rebuilding and recovery project ideas.	2017
Ellicott City Flood Workgroup Flood Report	Provides recommendations to protect the Ellicott City Historic District through enhancement of public safety and minimizing property damage.	2015
Ellicott City Hydrology and Hydraulic Study & Concept Mitigation Analysis	Uses a detailed H&H model to examine the effect of additional proposed conceptual improvements on flooding conditions. Several hydrologic models of the Hudson Branch, Tiber Branch and New Cut Branch sub watersheds of the Tiber-Hudson Branch were created to calibrate a baseline hydrologic model.	2017
Ellicott City Watershed Master Plan (planning process)	Helps define a comprehensive community-driven vision for rebuilding a stronger and more resilient Ellicott City, and plan will take a fresh and creative look at potential long-term flood solutions and strategies. [125]	Ongoing
Tiber-Hudson Stream Corridor Assessment	Provides a visual survey of the stream corridor in order to document specific conditions within the stream system that have the potential to exacerbate flood conditions and/or result in potential threats to property and infrastructure.	2017
Valley Mede Drainage Study	A comprehensive hydrologic and hydraulic analysis of the July 30, 2016 flooding event in the Valley Mede, Chatham and Nob Hill area. It also discussed how certain water retention controls, stream channel enhancements and local drainage improvements may reduce the amount of flooding for various storm conditions. [126]	2017

Unlike some of the other counties in the State, Howard County does not border either the Chesapeake Bay or the Atlantic Ocean, therefore there are limited significant-flood sources. Five-point-five (5.5) percent of the County's land area is in the 100-year floodplain. Since only a small percentage of Maryland floodplains lies in Howard County, the percentage of structures and population exposed to flooding are subsequently relatively low. However, a vulnerability determination must take into consideration the number of structures and people exposed to the potential flooding.

5.4.2 General Discussion of Hurricane/Tropical Storm Wind Vulnerabilities

Given its proximity to the Atlantic Ocean, Howard County is occasionally subject to the effects of hurricanes and tropical cyclones. These events are rarely as severe as those experienced on the eastern shore of Maryland or further south along the eastern seaboard or in the Gulf of Mexico. Howard County's location makes extreme Hurricane strength wind events (such as Saffir-Simpson Category 4 or 5 hurricanes) very unlikely.

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[125] Howard County Government, Ellicott City watershed Master Plan, available at https://www.howardcountymd.gov/Departments/Planning-and-Zoning/Community-Planning/Community-Plans/EC-Master-Plan.
[126] Howard County Government, Valley Mede Drainage Study Public Meeting, available at https://www.howardcountymd.gov/Events-and-Meetings/EventId/1078/e/valley-mede-drainage-study-public-meeting-15-nov-2017.

For Howard County, the most significant potential effect of hurricanes and tropical storms is flooding. In addition, these events could also bring about dangerous high winds. Most of the risk from hurricane and tropical storm winds in the mid-Atlantic region is related to structural damage rather than injuries and deaths. Howard County buildings are not especially vulnerable to wind effects from lower-intensity storms due to limited "mid" or "high-rise" development and strong building code enforcement.

Unfortunately for this study, accurate data concerning wind vulnerability is slim. In most instances, this information is not publicly available as private insurance covers wind damage except in the most extreme circumstances. The only source of information available regarding wind vulnerabilities is currently NOAA's National Climatic Data Center (NCDC) . While the NCDC data is useful, under-reporting may skew statistics. Under this category, the NCDC only listed one "Strong Wind" event and four "High Wind" events (excluding tornados and thunderstorm winds) between 1950 and 2017 in the database. It is clear that wind events have impacted the County in the past, such as those associated with Hurricanes/Tropical Storms Agnes, Floyd, Isabel, Irene, Lee, and Sandy. The NCDC appears to under-report the losses for many hazards including wind. Because of this, the measure of wind vulnerability is better described as "exposure," which is the value of the assets which are potentially at risk.

5.4.3 General Discussion of Winter Storm Vulnerabilities

As discussed in Chapter 4, Howard County is located in a region that is subject to frequent winter storms. The County is also vulnerable to infrastructure damage from a roof collaspe should the weight from the snow/ice become too great. The County's comprehensive building codes usually provide adequate protection against roof damage from snow and ice loading in all but the most extreme events. Other occurrences during winter storms may include automobile accidents and/or personal or pedestrian injuries due to road or sidewalk conditions.

Electrical system failures are also an issue, as a sudden temperature drop may cause electrical systems to malfunction. The large majority of Howard County's electrical infrastructure is owned and maintained by private-sector companies, the most prevalent being the Baltimore Gas and Electric (BGE) Company. These companies are responsible for all maintenance and repair of their own assets when impacted by snow or ice. Although these systems are vulnerable to the effect of winter storm hazards, there is no way to quantify these in this mitigation plan.

Unlike flood hazards, there is almost no open-source information about winter storm damages. Damages to residential structures are covered by private-sector insurance. Additionally, the County does not keep hazard-specific records about any damages to its facilities.

5.4.4 General Discussion of Tornado and Wind Event Vulnerabilities

Historical incidents of tornadoes in Maryland are very low compared to states in the Central and Southern parts of the country, however the occurences of thses types of events around the State are increasing[127]. Although the tornadoes that do hit the State are often relatively low in intensity, their increasing frequency should not be minimized. In terms of the County's vulnerabilities, non-

[127] Maryland Tornadoes https://www.weather.gov/lwx/events_mdtor96

engineered structures remain most at risk (these include balloon-frame residential buildings, manufactured housing, outbuildings, and mobile homes). Engineered buildings are generally designed to withstand higher wind loads as they are designed and built with connections and materials that resist positive and negative wind pressures.

5.5 Other Hazard Vulnerabilities in Howard County

Chapter 4 explained the process by which the County reduced eight possible natural hazards to a list of four (which were discussed above) selected for detailed analysis. The other four hazards addressed in Chapter 4 must be considered in order to fully assess hazard vulnerability affecting the County. The remaining four natural hazards are:

- Wildfires
- Lightning
- Earthquakes
- Drought

5.5.1 General Discussion of Wildfire Vulnerabilities

Howard County experiences several wildfires each year, particularly during periods of extended drought. Detection and supression capabilities are good within the County, so wildfires are generally located, contained, and extinguished in a timely manner. Wildland urban interface [128] exists within Howard County, but those areas are extremely limited in scope. Wood structures, and buildings built prior to the implementation of the building codes, remain the most vulnerable to wildfires. The overall low probability of severe wildfires in the region indicates the County is not particularly vulnerable to this hazard.

5.5.2 General Discussion of Lightning Vulnerabilities

Howard County is subject to numerous lightning strikes each year. They occur most frequently during the spring and summer months. Although lightning strikes cannot be predicted, and are not geographically constrained, the county's building codes are designed in part to minimize lightning damage or to ensure minimal damages occur. Because damage can occur to privately owned assets such as residential structures and/or electrical systems, there is no effective way of identifying nor calculating these figures, however it is likely that the damage is fairly limited.

5.5.3 General Discussion of Earthquake Vulnerabilities

Despite the 5.8 magnitude earthquake that shook rural Virginia in August 2011, and the recent 4.1 that struck the coast of Delaware in November 2017, most of Maryland lies in "seismic risk zone 1," meaning that only minor earthquake damage could occur in these parts. Although Howard County (and the State at large) does occasionally experience earthquakes, citizens are more likely to

[128] Hermansen-Baez, L. Annie, University of Florida IFAS Extension, *Wildland Urban Interface: Varied Definitions*, http://edis.ifas.ufl.edu/fr287.

experience earthquakes that originate in nearby States, such as those mentioned above. Thus, while the County may be vulnerable to the effects of seismic events, the improbability of a significant seismic event in the region garners this hazard a low rating.

In the event of an incident, the vulnerabilities to an earthquake are generally limited to un-reinforced masonry structures, built prior to the existence of building codes, and are subject to failure when exposed to lateral loads. As there is no database identifying these types of structures around the County, it is difficult to estimate, the level to which Howard County is vulnerable to significant earthquake damage, should one occur in the region. Hazus does provide a basic assessment of damages and those results are included at the end of Section 5.7.

5.5.4 General Discussion of Droughts and Extreme Heat Vulnerabilities

Howard County is somewhat vulnerable to the effects of droughts and extreme heat. Since the County is not heavily reliant on agriculture, the potential effects of a drought is limited to occasional water restrictions. As extreme heat is always a possibility in the summer months, and tends to coincide with drought conditions, the County has taken steps towards protecting its citizens during periods of extreme heat. In addition to cooling centers for those without cooling systems in their residences, the County disseminates information via social media about actions to take during high heat conditions. These actions help minimize heat-related illness, injuries, and loss of life throughout the County.

5.6 A Note on Future Trends

Howard County recognizes that hazards and the risks they present are likely to change from year to year, and that the emerging issue of global climate change will likely affect how hazards will impact the jurisdiction. Although there is no way to accurately anticipate these future developments, the County continually monitors trends in terms of probability and potential impacts as a way to develop and calibrate mitigation activities.

5.7 Estimate of Potential Losses

This section describes Howard County's potential losses (or otherwise known as risks). The term *vulnerability assessment* describes the extent to which physical assets, people, or operations are damaged when they are exposed to natural hazards. The term *loss estimation* is analogous to *risk assessment*, and refers to expected future damage resulting from the impacts of natural hazards. Depending on the type of information available for the analysis, risk can be calculated or estimated in several different ways.

5.7.1 Flood Risk in Howard County

Flood vulnerability is determined by several factors, the most significant being: (1) exposure, (2) relative elevation, (3) proximity to floodplain, and (4) physical and operational characteristics of the assets potentially at risk. Complete information about these factors is rarely available, so one must use the best information available to assess flood vulnerability.

This subsection focuses on future flood loss estimates based on best available data. The present section is intended to provide a moderately detailed overview of flood risk in the County. To reduce redundant analysis, this section replicates segments from the concurrently developed *2018 Howard County Flood Mitigation Plan*.

The first general measure is the number and estimated value of structures located in the 100-year floodplain. Howard County building footprints used with the Hazus generated 100-year floodplain indicates that approximately 235 buildings are located in the floodplain. This figure may under-estimate the number of individually owned assets in the floodplain, as the term "building" includes multiple unit structures, such as townhomes. Areas such as Ellicott City, Columbia, and Elkridge experience moderate to significant flood vulnerability, as shown in Table 5.2. This table shows the number of structures that are completely, or partially, within the 100-year floodplain.

Table 5.2 - Geographic Areas in Howard County With Moderate Or Significant Flood Vulnerability (Based on Number of Structures in The 100-Year Floodplain)
(Source: Howard County Flood Mitigation Plan, 2018

Area	Number of Structures
Ellicott City	50
Columbia	40
Elkridge	35

There are 7,939 acres within the floodplain in Howard County, which affect some 8,009 parcels of land. Not all parcels have significant exposure to flooding, specifically those parcels that only have some small portion of the property falling within the 100-year floodplain. Table 5.3 shows specifically County-owned land that is located within the 100-year floodplain. Over 3,455 acres of the 18,283 total acres the County owns are in the floodplain, which represents 19% of all Howard County property.

Table 5.3 - County-Owned Land, Total Area and Area in 100-Year Floodplain
(Source: Howard County GIS)

Classification	Total	Estimated acreage located in the 100-year floodplain
Board of Education	1,760 acres	621 acres
Parks	5,756 acres	842 acres
Open space	3,816 acres	937 acres
Public Works	6,951 acres	1,055 acres
Total	**18,283 acres**	**3,455 acres**

Flood Loss Estimation

Analysis of NFIP Flood Insurance Claims Data

The National Flood Insurance Flood Program (NFIP) claim statistics can help one better understand a community's flood vulnerability and risk. The NFIP is a federal program that enables property owners in participating communities to purchase insurance to protect against flood losses. In order to participate, communities must develop and continuously implement floodplain management regulations that will reduce future flood damages. If a community adopts and enforces floodplain management ordinances, the federal government will ensure flood insurance is available to those in the community.

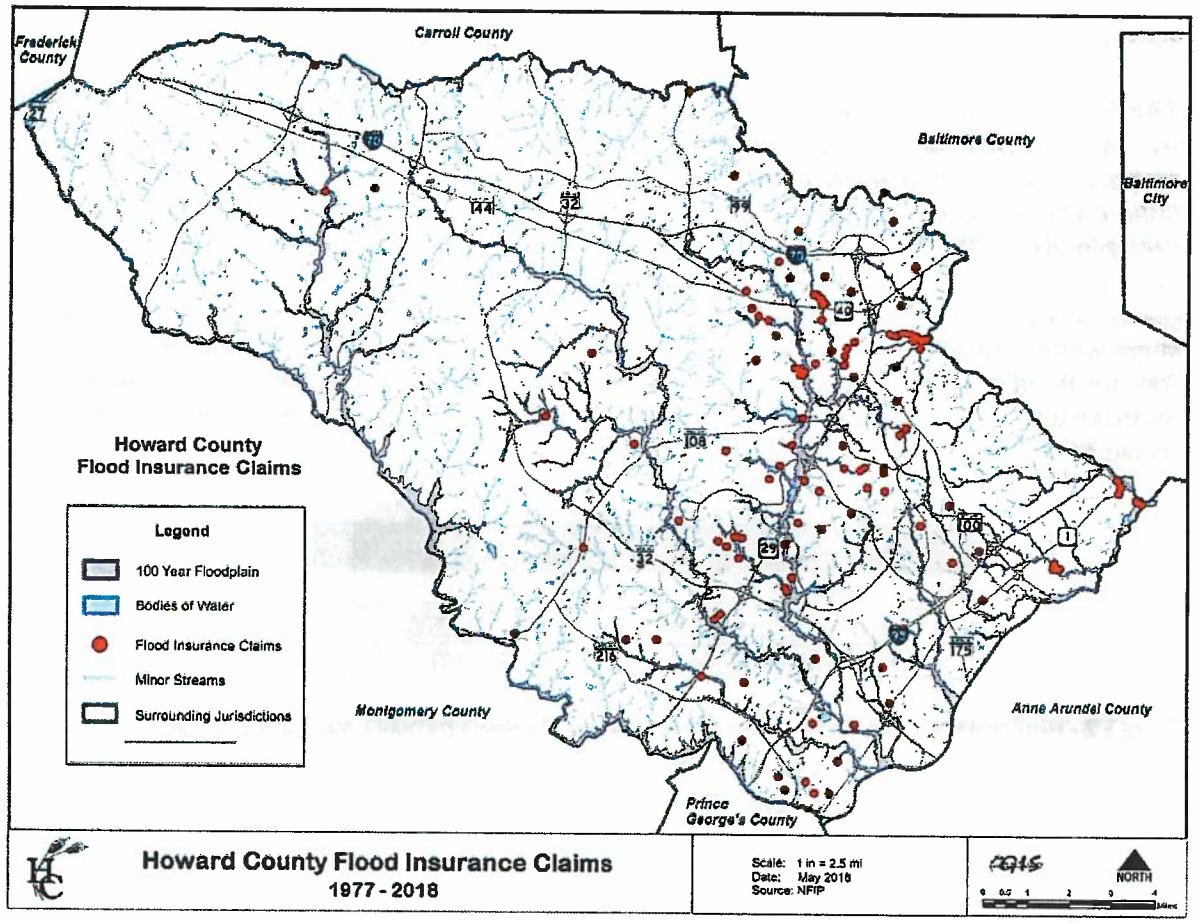
One loss estimation measure used is based on a NFIP claims data analysis. Since NFIP's formation in 1977, Howard County flood insurance policy holders have submitted 261 claims totaling $7,469,281. This is a relatively small number given the County's population and its number of structures. Other counties throughout Maryland see much higher totals, such as Anne Arundel and Baltimore County, with 43 and 66 million respectively. Unlike other flood-prone areas in the Country, the claims in Howard County are concentrated to specific incidents in 1977, 1981, and most recently in 2016. The low figure, combined with the fact that the with the exception of the Ellicott City Flood of 2016, many claims were filed over 25 years ago, may be attributed to proactive planning and policy measures undertaken by the County. Howard County has been assisting homeowners with making their properties less flood prone, as well as buying out homes that are most at risk for flooding. It may also be prudent to note that the flood claim data represents only properties that have flood insurance claims, and not those properties that were flooded but no claim was filed. See Table 5.4 and Figure 5.2 for county insurance information.

Table 5.4 - Howard County Insurance Information

Howard County Flood Insurance Numbers	
Policies in Force	1,032
Insurance In-force whole	$287,859,200
Written Premium In-force	$736,191

Figure 5.2 - Historical National Flood Insurance Program Claims in Howard County, Maryland 1977-2010

Source: Howard County GIS



To determine the average annual flood claim, the total amount of flood claims ($7,469,281) is divided by the number of years in the period (2018 – 1977 = 41), which results in $182,177. This number can then be multiplied by a present value coefficient to project total losses over a planning horizon to include the effect of discounting today's dollars. Based on this methodology, the average annual flood claim based on expected flood losses is estimated at $2,599,665. For reference, HAZUS calculates an average annual loss of $4,440,000 for the county.

Residential Repetitive and Severe Repetitive Loss Properties

A Repetitive Loss (RL) property is defined as any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Structures that flood frequently strain the National Flood Insurance Fund. Repetitive loss properties not only increase the NFIP's annual losses and the need for borrowing; but they drain funds needed to prepare for catastrophic events.

A Severe Repetitive Loss (SRL) property is defined as a residential property that is covered under a NFIP flood insurance policy and: 1) that has at least four NFIP claim payments (including building and contents) over $5,000 each; or 2) for which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

As of March 27, 2018, MDE reports that there are 14 non-mitigated repetitive loss properties in Howard County, one of which, is a severe repetitive loss property. There are two mitigated repetitive loss properties, which were acquired by the County using FEMA funds. Both houses were removed and the lots are now open space. As repetitive loss information is available from MDE at any time, and the information is covered by Privacy Act, the County does not include a table in this Plan Update or maintain a list on its computer network.

Flood Loss Estimates using Hazus v4.2

The 2018 Howard County FMP is an excellent source of detailed information about flood risks and potential flood mitigation projects in the County, and has been referenced here to offer data on estimates regarding potential flood losses. The FMP's section on risk utilizes Hazus to calculate potential flood losses. The Hazus assessment identified 235 buildings in the County within the boundaries of the 100-year floodplain. As explained in the FMP, flood depth grids are then intersected with the buildings' foundation elevation data to calculate expected losses in a 100 and 500-year flood as shown below in Tables 5.5 through 5.7.

Table 5.5 - Potential Damage in a 100 and 500-year Flood, by Damage Category

Degree of Damage	100-Year Count	500-Year Count
1-10%	10	30
11-20%	30	55
21-30%	25	30
31-40%	20	30
41-50%	20	20
Greater than 50%	30	65

Table 5.6 - 100-year Estimated Losses

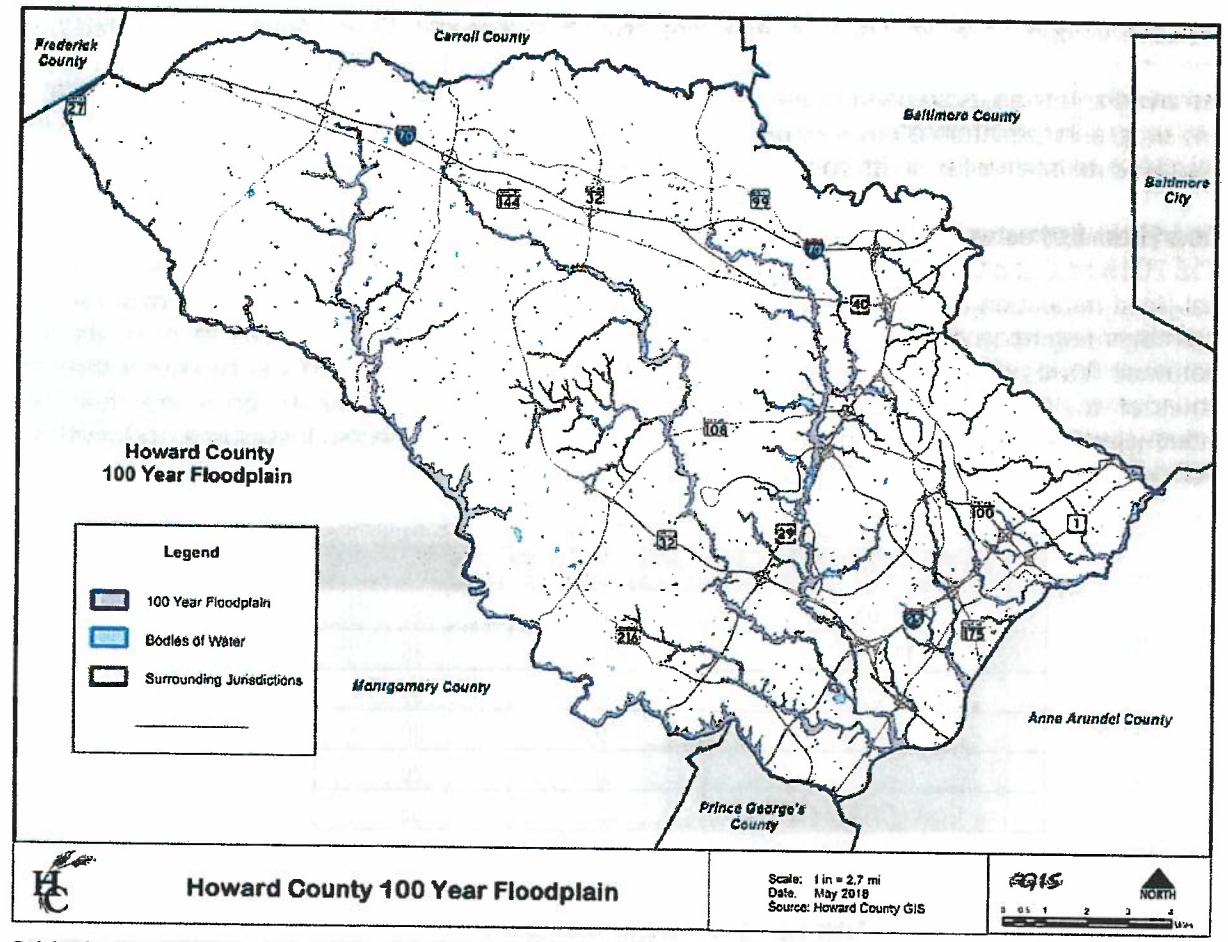
Study Area	Residential Building Loss	Residential Building and Content Loss	Commercial Building Loss	Total Building Loss	Total Building and Content Loss	Estimated Total Loss
Columbia	$1,234,000	$1,941,000	$57,000	$1,301,000	$2,184,000	$2,845,000
Elkridge	$620,000	$934,000	$19,000	$817,000	$1,843,000	$2,342,000
Ellicott City	$7,026,000	$10,589,000	$2,614,000	$9,526,000	$20,449,000	$37,207,000
County Total	$15,358,000	$23,319,000	$3,594,000	$19,830,000	$39,620,000	$66,889,000

Table 5.7 - 500-year Estimated Losses

Study Area	Residential Building Loss	Residential Building and Content Loss	Commercial Building Loss	Total Building Loss	Total Building and Content Loss	Estimated Total Loss
Columbia	$3,388,000	$15,294,000	$247,000	$3,660,000	$6,142,000	$8,375,000
Elkridge	$743,000	$1,383,000	$1,147,000	$3,641,000	$9,511,000	$15,510,000
Ellicott City	$9,951,000	$14,961,000	$3,650,000	$14,415,000	$30,217,000	$56,014,000
County Total	$26,168,000	$39,862,000	$6,608,000	$35,541,000	$71,722,000	$120,579,000

Figure 5.3 – 100-year Floodplain in Howard County

Source: Howard County GIS



Critical Facilities

For the purposes of this risk assessment, the label "critical facility" refers to five categories of locations that will be very important during the response and recovery phase of a hazard event. Those categories are: Medical Care Facilities, Emergency Operations Centers, Fire Departments, Police Departments and Schools. According to HAZUS, there are a total of 131 critical facilities in Howard County, Maryland. According the the County-supplied data, there are a total of 132 critical facilities in the County, as shown in Table 5.8.

Table 5.8 Critical Facilities in Howard County

Critical Facility Type	HAZUS Default Data	County-Supplied Data
Fire Stations	16	12
Police Stations	0	3
Schools	112	114
Hospitals	3	3

5.7.2 Hurricane and Tropical Storm Wind Risk in Howard County

Howard County's proximity to the Atlantic Ocean makes it slightly vulnerable to hurricane and tropical cyclone wind. Compared to other counties closer to the Atlantic coast, potential losses to assets and operations are relatively minimal. This subsection presents the results of wind loss

estimations that were completed with the Hazus 4.2 software. Since the software provides only general results, a detailed site-specific risk assessment should be conducted using information such as structural characteristics, physical surroundings, and occupancies. Several of these data parameters were estimated for the calculations below.

To model Hurricane impacts to Howard County for this mitigation plan, two Hazus analysis approaches were utilized, 1) a probabilistic hurricane analysis and 2) a historic hurricane analysis. The probabilistic analysis in Hazus is based on 100,000 years of modeled hurricane tracks, which is based on starting points of historic hurricanes with variations in travel direction, strength and size. Over 300,000 modeled storm tracks were run using these variables. After intersecting these storms with the county, Hazus looks at the losses generated from each event and determines statistically which would correlate to a specific return period event. The historic event modeled was Hurricane Hazel, which came within 25 miles of the western edge of Howard County in 1954. This is the closest storm track to Howard County based on available historic data.

Probabilistic Hurricane Results

Results provided by Hazus utilized in this report include debris estimates, number of buildings damaged and potential losses, as shown in Table 5.9 through Table 5.14.

100-Year Results

Table 5.9 - 100-year Probabilistic Hurricane event with 63mph peak gust wind speed

Debris (Total Tons)	Eligible Tree Debris (Tons)	Brick/Wood debris (Tons)
1,875	1,000	125

Eligible tree debris is debris that is assumed to be picked up by the county (Table 5.9). This includes debris put out on the road by residents cleaning up their own property as well as debris in public spaces that will need to be removed in order for the community to restore full operations.

Table 5.10 - Building Damage Count by General Occupancy for 100-year Hurricane

Occupancy	Minor Damage	Moderate Damage
Agriculture	1	0
Commercial	14	0
Education	1	0
Government	1	0
Industrial	5	0
Religion	1	0
Residential	58	1
Total Count	81	1

Table 5.11 - Total Estimated Loss for 100-year Hurricane

Loss Type	Residential	Commercial	Industrial	Others	Total
Property Damage	$9,515,000	$210,000	$70,000	$30,000	$9,825,000
Business Interruption	$5,000	$0	$0	$0	$5,000
Total	$9,520,000	$210,000	$70,000	$30,000	$9,830,000

Note: Results are rounded to nearest $5,000

500-Year Results

Table 5.12 - 500-Year Probabilistic Hurricane Event With 82mph Peak Gust Wind Speed

Debris (Total Tons)	Eligible Tree Debris (Tons)	Brick/Wood debris (Tons)
26,540	8,075	6,270

Eligible tree debris is debris that is assumed to be picked up by the county. This includes debris put out on the road by residents cleaning up their own property as well as debris in public spaces that will need to be removed in order for the community to restore full operations.

Table 5.13 - Building Damage Count by General Occupancy for 500-year Hurricane

Occupancy	Minor Damage	Moderate Damage	Severe
Agriculture	4	1	0
Commercial	65	6	1
Education	4	0	0
Government	2	0	0
Industrial	20	1	0
Religion	5	0	0
Residential	1,535	102	1
Total Count	1,635	110	2

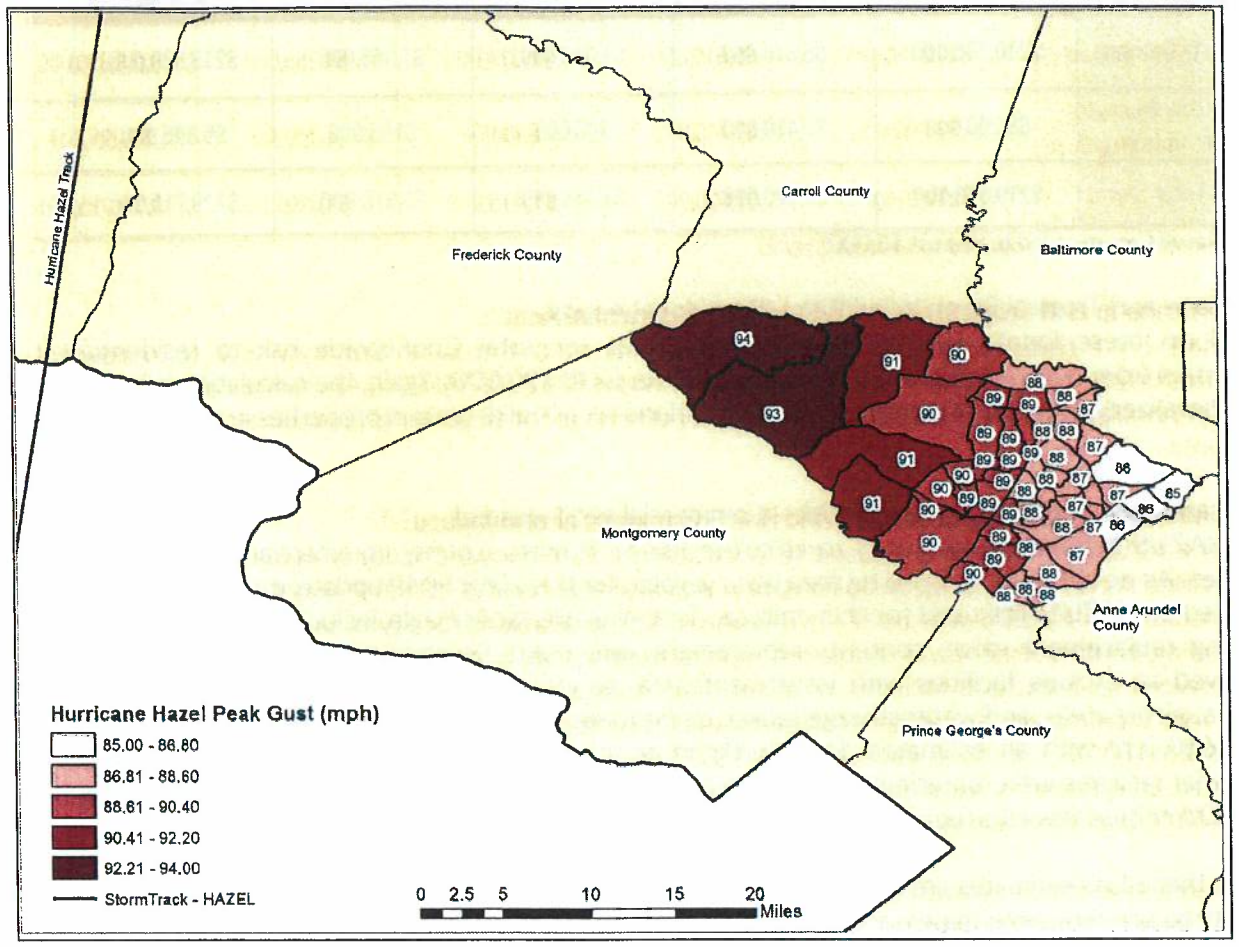
Table 5.14 - Total Estimated Loss for 500-year Hurricane

Loss Type	Residential	Commercial	Industrial	Others	Total
Property Damage	$99,045,000	$1,610,000	$365,000	$270,000	$101,290,000
Business Interruption	$3,245,000	$65,000	$5,000	$5,000	$3,320,000
Total	$102,290,000	$1,675,000	$370,000	$275,000	$104,610,000

Note: Results are rounded to nearest $5,000

Results from the 1954 Hurricane Hazel event are provided below. The results are based on if that same storm event occurred today. The storm generated peak gusts of 94 mph in western Howard County, and hurricane force winds across the entire county, as shown below in Figure 5.4.

Figure 5.4 – Hurricane Hazel Peak Gust (mph)



Results from the Historic Hurricane analysis include debris, shelter, and losses, shown in Table 5.15.

Table 5.15 - Estimated Debris from Hurricane Hazel

Debris (Total Tons)	Eligible Tree Debris (Tons)	Brick/Wood Debris (Tons)
93,500	23,500	40,600

Shelter analysis in Hazus is based on a variety of factors including Age, Income, Ethnicity, and Home Ownership information. This information is provided through the Census Demographic data included with Hazus, based on the 2010 census. The model predicts that 15 households will be temporarily displaced, however none are predicted to require short term sheltering. This does not mean that shelters will not need to be opened, rather it means that those who go to the shelters would likely not need to stay for an extended duration.

Estimated Losses from Hurricane Hazel

As previously stated, these losses are based on the storm occurring today and damaging the current built environment. This should not be compared to the actual storm event that occurs in 1954, when the county was much less developed. The results of this analysis are summarized in Table 5.16 and expanded upon below.

Table 5.16 – Estimated Losses by Building Type

Loss Type	Residential	Commercial	Industrial	Others	Total
Property Damage	$210,780,000	$5,610,000	$1,375,000	$1,355,000	$218,820,000
Business Interruption	$8,290,000	$1,410,000	$40,000	$155,000	$9,895,000
Total	$219,070,000	$7,020,000	$1,415,000	$1,510,000	$228,715,000

Note: Results are rounded to nearest $5,000

Hurricane and Tropical Storm Wind Risk – Residential Assets

Based on these inputs, this methodology estimates the total Countywide risk to residential properties from hurricane and tropical storm winds is $210,780,000. Again, the calculation is based on generalized inputs that do not represent conditions for all buildings and properties in the planning area.

Hurricane and Tropical Storm Wind Risk – Commercial and Industrial

The HAZUS software is also used to calculate risk to Howard County commercial and industrial facilities. As no site-specific building data was available for this 2018 HMP update, the standard data included in HAZUS was used for this analysis. The available facility data included square footage, building replacement value, contents replacement value, and structure type. The list was then reviewed to exclude facilities with insufficient data, as well as non-building sites (such as radio towers, picnic areas, and water storage tanks). Using these inputs, the risk to commercial properties is $5,610,000 with an estimated $1,410,000 in additional losses due to business interruption. Industrial facilities were determined to face $1,375,000 in damages with the potential of roughly $40,000 in business interruption losses.

Again, these loss estimates are intended to serve as initial assessments. This process allows the County to properly determine priorities for additional studies and/or mitigation actions.

5.7.3 Winter Storm Risk in Howard County

According to the 2017 Howard County HIRA, Howard County has experienced 137 severe winter weather events between 1969 and 2016 (severe winter weather events include any Avalanches, Blizzards, Cold/Wind Chill events, Extreme Cold/Wind Chill events, Freezing Fog, Frost/Freeze events, Heavy Snow events, Ice Storms, Lake-Effect Snow events, Sleet events, Winter Storms, or Winter Weather events to occur in the jurisdiction). The NCDC database should not be considered a complete archive of all damages caused by winter storms in the County, as the database does not include storm events prior to 1993. Even without that information, the available NCDC data is sufficient for a simple risk assessment. Table 5.17 shows the basic data required for the assessment, which is available from public sources. Since no injuries or deaths were reported for Howard County by the NCDC, this risk assessment focused on property damages associated with winter storms.

Table 5.17 - Data Parameters for Howard County Winter Storm Risk Assessment
Source: 2017 Howard County HIRA (1993-2016)

Data	Value
Winter storm events	137
Reporting Years	23

Average annual number of winter storm events	6
Total reported damages	$690,500
Annual damages	$30,020

While the Howard County Office of Risk Management maintains general information about damages to County facilities, it does not record the specific hazard that caused the damage. Unfortunately, the County also does not retain records regarding additional costs borne by the jurisdiction due to winter storms. Like most jurisdictions that are exposed to winter storm and ice hazards, the County forecasts for such response costs in its budget. These expenses typically include increased fire, rescue, and police services; snow and ice removal; and occasional staff overtime.

5.7.4 Tornado Risk in Howard County

The overall risk of tornadoes in Howard County is low compared to other parts of the Country. However, there is sufficient exposure to this hazard to perform a simple risk assessment to characterize potential future losses.

A simple calculation was performed using the same method as winter storm estimates. Again, this means that the result of the analysis should be regarded as a preliminary indication of the potential damages. Unfortunately, evaluation of specific previous mitigation actions requires technical information that was not available for this plan update.

The potential losses/risk calculation is based on the historic occurrences of tornado events. As there have only been 14 tornado events affecting the County since 1950 according to NCDC, thunderstorm wind events have been included for calculations. The first results begin in 1969, so the reporting years encompass 1969 to 2017 (Table 5.18).

Table 5.18 - Data Parameters for Howard County Tornado/Wind Event Risk Assessment
Source: NCDC (1969-2017)

Data	Value
Tornado/Thunderstorm Wind Events	221
Reporting Years	48
Average Annual Number of Tornado/Thunderstorm Wind Events	4.6
Total reported damages	$5.340,000
Annual damages	$111,250

5.7.5 Earthquake Risk in Howard County

As HAZUS has earthquake analysis capabilities, Howard County has included the results of that analysis to provide a general assessment of risk to Howard County. More frequent earthquake events in surrounding states have generated more consideration for future events potentially impacting the County. An annualized loss estimation analysis was conducted, and losses are broken down between Building Stock (structural, non-structural, content and inventory) and Income Losses (wage loss, capital related, rental and relocation). Table 5.19 below summarizes the estimated annualized losses for Howard County.

Table 5.19 - Earthquake Estimated Losses by Building Type

Loss Type	Single Family	Other Residential	Commercial	Industrial	Other	Total
Income Losses	$40,000	$7,000	$49,000	$2,000	$5,000	$102,000
Building Stock Losses	$240,000	$40,000	$73,000	$18,000	$14,000	$385,000
Total	$280,000	$47,000	$122,000	$20,000	$19,000	$487,000

Note: Results are rounded to the nearest thousand dollars

5.8 Summary of Risk Assessment

Mitigation planning provides communities a rational and standardized method when deciding what actions to undertake to reduce their natural hazards risks. While it is important to determine and implement specific mitigation actions, the risk assessment portion of a mitigation plan establishes the basis for prioritizing those mitigation efforts. The risk assessment in the HMP: (1) provides an idea of the most significant risks to Howard County; (2) identifies the hazards that present the most potential damage to the County assets; (3) ascertains where additional study may be warranted; and, (4) begins the process of identifying and prioritizing mitigation actions. Table 5.20 summarizes the results of the risk assessments for floods, hurricane/tropical storm winds, winter storms, earthquakes, and tornadoes for Howard County. The figures are based on calculations of direct damages, losses of functions, and casualties. Table 5.21 then lays out the overall hazard ranking for Howard County.

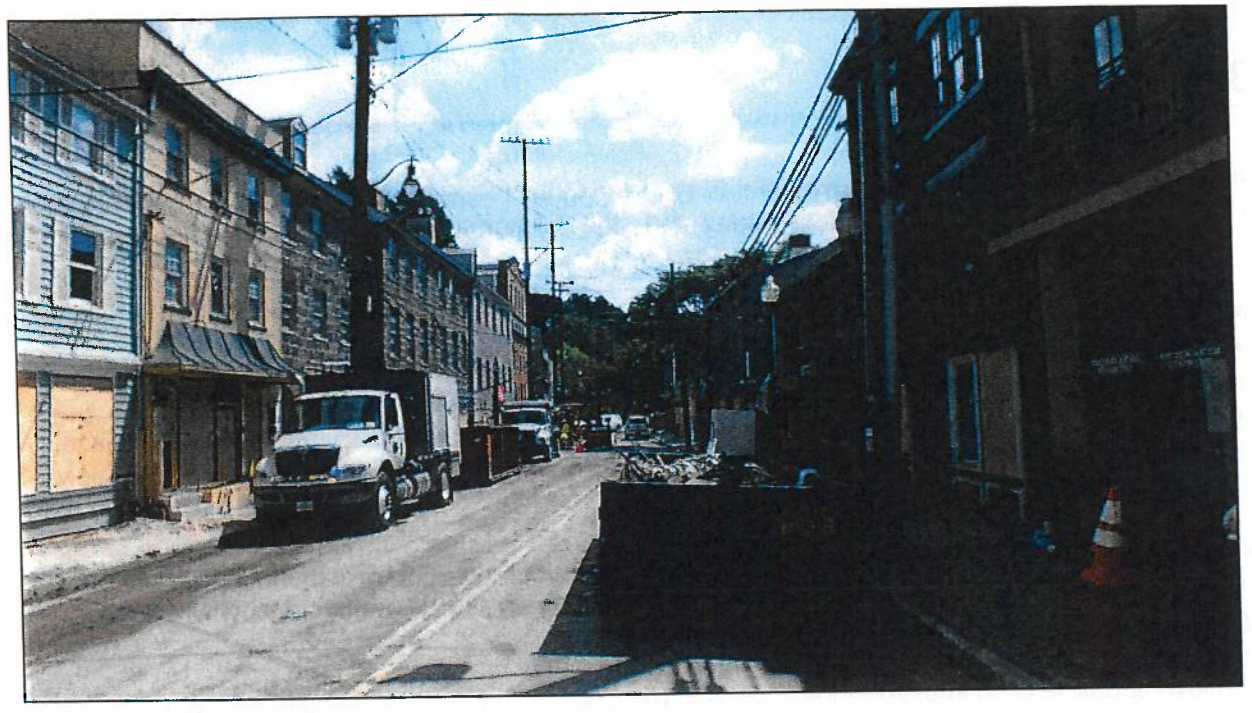
Table 5.20 - Summary of Howard County Average Annual Loss Estimations

Hazard	Asset	Annual Losses
Floods	Residential (using NFIP claims projection)	$2,599,665
Floods	Residential (using Hazus claims projection)	$4,440,000
Hurricane wind	All properties (Hazus probabilistic estimate)	$9,830,000
Winter Storm	All properties (based on NCDC)	$30,020
Tornado	All properties	$111,250
Earthquake	All properties	$487,000

Table 5.21 - Overall Hazard Ranking for Howard County (Likely Scenario)

Natural Hazard	Risk Rank
Flood	1
Severe Winter Weather	2
Hurricane Tropical Storm	3
Drought	4
Lightning	5
Tornado/Wind Storm	6
Earthquake	7
Wildfire	8

CHAPTER 6 – CAPABILITY ASSESSMENT



6.1 IFR Requirements for Plan Integration

IFR §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

6.2 Introduction

Through the dedication and hard work of multiple County departments and agencies, Howard County continues to maintain a high level of preparedness through the application of hazard mitigation principles. For example, the County maintains strong flood-control practices, which includes rigorous permitting procedures which aim to ensure flooding is kept to a minimum in the region. However, the County is constantly looking for opportunities to implement, update, and cross-pollinate hazards mitigation principles into various plans, ordinances, regulations, and programs across the County. This approach ensures that all documents are well-coordinated, complementary, and that effective hazard mitigation principles are applied in all aspects of County management.

The subsections below include a review of select planning documents and ordinances used by the County in the areas of building standards, storm water management, comprehensive planning, emergency operations and capital improvements programming. Areas where hazard mitigation

principles are addressed or should be addressed are indicated. Options to incorporate hazard mitigation considerations into these documents have been included so that a seamless application of mitigation principles can be integrated into the plans and documents.

6.3 Plan Integration

A Document Review comprises an inventory of the County's existing planning and regulatory tools and a review and incorporation of existing plans and other technical information as appropriate. The purpose of a plan/ordinance review is tri-fold:

- To identify existing county standards and mandates
- To provide an inventory and review of sample plans and ordinances and identify sections in these documents that address hazard mitigation-related issues
- To provide a platform to integrate plans and other documents so recommendations and strategies are not in contradiction with one another (e.g., between the hazard mitigation plan and comprehensive plan).

The sections below include a review of Howard County's comprehensive plan, floodplain regulations, and emergency strategic plan, and identifies areas in these documents where flood mitigation principles are addressed.

Howard County Comprehensive Plan – PlanHoward2030

The following policies and implementing actions in the County comprehensive plan, developed by the Howard County Department of Planning and Zoning, relate directly to mitigation and are echoed in this document (Table 6.1);

Table 6.1 – PlanHoward 2030 Review
Source: Howard County Department of Planning and Zoning, 2017

Plan Topic	Page Number	Item Type	Current Clause
Environmental Protection	19	Policy 3.1	Ensure the adequacy of wastewater treatment capacity.
	19	Policy 3.2	Reduce pollution loads to surface and groundwater.
	19	Implementing Action	**Stormwater Utility.** Institute a dedicated fund to ensure increased and sustained funding for stormwater and watershed management programs.
	20	Policy 3.3	Use watershed management plans to guide the protection and restoration of water resources.
	20	Implementing Action	**Watershed Management Plans.** Prepare comprehensive watershed management plans for all watersheds, to set priorities and guide efforts to protect, restore, and improve the County's water resources. Complete and update all watershed management plans on a regular cycle.
	20	Implementing Action	**Forest Cover and Riparian Forest Buffers.** Establish and achieve measurable goals for forest cover and riparian forest buffers in all County watersheds.
	20	Implementing Action	**Wetlands.** Develop a wetlands program to inventory, map, protect, and enhance wetland resources.

Plan Topic	Page Number	Item Type	Current Clause
	20	Policy 3.4	Coordinate regional protection of water resources.
	20	Implementing Action	**Patuxent and Patapsco Rivers.** Coordinate and cooperate with other local, regional, and State agencies and organizations on joint watershed planning and management for the Patuxent and the Patapsco Rivers.
	22	Implementing Action	**Best Management Practices.** Expand current outreach and education efforts to promote and assist private property owners with the implementation of best management practices.
	24	Implementing Action	**Streams, Wetlands, and Floodplains.** Evaluate the effectiveness of current regulations in protecting streams, wetlands, and floodplains.
	25	Policy 3.8	Improve stormwater management practices throughout the County to help restore and protect water resources.
	25	Implementing Action	**Redevelopment.** Ensure redevelopment is designed and implemented to reduce stormwater runoff rate, volume, and pollution to the maximum extent practicable.
	Recommendation: There are no additional recommendations at this time.		
Resource Conservation	Recommendation: Include an additional implementing action to protect historic resources from the impacts of natural hazards through preservation-based hazard mitigation solutions.		
Economic Development	Recommendation: Develop a new policy and implementing actions that encourages economic resilience and encourages business owners to have a business continuity plan for flood and other hazard events.		
Public Facilities and Services	105	Policy 8.4	**POLICY 8.4 –** Ensure the adequacy of water and sewer services.
	105	Implementing Action	**Wastewater Treatment Plant Capacity.** Monitor flows to the Little Patuxent Water Reclamation Plant to ensure sufficient capacity for projected growth in the Planned Service Area.
	108	Policy 8.7	**POLICY 8.7** – Identify and fund the most cost-effective strategies for Watershed Implementation Plan execution.
	108	Implementing Action	**Best Management Practices.** Monitor and evaluate the cost-effectiveness of diverse best management practices to maximize nutrient reduction from the funds expended.
	119	Policy 8.16	**POLICY 8.16** – Minimize loss of life, loss of property, and injury due to fire or medical emergencies.
	119	Implementing Action	**Fire Stations.** Construct and staff the new and replacement fire stations in the current Capital Improvement Program (Waterloo, Elkridge, and Banneker). Renovate and rehabilitate existing fire stations as appropriate to ensure the continued provision of efficient service.
	120	Implementing Action	**Underground Cisterns.** Continue to construct underground cisterns to support fire suppression in the Rural West.
	120	Implementing Action	**Fire and Rescue Vehicles.** Provide funding to replace fire and rescue vehicles when needed.

Plan Topic	Page Number	Item Type	Current Clause
	120	Implementing Action	**Adequate Resources.** Ensure the Police Department has adequate staff and equipment based on levels of crime and demand for services.
	Recommendation: There are no additional recommendations at this time.		
Community Design	138	Implementing Action	**Infrastructure Gaps.** Expand existing infrastructure for older communities that were constructed under prior regulations, so these communities could benefit from additional improvements such as storm drains and sidewalks.
	138	Implementing Action	**Environmental Enhancement.** Expand environmental remediation to address storm water management, stream bank erosion, and buffer conservation.
	Recommendation: There are no additional recommendations at this time.		

Howard County Code of Ordinances – Subdivision and Land Development, Floodplain, & Stormwater Management (2015)

The following sections of the Howard County Subdivision and Land Development, Floodplain, and Stormwater Management Ordinances relate to mitigation and are acceptable standards and echoed in this document (Table 6.2);

Table 6.2 – Howard County Code of Ordinances Review – Subdivision and Land Development, Floodplain, and Stormwater Management Ordinances
Source: Howard County Code of Ordinances, 2015

Title 16 – Subtitle 1 – Subdivision and Land Development		
Plan Topic	**Item Number**	**Current Clause**
Sec. 16.104 - Waivers	16.104, (d), (2-4)	No Waivers of Floodplain, Wetland, Stream, or Steep Slope Regulations in the Tiber Branch Watershed. The Department may not grant waivers of any requirement of section 16.115 or section 16.116 of this title for any property located in the Tiber Branch Watershed unless the waiver: 2. Is necessary for the reconstruction of existing structures or infrastructure damaged by flood, fire, or other disaster; 3. Is necessary for the construction of a stormwater management or flood control facility as part of a redevelopment project; 4. Is necessary for the retrofit of existing facilities or installation of new facilities intended solely to improve stormwater management or flood control for existing development;
Sec. 16.115 – Floodplain Preservation	16.115, (a), (1-3)	**Development Restricted in 100-Year Floodplain (Base Flood Elevation).** Development within the boundaries of the 100-year floodplain (base flood elevation) shall be pursuant to title 16, subtitle 7 of this Code. Most land within base flood elevation is considered a protection area (i.e., a stream valley or valuable ecological area or scenic resource) which is shown: (1) In the General Plan of Howard County for conservation status; or (2) In the master plan of parks for acquisition as a conservation area; or (3) In the capital improvement program for acquisition as a conservation area

	16.115, (b), (1-2)	**Floodplain Protection.** In subdivisions and site development plans containing a 100-year floodplain (base flood elevation), the floodplain land shall be protected in accordance with one of the following alternatives. (1) Deed the floodplain land to the County. Developers are encouraged to dedicate and deed the land in the 100-year floodplain (base flood elevation) to Howard County as permanent open space. (2) Grant a floodplain easement to Howard County. If the floodplain is not dedicated to the County, the developer shall grant the County right of entry through a perpetual easement
	16.115, (c), (1-2)	**Prohibitions on Use of Floodplain Land:** (1) A person shall not store materials of any kind in a floodplain either temporarily or permanently. Accordingly, building materials and other debris shall not be stored or discarded in floodplains. (2) No clearing, excavating, filling, altering drainage, or impervious paving, may occur on land located in a floodplain unless required or authorized by the Department of Planning and Zoning...
Sec. 16.116 – Protection of Wetlands, Streams, and Steep Slopes	16.116, (a), (1-3); (b), (1-2)	**Streams and Wetlands:** (1) Grading, removal of vegetative cover and trees, paving, and new structures shall not be permitted within 25 feet of a wetland in any zoning district. (2) Grading, removal of vegetative cover and trees, paving, and new structures shall not be permitted within: (i) Fifty feet of an intermittent stream bank; (ii) Seventy-five feet of a perennial stream bank for Use I streams as classified by the Maryland Department of the Environment in residential zoning districts and residential and open space land uses in the NT, PGCC, and MXD districts; (iii) One hundred feet of a perennial stream bank for Use III and IV streams; and (iv) Fifty feet of a perennial stream bank in nonresidential zoning districts. (3) In residential subdivisions, wetlands, streams, and their buffers shall be located in required open space or a non-buildable preservation parcel **(b) Steep Slopes.** (1) Grading, removal of vegetative cover and trees, new structures, and paving shall not be permitted on land with existing steep slopes, except when: (2) There is sufficient area, a minimum ten feet, outside of stream and wetland buffers for required sediment and erosion control measures.
Sec. 16.119 – Highways, Streets, and Roads	16.119, (a), (9-12); (c)	**General Guidelines.** In designing a highway, street, or road system, the following guidelines shall apply. (9) The street system layout shall be designed insofar as practicable to preserve natural features such as streams, wetlands, forest, topography, scenic views, and other natural features. (11) Street system layout shall provide for the acceptable disposal of stormwater to comply with provisions elsewhere in this subtitle and the Design Manual. (12) Where topography or other conditions make the inclusion of utilities or drainage facilities within street rights-of-way impractical, perpetual unobstructed easements at least 20 feet in width for such utilities shall be provided across property outside the street right-of-way as determined by the Department of Public Works. **(c) Grades.** Grades of streets shall not exceed the standards of the Design Manual, except that the Department of Planning and Zoning after consultation with the Department of Public Works may

		permit steeper grades where warranted by unusual topographic conditions or for the purpose of preserving trees or other natural conditions.
Sec. 16.123 – Grading, Soils, and Sediment Control	16.123, (c), (1, 3)	**Sediment Control:** (1) The developer shall plan for practical and effective sediment control on the site to prevent off-site damages due to erosion and sedimentation processes which are accelerated by changing vegetation and grades. (3) Plans for erosion and sediment control measures shall be prepared in accordance with the requirements of the Howard Soil Conservation District and shall be approved by the Department of Planning and Zoning.
Sec. 16.131 – Sewage Disposal and Water Supply	16.131, (b)	**Sewage Disposal and Water Supply Required Pursuant to Regulations.** Subdivision and site development plans shall provide for sewage disposal and for an appropriate supply of potable water in accord with the provisions of the Howard County master plan for water and sewerage, the regulations of the Maryland Department of Environment and the regulations of the Howard County Health Department.
Sec. 16. 133 – Storm Drainage		**Requirement to Construct Storm Drainage.** (1) The developer shall construct storm drains to handle on-site runoff; and (2) The developer shall provide on-site drainage easements; and (3) The developer shall provide off-site drainage easements; and (4) The developer shall provide for the handling of off-site runoff to an acceptable outlet in the same watershed pursuant to subsection (c) below. **Options for Handling Off-site Runoff:** Developers shall do one of the following for all subdivisions: (1) Provide for the construction of all necessary drainage structures through and between the developer's subdivision and an acceptable outlet in the same watershed; or (2) If all or part of the necessary drainage structures between the developer's subdivision and an acceptable outlet in the same watershed has been provided by another developer, the developer of the proposed subdivision shall pay the County an off-site drainage fee prior to recordation of the plat; or (3) Pay the County an off-site drainage fee prior to recordation of the plat.
Title 16 – Subtitle 7 - Floodplain		
Plan Topic	**Item #**	**Current Clause**
Sec. 16.705 – Requirements and Restrictions Applicable to the floodway	16.705, (c), (1-6)	**Buildings and Structures.** In addition to the requirements set forth in the Howard County Building Code, new buildings and structures and substantial improvement of existing structures located in any special flood hazard area shall: 1. Be designed (or modified) and constructed to safely support flood loads. Structures shall be designed, connected and anchored to resist flotation, collapse or permanent lateral movement due to structural loads and stresses, including hydrodynamic and hydrostatic loads and the effects of buoyancy. 2. Be constructed by methods and practices that minimize flood damage. 3. Use flood damage-resistant materials below the elevation of the lowest floor. 4. Have electrical systems, equipment and components, and mechanical, heating, ventilating, air conditioning, and plumbing appliances, plumbing fixtures, duct systems, and other service equipment located at or above the elevation of the lowest floor required in section 3112 of the Howard County Building Code.

	16.705, (e), (1-3)	**Protection of Water Supply and Sanitary Sewage Systems.** 1. New and replacement water supply systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems. 2. New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into systems and discharges from systems into floodwaters. 3. In addition to the requirements of section 3.808 of this Code, on-site waste disposal systems shall be located to avoid impairment to or contamination from them during conditions of flooding.
Sec. 16.706 – Permits	16.706, (e), (1-2)	**Additional Application Requirements – Certain Development.** A permit application for development proposals and subdivision proposals having the lesser of five lots or at least five acres in special flood hazard areas where base flood elevations are not shown on the FIRM shall include: 1. A determination of the base flood elevations; and 2. If hydrologic and hydraulic engineering analyses are submitted, such analyses shall be performed in accordance with the requirements and specifications of MDE and FEMA.
Sec. 16.710 – Subdivision Proposals and Development Proposals	16.710, (a-c)	In accordance with section 16.115 of this Code, in all flood zones, subdivision proposals and development proposals shall: (a) Be consistent with the need to minimize flood damage and are subject to all applicable standards in this subtitle and the Howard County Building Code. (b) Have utilities and facilities such as sewer, gas, electrical, and water systems located and constructed to minimize flood damage. (c) Have adequate drainage paths provided to reduce exposure to flood hazards and to guide floodwaters around and away from proposed structures.
Sec. 16.711 – Variances	16.711, (c), (1-2)	**Variance Prohibited.** 1. A variance shall not be issued within any designated regulatory floodway if any increase in flood levels during the base flood discharge would result. 2. A variance may not be issued for any property located in the Tiber Branch Watershed unless the variance: (ii) Is necessary for the reconstruction of existing structures or infrastructure damaged by flood, fire, or other disaster; (iii) Is necessary for the construction of a stormwater management or flood control facility as part of a redevelopment project; (iv) Is necessary for the retrofit of existing facilities or installation of new facilities intended solely to improve stormwater management or flood control for existing development; (v) There will be improvement to flood control in the Tiber Branch Watershed at least ten percent more than what would otherwise be required by law;
Title 18 – Subtitle 9 – Stormwater Management		
Plan Topic	**Item #**	**Current Clause**
Sec. 18.903 – Design Criteria, Minimum Control	18.903, (a), (2-4); (b)	(a) The minimum control requirements established in this section and the design manual are as follows: (2) Control of the two-year and ten-year frequency storm event is required according to the design manual and all subsequent revisions if the County determines that additional

Requirements; Alternatives		stormwater management is necessary because historical flooding problems exist and downstream floodplain development and conveyance system design cannot be controlled. (3) One-hundred-year peak management control is required according to the design manual. For purposes of calculating the 100-year 24-hour storm event, 8.51 inches of rainfall depth shall be the minimum depth used. (4) The County may require more than the minimum control requirements if: (i) Hydrologic or topographic conditions warrant; or (ii) Flooding, stream channel erosion, or water quality problems exist downstream from a proposed project. (b) Stormwater management where applicable, shall be consistent with adopted and approved watershed management plans or flood management plans as approved by the Maryland Department of the Environment in accordance with the Flood Hazard Management Act of 1976.
Sec. 18.904 – Stormwater Management Measures	18.904, (a,g,h)	**Alternatives.** Alternative ESD planning techniques and treatment practices and structural stormwater measures may be used for new development runoff control if they meet the performance criteria established in the design manual and all subsequent revisions. Practices used for redevelopment projects shall be approved by the County. **Modifications.** For the purposes of modifying the minimum control requirements or design criteria, the owner or developer shall submit to the County an analysis of the impacts of stormwater flows downstream in the watershed.
Sec. 18.905 – Stormwater Management Design Process	18.905, (6)	(6) If a stormwater management plan involves direction of some or all runoff off of the site, the developer shall obtain from adjacent property owners any easements or other necessary property interests concerning flowage of water.
Sec. 18.908 – Waivers; Watershed Management Plans	18.908, (a), (4), (ii-v)	**(a) Waiver Requests.** A request for a waiver under this section shall: (4) Be prohibited for any property located in the Tiber Branch Watershed unless the waiver: (ii) Is necessary for the reconstruction of existing structures or infrastructure damaged by flood, fire, or other disaster; (iii) Is necessary for the construction of a stormwater management or flood control facility as part of a redevelopment project; (iv) Is necessary for the retrofit of existing facilities or installation of new facilities intended solely to improve stormwater management or flood control for existing development; (v) Upon completion of construction of the development, there will be improvement to flood control in the Tiber Branch Watershed at least ten percent more than what would otherwise be required by law; or
Sec. 18.910 - Redevelopment	18.910, (b), (c)	(a) All redevelopment projects shall reduce existing impervious area within the limit of disturbance by at least 50 percent. (b) Alternative stormwater management measures may be used to meet the requirements in subsection.

Howard County Emergency Strategic Plan

The following goals and objective of the Howard County Emergency Strategic Plan, developed by the Howard County Office of Emergency Management, relate directly to mitigation and are echoed in this document (Table 6.3).

Table 6.3 – Howard County Emergency Strategic Plan Review
Source: Howard County Emergency Strategic Plan, Office of Emergency Management, 2016

Plan Topic	Item Type	Current Clause
Strategic Goal 1	Goal	**Strengthen Howard County's capabilities to restore and stabilize government operations, economy and community life.**
	Objectives	Develop plans for a post-disaster business and nonprofit economic recovery advisory taskforce to ensure that County recovery planning addresses economic recovery.
		Develop a recovery plan complete with short-term and long-term recovery strategies.
		Develop plans to establish a County Disaster Recovery Center to provide operational disaster assistance to the community following a disaster.
Strategic Goal 3	Goal	**Prevent, protect, and mitigate against manmade and natural hazards.**
	Objectives	Maintain, improve, and update the mitigation plan.
		Synchronize the timelines of all mitigation planning activities
		Seek additional mitigation grant funding and ensure match availability as applicable.
		Expand mitigation plan to include manmade hazards.
		Initiate the mitigation steering committee to implement mitigation planning objectives and strategies.
		Integrate mitigation plans with Department of Planning and Zoning plans.
		Create an accountability plan for mitigation action items.
Strategic Goal 4	Goal	**Tailor emergency management funding, projects, and planning initiatives according to the HIRA, THIRA, and any relevant risk and vulnerability assessments.**
	Objectives	Use risk and vulnerability assessments to determine funding priorities, and to direct county investments towards increasing preparedness, reducing risk, and increasing the capacity to respond and recover.
		Base mitigation priorities on the findings from risk and vulnerability assessments.
		Update and review risk and vulnerability assessments on a regular cycle.
		Use risk and vulnerability assessments to identify gaps in planning and resources.
Strategic Goal 5	Goal	**Develop and implement a community outreach program and identify opportunities to foster relationships among individuals and community groups.**
	Objectives	Provide easy to understand information on hazard risks to residents of high-risk areas to encourage them to take action to reduce risks and build resilience.
		Ensure that pre-disaster preparedness, mitigation information, and post-disaster assistance programs and services are available to all people in the community.
		Develop a plan to provide leadership and support, through guidance documents and dissemination of best practices, to encourage businesses and nonprofits to prepare mitigation and recovery plans.
		Identify and target community preparedness education efforts for communities without adequate resources

Plan Topic	Item Type	Current Clause
Strategic Goal 7	Goal	Adopt a strategic planning process that holistically integrates planning, training, exercises, and evaluation, and that ensures plans are vertically and horizontally synchronized with appropriate departments, stakeholder agencies, and jurisdictions.
	Objectives	Ensure that the County's emergency management program (including mitigation, preparedness, response, recovery, and training) integrates planning efforts for the whole community.
		Continue to standardize emergency procedures, protocols, and policies throughout the County in order to promote a unified response when necessary.
Strategic Goal 8	Goal	Maintain a formal training and exercise program that is driven by hazard vulnerabilities, corrective actions from after action reports and gaps in capabilities and plans.
	Objectives	Ensure training and exercises are implemented as appropriate to evaluate and improve capabilities, preparedness, plans, strategies, and operational readiness in a fault-free environment.
		Incorporate and organize training opportunities for officials and emergency management and response personnel, as well as the public in an effort to improve inter and intra departmental collaboration.
Strategic Goal 9	Goal	Continually improve Emergency Operations Center (EOC) and Departmental Operation Centers (DOCs) functions and capabilities.
	Objectives	Ensure the EOC and County DOCs are properly equipped to meet planning, training, exercise, and activation needs.
		Maintain a Joint Information System with current information on hazards and activities to prevent injuries and property loss in Howard County.
Strategic Goal 10	Goal	Enhance and expand partnerships and collaboration with Non-Governmental Organizations (NGOs), faith-based organizations, the private sector, and public sector agencies.
	Objectives	Link businesses together with government resources to create a resource network for emergency events to enable the marshalling of resources to confront novel or complex disasters.
		Ensure community preparedness for and rapid recovery from disaster threats in Howard County and the region by providing businesses with encouragement and with the tools to assess their risks and to develop appropriate plans.
		Increase private-sector involvement, information, tools, and education in countywide preparedness and recovery.

6.4 Howard County Government Organization

The Howard County government is comprised of a County Executive and the County Council representing five Council Districts. The County Council enacts local legislation, determines County policies and plans and establishes an annual budget.

6.4.1 County Emergency Response Capabilities and Responsibilities

Howard County Government is organized into twelve departments, with each department further divided into offices, bureaus and/or divisions. Several of these departments and offices are

responsible for planning and responding to natural hazard events that occur within the County. The primary Departments that plan for, and respond to natural hazard events include:

- **Office of Emergency Management (OEM):** OEM is the local emergency organization for emergency management in Howard County and is responsible for "implementing programs and establishing positions recommended by the Maryland Emergency Management Agency to meet Federal and State standards." [129] OEM also develops and implements local and State emergency management plans for the County. OEM has the responsibility for coordinating all components of the County's emergency response capabilities. Those components include, but are not limited to: the civil defense efforts, fire and police, public health and emergency medical services, public works, volunteer and any other groups or agencies contributing to the management of emergency situations. OEM also facilitates public, multi-government agency planning efforts that enhance domestic preparedness for all hazards.

- **Department of Planning and Zoning (DPZ):** DPZ is responsible for "comprehensively planning for the growth and development of the County" [130] by creating innovative plans and strategies to address environmental concerns, economic development, housing, transportation and land use within the jurisdiction. DPZ reviews variances as well as zoning and subdivision regulations to enhance and protect the health, safety and welfare of its citizens.

- **Department of Inspection, Licensing and Permits (DILP):** DILP is responsible for the protection of public health, safety and welfare through the issuance of licenses and permits. The Department also conducts inspections as required by law and enforces codes, laws, rules, and regulations relating to facilities and utilities.

- **Department of Fire and Rescue Services (DFRS):** DFRS is responsible for the administration of fire suppression and prevention, fire training, arson investigation, rescue services, and emergency medical emergencies, within the County. The Department is devoted to protecting the citizens of Howard County and their property from fire and other hazardous conditions through public education, fire prevention, code enforcement and professional emergency response. DFRS is considered a "combination" Department, made up of both career and volunteer firefighters.

- **Howard County Police Department (HCPD):** The HCPD is responsible for the operation and enforcement of the laws, rules, and regulations concerning the following: the preservation of the public peace, the prevention of crime, the apprehension of criminals and the protection of the rights of person and property. The Police Department is dedicated to protecting life and property, enforcing the law, and assisting victims.

- **Department of Public Works (DPW):** DPW is responsible for the County's capital projects and also designs, constructs, oversees, and maintains the County's public facilities and utilities (roads, bridges, water systems, sewerage systems, and draining operations). The protection of these facilities and infrastructure against natural hazards is of utmost importance to the advancement of quality of life for County citizens.

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[129] Id. at 17 § 109 (a)(1).
[130] Howard County Code tit. 16 § 801 (c) (2009).

The following statistics for law enforcement, fire departments, medical services, and schools are current as of publication of this updated 2018 HMP. However, they are subject to change and will be updated appropriately.

- **Law Enforcement** – Howard County is served by the Howard County Police Department. The Police Department has two stations, Northern District (Headquarters) and Southern District. Also, the Maryland State Police – Waterloo Barrack is located in Howard County.

- **Fire Departments** – Howard County is served by the Howard County Department of Fire and Rescue Services. The County maintains twelve fire stations throughout the County.

- **Medical Services** – Howard County is an acute-care medical center and a member of Johns Hopkins Medicine. Sheppard Pratt Hospital in Ellicott City is a psychiatric facility serving a range of patients. Medstar Health is part of the largest healthcare provider in Maryland and is has locations in the county. Altogether, Howard County has:
  - 1 inpatient hospital (Howard County General Hospital)
  - 1 hospice and palliative care facility
  - 1 home health facility
  - 6 nursing homes
  - 11 large assisted living facilities (17+ residents)
  - 72 small assisted living facilities (1-16 residents)

- **Recreation and Parks** – The Howard County Department of Recreation and Parks (DRP) offers more than 50 parks, and are responsible for the maintenance, operation, and stewardship of 9,378 acres of land.[131] In addition, DRP manages and oversees recreation facilities, the Robinson Nature Center, historic sites, as well as natural resource areas and the thousands of acres of open space throughout the county. The Department owns and operates 25 historic sites, all of which are either stand-alone sites or structures located within county-owned parks.[132] Of the total park and open space, 25 percent are considered natural resource areas, while the DRP oversees about 1,035 parcels of open space.[133] The Maryland Department of Natural Resources manages two State parks and a wildlife management area in the County, totaling over 9,700 acres.[134]

- **Critical Facilities** – The list of County critical facilities and infrastructures was re-evaluated and updated. The HCPD and OEM identified the facilities and infrastructures that are considered the most critical to County Government operations. Planners and engineers evaluated a subset of these facilities as part of the vulnerability assessment process used in the updated HIRA. These critical facilities included: Emergency Services, Key Government, Criminal Justice, Transportation, Water/Waste Water Treatment, Research, Major Retail, and Entertainment.

[131] Howard County Recreation and Parks Department, Howard County Land Preservation Parks and Recreation Plan, page 32.
[132] Howard County Recreation and Parks Department, Howard County Land Preservation Parks and Recreation Plan, page 34.
[133] Howard County Recreation and Parks Department, Howard County Land Preservation Parks and Recreation Plan, page 33.
[134] Howard County Recreation and Parks Department, Howard County Land Preservation Parks and Recreation Plan, page 36.

CHAPTER 7 - MITIGATION STRATEGY

7.1 IFR Requirements for Mitigation Strategy

IFR §201.6(c)(3): *The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.*

IFR §201.6(c)(3)(i): *[The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

IFR §201.6(c)(3)(ii): *[The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.*

IFR §201.6(c)(3) (iii): *[The mitigation strategy section shall include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

7.2 Mitigation Goals and Objectives

The mitigation strategy serves as the long-term road map to reduce the potential losses, vulnerabilities, and shortcomings identified in the Hazard Identification and Risk Assessment section.

A typical mitigation strategy includes a list of goals and objectives, along with specific mitigation actions to address the goals and objectives. Actions are then prioritized, based on the community's requirements.

The mitigation strategy in this Plan comprises the following six subsections:

- Goals and Objectives
- National Flood Insurance Program and Continued Compliance
- Prioritization of Mitigation Actions
- Identification and Analysis of Mitigation Techniques
- Mitigation Action Implementation Plan
- Deleted, Combined, and Removed Actions

7.2.1 Definitions

Goals: Goals represent broad statements that are achieved through the implementation of more specific, action-oriented objectives. Goals provide the framework for achieving the intent of the mission statement.

Objectives: Objectives define strategies or implementation steps to attain the identified goals. Compared to goals, objectives are more specific and measurable.

Hazard Mitigation Projects: Projects are defined as specific actions taken to address defined vulnerabilities to existing buildings or systems. Potential funding sources are listed for each project.

Mitigation Action Plan: Prioritized listing of actions (policies and projects), including a categorization of mitigation technique, hazards addressed, individual or organization responsible for implementation, estimated timeline for completion and list of potential funding sources.

7.2.2 Howard County's Mitigation Goals and Objectives

For the purposes of this Plan, goals are defined as general policy guidelines or broad statements that represent a vision for a community. Howard County's Mission is "to develop practical planning solutions for the variety of hazards that pose a risk to Howard County".

The Howard County Goals have undergone many iterations since the initial County Plan in 2004. To understand the evolution of this plan updates goals, a brief discussion of the various incarnations is provided below. The original 2004 plan addressed six overarching mitigation goals to serve as guidelines for the Howard County government, its agencies and stakeholders. Those goals were developed to reduce the impact of natural hazards across the County.

- Saving lives and property;
- Reducing vulnerabilities to future natural hazards;
- Guiding and speeding post-disaster recovery;
- Enhancing mitigation efforts;
- Taking advantage of mitigation funding opportunities; and
- Promoting public participation.

As part of the 2012 HMP Update process, the Steering Committee reviewed and discussed the six original goals and determined that the last five goals supported the objective of the first goal, namely the "saving lives and property" and decided to replace these six goals with a single overarching mitigation goal.

The 2012 mitigation goal statement was: *Strive to save lives and protect property within Howard County.* The remaining five goals were enhanced and further developed as objectives for the plan update as indicated below.

1. Enhance mitigation efforts to reduce vulnerabilities to future natural hazards;
2. Improve preparedness, response, recovery and mitigation functions within the County;
3. Continue to pursue available mitigation funding opportunities for future projects;
4. Continue to engage and educate the public on mitigation natural hazards; and
5. Ensure continual implementation of mitigation actions.

The JSC for the 2018 HMP determined that the goals, and subsequent objectives, should be modeled after the same six mitigation categories as the State of Maryland Hazard Mitigation Plan and undertook a comprehensive restructuring of the goals and objectives. Various Howard County departments and staff, as well as community and business representatives helped establish the mitigation goals and objectives for this Hazard Mitigation Plan Update.

Following is the list of the 2018 Howard County Hazard Mitigation Plan goals and objectives. The goals and objectives have been organized to mirror the 2016 Maryland State Hazard Mitigation Plan categories, to be in harmony with the goals from the State Plan, categorized to match the goals in the Howard County Flood Mitigation Plan, and to be applicable at the local level. An additional category of Historic and Cultural Resources has been added in light of the major flood events affecting the County.

<u>Property Protection</u>

Goal 1: Identify future mitigation actions from lessons learned during preparedness, response, and recovery activities throughout the county.

- Document and review after-action reports (AAR) and improvement plans (IP) for various incidents, events, and hazards throughout the county to identify future mitigation actions.
- During response and recovery activities, solicit ideas and recommendations, as well as experiences, both positive and negative, in order to develop potential mitigation actions.

Goal 2: Identify and pursue available mitigation funding opportunities for future mitigation projects.

- Identify and apply for grant opportunities that will support structural and non-structural hazard mitigation projects.
- Identify and apply for grant opportunities that will support hazard mitigation awareness and training programs.
- Provide information to business and property owners on potential funding sources for private property mitigation projects and actions

Public Education and Awareness

Goal 3: Engage and educate the community on the roles, responsibilities, and activities of the Office of Emergency Management (OEM).

- Promote OEM activities and initiatives at county sponsored events and through county-operated media channels.
- Provide opportunities, events, and/or mechanisms for citizens to meet with, or speak to emergency management professionals.

Goal 4: Engage and educate the public on natural hazards and potential mitigation actions to encourage personal awareness and responsibility.

- Develop and support disaster preparedness education and awareness programs that target residents, visitors, businesses, and elected officials.
- Support incentive programs, for both public and private sectors, that promote structural retrofits where appropriate.

Preventative Measures

Goal 5: Reduce the potential impact of natural disasters on public and private property to protect people and minimize losses.

- Discourage new development in high hazard areas through appropriate regulations and land use planning.

Goal 6: Ensure hazard mitigation goals are consistent with all other County plans and ordinances.

- Incorporate hazard mitigation principles into new and existing County plans and ordinances.
- Encourage private business, industry, and institutional entities to integrate emergency plans with County mitigation/emergency plans, where appropriate

Goal 7: Develop an accountability plan and a mechanism for tracking mitigation action implementation.

- On an annual basis, examine mitigation action implementation progress, and encourage timely completion.

Natural Resource Protection

Goal 8: Protect natural resources and open-spaces that provide flood, and other hazard mitigation functions.

- Prioritize actions that protect natural resources while supporting community resiliency and other hazard mitigation efforts.

Emergency Services

Goal 9: Ensure critical facilities (fire stations, police stations, hospitals) and infrastructure (water and sewer facilities, electrical and other utilities, and transportation systems) vital to disaster response and recovery, are less vulnerable to, and better able to withstand, natural hazards.

- Identify appropriate mitigation techniques for any critical facilities currently in the 100-year floodplain and direct construction of any *future* critical facilities out of the 100-year floodplain.

- Ensure roads/access to facilities located near the 100-year floodplain are not impeded.

Structural Projects

Goal 10: Reduce potential disruption of the County's critical infrastructure during hazard events.

- Ensure regular maintenance of the County's critical infrastructure that lies within the 100-year floodplain.
- Identify vulnerable existing critical facilities and infrastructure and encourage pre-disaster retrofit.
- Coordinate with the managing entities for any privately-owned infrastructure, including dams, retaining ponds, and berms, to encourage regular inspections on all structures, and improvements when and where warranted.

Historic and Cultural Resources

Goal 11: Protect historical and cultural assets across the County from flooding and other natural hazards.

- Utilize historical preservation data to identify protective measures for historical properties and cultural resources.

Further description of the action categories are found in the sections below.

7.2.3 Mitigation Categories

In formulating the 2018 Mitigation Strategy, the JSC explored six mitigation categories for attaining the Plan's goals and objectives. These include: Prevention, Property Protection, Natural Resource Protection, Structural Projects, Emergency Services, and Public Outreach and Education. These categories formed the basis of the mitigation actions in the Plan Update. Descriptions of these categories and examples for each category are included below:

1. Preventative Measures
   Preventative activities are those that are performed to keep hazard related issues from exacerbating in the community. They are effective in reducing a community's future vulnerability, particularly in areas where development has not occurred. Examples of preventative activities include: zoning and subdivision regulations; building code; hazard mapping; open space preservation; floodplain regulations; stormwater management; drainage system maintenance; and capital improvements programming.

2. Property Protection
   Property protection measures include those actions that can be undertaken by private homeowners, so their structures can: better withstand hazard events, be removed from hazardous locations, or can be insured to cover potential losses. Examples include: acquisition; relocation; building elevation; critical facilities protection; retrofitting (i.e., wind proofing, flood proofing, seismic design standards, etc.); insurance; drainage; and safe room construction.

3. Natural Resource Protection
   Natural resource protection activities include those actions that can reduce the impact of hazards by preserving or restoring the function of natural systems. Natural systems that can be classified as high hazard areas include floodplains, wetlands and barrier islands. Thus, natural resource protection can serve the dual purpose of protecting lives and property while enhancing water quality or recreational opportunities. These actions are usually implemented by parks, recreation or conservation agencies. Examples include: floodplain protection; fire resistant landscaping; erosion and sediment control; wetland restoration; habitat preservation; and slope stabilization.

4. Structural Projects
   Structural mitigation projects are designed to reduce the impact of hazards by building new structures or hardening existing structures. Structural projects are usually designed by engineers and managed or maintained by public works staff. Examples include: reservoirs; levees, dikes, and floodwalls; detention and retention basins; channel modification; and storm sewer construction.

5. Emergency Services
   Although emergency services are not necessarily considered mitigation techniques, these services minimize the impact of a hazard on people and property. Actions taken immediately prior to, during, or in response to a hazard event include: warning systems; search and rescue operations; evacuation planning and management; and flood fighting techniques.

6. Public Outreach and Education
   Public Information and awareness activities are conducted to advise and educate residents, business owners, potential property buyers, and visitors about hazards and mitigation techniques that can be used to protect lives and property. Examples of measures used to educate and inform the public include: outreach and education; training; demonstrations; real estate disclosure; and hazard expositions.

7.3 Continued Compliance with the National Flood Insurance Program (NFIP)

Requirement §201.6(c)(3)(ii): *[The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program (NFIP), and continued compliance with NFIP requirements, as appropriate.*

We understand that while FEMA is the official administering agency for NFIP participation, it is the community's responsibility to have the capability and to serve as a resource for flood mitigation activities. Howard County is a participant in the NFIP and is committed to continuing compliance with the NFIP via three basic components of the NFIP:

- Floodplain identification and mapping risk;
- Responsible floodplain management; and
- Flood insurance.

The County currently addresses and will continue to address NFIP compliance and requirements in the future through:

7.3.1 Flood Identification and Mapping

- The County makes the Flood Insurance Rate Map and Flood Insurance Studies available to the public. These documents are housed in the County's Stormwater Management Division (Bureau of Environmental Services). They are also available at County libraries.
- All Letters of Map Revisions (LOMRs) are reviewed by County officials. If during the subdivision review process a new development determines a reduction in the floodplain delineation of the FIRM floodplain, the developer is required to address FEMA requirements.
- The County provides advice to community residents regarding elevation certificates and Letter of Map Amendment (LOMA) applications.
- The County maintains records of approved letters of map change.

7.3.2 Floodplain Management

- Restrictions on flood plain use are enforced through the subdivision and building permit process.
- All proposed development requires plans to go through the County's subdivision approval process or to acquire a building permit for new structures. However, County Code prohibits any new structures in the 100-year flood plain.
- All new structures are required to be at least two feet above the 100-year base flood elevation.

7.3.3 Flood Insurance

- The County is committed to educating residents about the value and availability of flood insurance. An annual letter is sent to residents explaining the importance of flood insurance and where it may be obtained.
- The County will assist residents in interpreting the FIRM and County flood studies to determine the resident's property's flood plain status, and offers advice regarding elevation certificates and LOMA applications if asked.
- The previous Community Assistance Visit was conducted 2012 and, as of that date, Howard County was found to meet the requirements for continued participation in the NFIP. This year's CAV was scheduled for May 15, 2018. The visit was successful and formal report/feedback is currently pending.

Table 7.1 – Howard County Flood Insurance Program Continued Compliance Questionnaire

Flood Identification and Mapping	
Does the County make the Flood Insurance Rate Map and Flood Insurance Studies available to the public? Where are these documents housed within the County?	Yes. These are available digitally through FEMA with links provided on County website. They are also available at County libraries.
Will the recently developed Digital Flood Insurance Rate Maps be made available to the public as well? How?	See above.

Are Letters of Map Revisions (LOMRs) reviewed and signed by County officials? If during the subdivision review process, a new development determines a reduction in the floodplain delineation of the FIRM floodplain, is the developer required to submit a LOMR submission to FEMA?	Yes, in that there's a reduction in floodplain elevations as a result of a new development but if there is a decrease the developer is required to address FEMA requirements.
Does the County provide advice to community residents regarding elevation certificates and Letter of Map Amendment (LOMA) applications?	Yes. certificates provided to public upon request. If approached by an individual about LOMA we will meet with them and discuss
Does the County maintain records of approved letters of map change?	
Does the County assist residents in interpreting the FIRM and County flood studies to determine the property's status in the floodplain? If yes, which department?	Any one of the following – Dept of Planning and Zoning, Dept of Inspections, Licenses, and Permits, Dept of Public Works – Stormwater Management Division.
Floodplain Management	
Are any restrictions on floodplain use enforced through the subdivision and building permit process?	Building in regulated floodplains is not allowed/
Do all proposed developments require plans to go through the County's subdivision approval process or to acquire a building permit for new structures?	Yes.
Are all new structures required to be at least 1.5 feet above the 100-year base flood elevation?	Yes, the current requirement is 2 feet.
Is the County committed to educating residents about the value and availability of flood insurance? Is an annual letter sent to residents in the floodplain explaining the importance of flood insurance and where it may be obtained?	Yes. Information about floodplains and flood insurance is included in inserts within annual tax bills to all residents.
Does the County assist residents in interpreting the FIRM and County flood studies to determine their property's floodplain status, and offer advice regarding elevation certificates and LOMA applications?	Yes.
When was the last Community Assistance Visit conducted and, as of that date, was Howard County found to meet the requirements for continued participation in the NFIP?	2012. Yes. Next CAV is scheduled for May 15, 2018.

7.4 Mitigation Actions

As part of the update process, the JCS guided the development of new mitigation actions during several work sessions discussed in Chapter 3. Based on qualitative ranking during the 2017 HIRA, the following four hazards were deemed as high priority natural hazards by the County: flood, hurricane and tropical storms, severe winter weather, and drought.

Specific mitigation actions have been derived from the goals and objectives developed by the JSC. Additionally, this section includes mitigation actions determined to be "in progress" or "ongoing" from the previous Flood Mitigation Plan and as such, have been carried over in this update.

In addition to those actions carried forward from the original plan, 19 new actions were developed for inclusion in the Plan Update, which resulted in a total of 40 mitigation actions. Once these actions were finalized, an implementation strategy was developed, which identified the following for each of the mitigation actions:

- Related hazard(s);
- Lead Departments for implementation;
- Funding source (Federal, State, County funds or grants);
- Estimated cost;
- General timeline; and
- Mitigation category.

The new mitigation actions developed have been classified in the same six categories as the goals and objectives. For each action item, the relevant category is identified. The agencies responsible for implementation, applicable funding sources, an approximate cost, and general timeline for the implementation of each mitigation action are also included. All of these actions and attributes are identified in Table 7.4.

It is important to note that each of the responsible agencies listed below have ever-expanding responsibilities with limited staff resources. In order to accomplish many of these actions, strategies will have to be employed to either secure additional help or rearrange short-term priorities.

A detailed list of funding sources is provided at the end of this chapter. The abbreviations used below in the mitigation actions table refer to the funding resources listed in that section.

7.4.1 Evaluating Mitigation Actions for Cost-Effectiveness

In accordance with FEMA mitigation planning requirements, the Natural Hazards Mitigation Plan Steering Committee evaluated the cost-effectiveness of each of the actions listed in the table below. This usually involved coordination and discussions with the specific departments and individuals in the County that will be responsible for implementing the actions. In many cases, the actions listed in the table are part of larger mitigation strategies, or are studies intended to be precursors to potential mitigation actions, if the actions are determined to be feasible and cost-effective through more detailed evaluations.

The County used three sources to develop the actions below: (1) the original Natural Hazard Mitigation Plan; (2) other plans and documents such as the Capital Improvement Plan; and (3) directly soliciting information from County departments and individuals with specific knowledge of certain kinds of hazards and actions. Although there was generally little information available about cost-effectiveness available from any of these sources, the County sought this information and reviewed it where available. Regarding the feasibility of the listed actions, as part of the interim review of the HMP update document, this and other sections were circulated to members of the JSC for technical review. As part of that process, the members were asked to provide a preliminary assessment of the feasibility of the actions; only actions that were determined to be feasible are included in this update.

7.5 Prioritization

The following questions were used by the Steering Committee to determine the level (high, medium, and low) for the social, administrative, and economic considerations for each action. These priorities were translated into points and facilitated the ranking and identification of high priority projects as shown in Table 9.1.

Social Considerations – Life/Safety Impact

- Will the project have minimal/direct/or significant impact on the safety of businesses, residents, and properties?
- Will the proposed action adversely affect one segment of the population?
- Will the project be a proactive measure to reducing flood risk?

Administrative Considerations – Administrative/Technical Assistance

- Is there sufficient staff currently to implement the project?
- Is training required for the staff to implement this project?

Economic Considerations – Project Cost

- What is the approximate cost of the project?

These considerations were then grouped into low, medium, and high categories and assigned points values. Timelines for these projects were also established:

- Short-range projects – implemented within first 2 years;
- Medium-range projects - 3 to 5 years; and
- Long-range projects – over 5 years.

It should be noted that this Plan does not include a prioritization of projects within a category; i.e., there is no ranking of projects listed within the Natural Resources category. Points were then assigned to each action and totaled, in order to determine the ranking of actions as shown in Table 7.2.

Table 7.2 Evaluation Criteria for Project Prioritization

Criteria	Points	High	Points	Medium	Points	Low
Life/ Safety Impact	10	Significant impact on public safety for businesses, residents, properties	6	Direct impact on businesses, residents, properties	2	Minimal/negligible impact on businesses, residents, properties
Administrative/ Tech Assistance	5	No additional staff or technical support needed to implement action	3	Some administrative and technical support needed to implement action	1	Significant administrative and technical support needed to implement action
Project Cost	5	Low cost (<$25,000)	3	Moderate cost ($25,000-$100,000)	1	High cost to implement (>$100,000)

Table 7.3 defines the acronyms used to populate the actions table.

Table 7.3 Acronyms for Mitigation Action Item Implementation Table

Acronym	Definition
BOE	Board of Education
CDBG	Community Development Block Grant
CERT	Community Emergency Response Teams
CIP	Capital Improvement Plan
COOP	Continuity of Operations
DFRS	Department of Fire and Rescue Services
DILP	Division of Inspections, Licensing, and Permits
DNR	Department of Natural Resources
DPW	Department of Public Works
DPZ	Department of Planning and Zoning
DRP	Department of Recreation and Parks
EMPG	Emergency Management Performance Grant
FEMA	Federal Emergency Management Agency
FMA	Flood Mitigation Assistance
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
MDE	Maryland Department of the Environment
MDOT	Maryland Department of Transportation
MEMA	Maryland Emergency Management Agency
OEM	Office of Emergency Management
PDM	Pre-Disaster Mitigation
PHEP	Public Health Emergency Preparedness
PIO	Public Information Officer
RLP	Rural Legacy Program
SHA	State Highway Administration
TBD	To be Determined
UASI	Urban Areas Security Initiative

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Table 7.4 - Prioritization and Implementation of Mitigation Actions

Action ID	Mitigation Project Description	Hazard(s) Mitigated	Lead Agency	Prioritization: Life/Safety Impact	Admin/Tech Assistance	Cost Ranking	Total	Implementation: Funding Source	Est. Cost	Timeline	Action Category
Ongoing/In Progress Actions (From Previous Plan)											
1	Establish pre-disaster debris contracts and craft debris site MOUs with appropriate County agencies and regions.	All Hazards	DPW - Bureau of Environmental Services, Solid Waste (Operations Division)	2	5	5	12	County Funds	Staff Time	1 year	Emergency Services
2	Implement the operational strategies and Cistern Plan for dealing with rural water supply during protracted drought events.	Drought	DFRS	6	5	5	16	County Funds	Staff Time	Ongoing	Emergency Services
3	Continue to educate key emergency management stakeholders (Executives Cabinet and Emergency Management Operations Group members) by conducting trainings and exercises.	All Hazards	OEM	2	5	3	10	UASI; EMPG; County Funds	$50,000-100,000	Ongoing	Emergency Services
4	Conduct a feasibility study to identify existing County-owned Class 4 buildings, and establish policy that all existing and new County-owned Class 4 buildings and critical facilities are hardened and considered for incorporating safe rooms.	All Hazards	DPW - Bureau of Facilities	2	3	5	10	PDM; HMGP	Staff Time	Ongoing	Emergency Services
5	Develop an Emergency Preparedness, Training, and Exercise Plan that includes a regular maintenance plan and an annual budget.	All Hazards	OEM	2	5	5	12	EMPG; UASI; County Funds	Staff Time	Ongoing	Emergency Services
6	Establish a pre-EMAC personnel and equipment identification process to deploy County personnel and equipment to surrounding jurisdictions and/or regional/national disaster events.	All Hazards	OEM	6	5	5	16	County Funds; Urban Areas Security Initiative (UASI)	Staff Time	Ongoing	Emergency Services
7	Continue to enhance and develop mutual aid agreements with neighboring jurisdictions and state partners.	All Hazards	OEM	6	5	5	16	County Funds	Staff Time	Ongoing	Emergency Services

Mitigation				Prioritization				Implementation			
Action ID	Project Description	Hazard(s) Mitigated	Lead Agency	Life/Safety Impact	Admin/Tech Assistance	Cost Ranking	Total	Funding Source	Est. Cost	Timeline	Action Category
8	Conduct annual training/exercises for Emergency Operations Center and Department Operations Center personnel on how to continuously staff the centers through a protracted disaster.	All Hazards	OEM	2	5	5	12	County Funds	Staff Time	Ongoing	Emergency Services
9	Develop a County Emergency Water Supply Plan.	All Hazards	DPW - Bureau of Utilities	10	1	1	12	County Funds	$100,000-150,000	3-5 years	Emergency Services
10	Develop a policy setting out County's role in post-disaster curbside debris pick up and debris removal.	All Hazards	DPW - Bureau of Environmental Services, Office of Law, Risk Management	6	5	5	16	County Funds	Staff Time	1-2 years	Emergency Services
11	Continue to evaluate and remove trees throughout the County's park system that are at risk of falling during storms and high wind events.	Tornado/Wind Storm	DRP	2	3	5	10	County Funds	Staff Time	Ongoing /As needed	Natural Resources
12	Continue to adopt the most updated version of the National Electrical Code (NEC).	All Hazards	DILP	10	5	5	20	County Funds	Staff Time	Ongoing	Preventative Measures
13	Continue to host annual workshops for local builders to discuss how to build homes that are more resistant to natural hazards.	All Hazards	DILP	2	5	5	12	County Funds	Staff Time	Ongoing	Public Education and Outreach
14	Review existing building codes every three years to ensure they have been deemed satisfactory in assessing serious damage caused by specific hazards.	All Hazards	DILP	2	5	5	12	County Funds	Staff Time	Ongoing	Preventative Measures
15	Evaluate each County department's ability to maintain a suitable workforce during a protracted disaster.	All Hazards	OEM	10	5	5	20	County Funds	Staff Time	Ongoing	Emergency Services
16	Continue to perform routine maintenance to keep street trees healthy so they are less likely to fall or break during a severe weather event.	All Hazards	DPW - Bureau of Highways	2	5	5	12	County Funds	Staff Time	Ongoing	Natural Resources
17	Continue to conduct an annual snow emergency coordination meeting in the fall with the County	Winter Storm / Nor'easter	DPW - Bureau of Highways	2	5	5	12	County Funds	Staff Time	Ongoing	Emergency Services

Action ID	Mitigation: Project Description	Hazard(s) Mitigated	Lead Agency	Prioritization: Life/Safety Impact	Admin/Tech Assistance	Cost Ranking	Total	Implementation: Funding Source	Est. Cost	Timeline	Action Category
	Departments involved in snow emergency response.										
18	Continue to maintain and update an annual plan to supplement Public Work's snow removal teams with Department of Recreation and Parks and Fire Department personnel.	Winter Storm / Nor'easter	DPW, DRP, DFRS	6	5	5	16	County Funds	Staff Time	Ongoing	Emergency Services
19	Educate all building safety coordinators about safety, evacuations, appropriate assembly areas and shelter-in-place guidelines.	All Hazards	Risk Management	2	5	5	12	County Funds	Staff Time	Ongoing	Emergency Services
20	Combine the Natural Hazards Mitigation Plan and Flood Mitigation Plan to ensure annual review cycles are synchronized.	All Hazards	OEM, DPW – SWMD	10	3	3	16	County Funds; EMPG	$50,000-100,000	1 year	Preventative Measures
21	Establish a comprehensive critical infrastructure protection program that focuses on security and consequence management.	All Hazards	HCPD, OEM, DFRS, DPW, DTCS, Risk Management, and Health Department	10	5	5	20	UASI; Capital Budget; County Funds	Staff Time	Ongoing	Preventative Measures
	New Actions										
22	Continue regular maintenance program for the County's emergency generators that includes a schedule to change filters, etc.	All Hazards	DPW	2	5	5	12	County Funds	Staff Time	Ongoing	Emergency Services
23	Increase public awareness on wildfires by providing outreach and education on urban/wildland interface and increasing buffers and defensible spaces to reduce vulnerability	Wildfire	OEM / DFRS	2	5	5	12	EMPG	$10,000	Ongoing	Public Education and Outreach
24	Work with County departments and strategic partners to better serve at-risk populations (elderly persons, homeless populations, persons with physical or mental disabilities) through effective public outreach on various hazards and monitor for gaps in providing emergency services to those populations.	All Hazards	OEM	6	5	5	16	County Funds	Staff Time	Ongoing	Public Education and Outreach

Mitigation				Prioritization				Implementation			
Action ID	Project Description	Hazard(s) Mitigated	Lead Agency	Life/Safety Impact	Admin/Tech Assistance	Cost Ranking	Total	Funding Source	Est. Cost	Timeline	Action Category
25	Continue to conduct training exercises for hazard events at least twice a year.	All Hazards	OEM	2	5	5	12	County Funds; EMPG	Staff Time	Ongoing	Emergency Services
26	Maintain requirements to continue recognition as a Storm Ready Community (by the National Weather Service StormReady® Program).	All Hazards	OEM	10	5	5	20	County Funds	Staff Time	Ongoing	Emergency Services
27	Continue to conduct seminars in schools on various hazards that could threaten the County and provide informational packets on the county's natural and man-made hazards.	Tornado/Wind Storm, Hurricane, Winter Storm/Nor'easter, Lightning, Flooding	OEM	6	5	5	16	County Funds	Staff Time	Ongoing	Public Education and Outreach
28	Continue to utilize FEMA's Integrated Public Alert and Warning System (IPAWS) for sudden onset hazards such as tornados, thunderstorms, or flash floods.	All Hazards	OEM	10	5	5	20	County Funds; UASI	Staff Time	Ongoing	Public Education and Outreach
29	Coordinate with County PIO and related stakeholders to develop a "pre-approved' set of releases to be disseminated to the public in a timely manner in the event of an emergency.	Tornado/Wind Storm, Flooding, Lightning	OEM	6	5	5	16	County Funds	Staff Time	Ongoing	Public Education and Outreach
30	Maintain NOAA Weather Alert radios located in designated critical facilities across the County.	All Hazards	Administration - Risk Mgmt.	2	5	5	12	UASI; EMPG	$5,000	Ongoing	Public Education and Outreach
31	Encourage local businesses and local industry owners to develop a business continuity plan and provide educational materials.	All Hazards	OEM	10	5	5	20	State homeland security grant; County Funds; EMPG	Staff Time	Ongoing	Public Education and Outreach
32	When updating zoning ordinance, consider provisions for identification of all hazard areas.	All Hazards	DPZ	6	1	5	12	County Funds	Staff Time	2-3 years	Preventative Measures
33	Continue to update, maintain, and implement existing emergency plans, including but not limited to, recovery, response, and/or emergency operations plans	All Hazards	OEM	6	5	5	16	EMPG; UASI; County Funds	Staff Time	Ongoing	Emergency Services

Mitigation				Prioritization				Implementation			
Action ID	Project Description	Hazard(s) Mitigated	Lead Agency	Life/Safety Impact	Admin/Tech Assistance	Cost Ranking	Total	Funding Source	Est. Cost	Timeline	Action Category
34	When updating the County's area plans and comprehensive plan, include hazard mitigation considerations to reduce risk to natural hazards throughout the County.	All Hazards	DPZ	6	3	5	14	County Funds	Staff Time	Ongoing	Preventative Measures
35	Ensure that applicable codes and ordinances, such as building codes, floodplain ordinances, wetland protection, and erosion and sediment control standards are consistently enforced.	All Hazards	DILP/DPZ	6	5	5	16	County Funds	Staff Time	Ongoing	Preventative Measures
36	Utilize tracking reports during the annual review process to identify potential barriers or hindrances to implementation of hazard mitigation activities and projects.	All Hazards	OEM	2	5	5	12	County Funds	Staff Time	Ongoing	Preventative Measures
37	Consider natural resource preservation and land use planning initiatives that ensure natural resource areas that provide hazard mitigation benefits, remain open spaces, to retain the natural benefits they provide.	All Hazards	DPZ; Admin. - OCS	6	5	5	16	County Funds	Staff Time	Ongoing	Natural Resources
38	Continue to educate homeowners on the potential risk of earthquakes and on safety techniques to follow during and after an earthquake.	Earthquake	OEM	2	5	5	12	County Funds	Staff Time	Ongoing	Public Education and Outreach
39	Collect information and develop a queryable database of specific hazard events that caused any damages to County infrastructure and critical facilities.	All Hazards	OEM	2	1	5	8	County Funds	Staff Time	1-2 years	Emergency Services
40	Maintain the tree and brush trimming program to protect access to critical facilities and to prevent emergency services from being disrupted due to falling trees or branches, before and/or after a hazard event.	All Hazards	DRP; DPW -Facilities	2	5	5	12	County Funds	Staff Time	Ongoing	Emergency Services

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Table 7.5 identifies the highest priority projects based on their total scores.

Table 7.5- Highest Scored Mitigation Actions

Action ID	Project Description	Score
12	Continue to adopt the most updated version of the National Electrical Code (NEC).	20
15	Evaluate each County department's ability to maintain a suitable workforce during a protracted disaster.	20
21	Establish a comprehensive critical infrastructure protection program that focuses on security and consequence management.	20
26	Maintain requirements to continue recognition as a Storm Ready Community (by the National Weather Service StormReady® Program).	20
28	Continue to utilize FEMA's Integrated Public Alert and Warning System (IPAWS) for sudden onset hazards such as tornados, thunderstorms, or flash floods.	20
31	Encourage local businesses and local industry owners to develop a business continuity plan and provide educational materials.	20

7.6 Deleted, Combined, and Removed Actions

Action items from the original 2012 Hazard Mitigation Plan that have been completed, deemed infeasible, or merged/combined with another action item have been removed from this plan. Those actions are itemized, described, and justified in Table 7.7 below.

Definitions for the status updates are given in Table 7.6 below, while Table 7.7 shows the status from the 2012 Hazard Mitigation Plan

Table 7.6 Status Update Definitions

Status	Definition
In Progress	Work has been initiated on these actions. These projects have a definite end-date.
On-Going	Actions that are performed on a regular and continuous basis by the County.
Completed	The department has completed the action since the development of the 2012 plan.
Not Applicable	Actions that were deemed by the JSC to not apply to the HMP.
Cancelled	SWM or OEM has decided to terminate the project.
Infeasible	After further study this project was deemed to be infeasible based on benefit/cost analysis, engineering study, or other criterion.

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Table 7.7 Cancelled, Completed, or Removed Actions from the 2012 Hazard Mitigation Plan

No.	Action Item Description / Benefits	Status	Notes
2	Through partnerships with the Maryland Department of Natural Resources, the Department of Recreation and Parks and the Columbia Association, identify areas within the County where hazards exist in the wild land/urban interface setting. Work with the appropriate organizations to develop strategies to remove the accumulation of hazards and excessive fuels (trees, trash, etc.) within the identified areas.	Infeasible	Not the purview of DRP. This action item is infeasible, cost prohibitive and environmentally sensitive. DFRS has no authority or funding to require land owners to complete this requirement other than what is already required in the fire code.
3	Based on the results of the identification process in Item 2, initiate a process to remove sources of fuel in potential wildfire areas.	Infeasible	Based on Cost-Benefit Analysis, and environmental analysis this was determined infeasible. This action item is infeasible, cost prohibitive and environmentally sensitive. DFRS has no authority or funding to require land owners to complete this requirement other than what is already required in the fire code.
5	Partner with the Maryland Department of Natural Resources - Forest Service to explore the possibility of Howard County becoming a "Fire wise" community.	Infeasible	Howard County is in a low-risk fire zone according MD Department of Natural Resources.
7	Devise a robust public outreach plan/program to educate the general public and stakeholders on how to prevent, prepare for, and recover from natural hazards. Refer to the FEMA library for information on various topics and tailor information to fit the needs of the County.	Completed	This is the ReadyHoCo Outreach Program
8	Update the County and OEM websites with pertinent hazard preparedness and mitigation information, including downloadable documents and web links for FEMA, MEMA, National Oceanic and Atmospheric Administration and the National Weather Service.	Completed	On the site
15	Continue to identify all existing critical infrastructure and then create a GIS map layer.	Completed	Layers available in Countyview website
17	Install transfer switches at all County designated shelters.	Complete	All four shelter sites have generator power.
19	Develop a policy setting out County's role in curbside debris pick up. Develop list of contractors for debris removal for private property.	In progress/ Infeasible	We technically can't do work on private property, so we have developed a volunteer management plan that allows us to connect property owners with non-profit groups that can assist them

No.	Action Item Description / Benefits	Status	Notes
20	Continue to provide the Department of Technology and Communication Services, GIS Unit with information regarding access points and trails for emergency vehicle use within the County's park system.	Completed	Information in CAD. From our stand point, This is an ongoing project, this information in addition to State Park property is included and verified in the mapping system used by DFRS for emergency response. As building and developments are completed some of this information changes, in addition to infrastructure upgrades that change the ratings of trails and bridges.
26	Review and, if needed, improve the process for fast-tracking permits and inspections following disasters. When a disaster occurs, those structures affected will be processed first before the normal work load.	Completed	
30	Continue to station Public Works and Fire Department personnel in key locations for flood level monitoring and notification to the Office of Emergency Management.	Cancelled	Cancelled due to flood gauge monitoring system. Although flood level monitoring is no longer needed due to the gauge monitoring system, Special Operations members from HCDFRS routinely visit sites during rain events to monitor water levels for situational awareness and to develop pre-deployment plans as access to the flood gauge monitoring is limited.
35	Conduct an assessment of the County's critical facilities to assure that all technology sites have backup power.	Completed	Main server areas are on generator power, and many resources have moved to cloud computing
36	Conduct regular training sessions for emergency response personnel regarding the County's legal authority during emergency situations.	Not Applicable	
37	Implement a community notification system to notify residents of hazards affecting the community. Widespread benefits related to increased life safety and response.	Completed	Everbridge, WEA/EAS System
38	Upload preparedness information onto the County and OEM websites, and develop pamphlets and other outreach material discussing how residents and businesses can protect themselves, their property and assets from natural hazards. Refer to the FEMA library for information on various topics and tailor information to fit the needs of the County	Completed	Part of the Ready HoCo Program
43	Identify and develop a GIS layer for public retaining walls in the County.	Not Applicable	
48	Conduct an assessment of the County's critical facilities to determine emergency backup power requirements. Prioritize the listed emergency backup power projects and implement as funds are available.	Completed	

No.	Action Item Description / Benefits	Status	Notes
49	Survey streams above "critical public facilities" to determine where maintaining debris free stream flow is required to avoid an "imminent hazard" to those facilities and then create a GIS layer.	Infeasible	It is impractical to develop a GIS layer as these locations change frequently over time.
52	Purchase 800/900 MHz radios for Debris Management Team (9 vehicles).	Completed	They are now available from radio cache.
53	Develop a Department of Public Works DOC (Department Operations Center) at the Bureau of Utilities facility.	Completed	
54	Plan and design a hardened/secure facility at the PSTC for a future 911 Communications Center and Emergency Operations Center that meets all applicable homeland security and fire safety codes, regulations and standards.	Cancelled	That site has not been determined to be the site of a future EOC/Dispatch Center
57	Conduct flood study of the 2011 Ellicott City flashflood during TS Lee to determine why/how it happened and what mitigation actions can be taken to prevent or reduce the hazard in the future.	Completed	

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7.7 Existing Plans, Policies, Programs, and Resources

In order to ensure that the County can accomplish its suggested hazard mitigation actions through its existing mechanisms, the County's existing authorities, policies, programs, and available resources, have been identified. A detailed analysis of existing plans and programs is included in Chapter 6 of this updated HMP.

Comprehensive plans, Zoning, Subdivision and Land Development Regulations are administered by the Department of Planning and Zoning. The County's Building Code (including the Residential Code, Mechanical Code, Energy Conservation Code and Life Safety Code) is administered by the Department of Inspections, Licenses and Permits. The County's efforts to implement and integrate hazards mitigation principles throughout its various plans, ordinances, regulations and programs are well-coordinated and further outlined in Chapter 6.

County Departments that are typically the most involved in mitigation activities include those in planning, public works, licensing and inspections, and emergency management. Staffing details for those Department are outlined below.

- Department of Planning and Zoning (DPZ)

  The Department of Planning and Zoning has a total of 53 personnel and is comprised of six divisions that work on various subject matters, including Community Planning, Development Engineering, Land Development, Research, Resource Conservation and Zoning Administration.

  The five staff in community planning work on long range projects such as the Ellicott City Master Plan and the county's general plan. The Development Engineering is comprised of six staff who work on various engineering-related issues – in particular, items related to transportation and storm water management. The 10 staff in land development are responsible for overall plans review. The seven staff in research are responsible for census, data management and demographic reporting. The six staff in Resource Conservation address issues with either a historic, environmental or agriculture focus.

  Transportation policy and planning are managed by the Office of Transportation and now fall under County Administration's authority – and is staffed by seven people. This office also coordinates the County role in the Regional Transportation Agency.

- Department of Public Works (DPW)

  The Department of Public Works consists of five different Bureaus and the Director's Office including Real Estate (20 personnel): Bureau of Environmental Services (50 personnel); Bureau of Engineering (53 personnel); Bureau of Facilities (67 personnel); Bureau of Highways (121 personnel), and Bureau of Utilities (139 personnel). It is one of the largest Departments in Howard County government.

- Department of Inspections, Licenses, and Permits (DILP)

The Department of Inspections, Licenses, and Permits is divided into different bureaus, such as Licenses and Permits, Inspection and Enforcement, Plan Review, Operations and Administration. DILP employs 65 personnel.

- Office of Emergency Management (OEM)

  The Office of Emergency Management is located within Department of Fire and Rescue Services. The Office of Emergency Management consists of 8.5 employees, who all support emergency planning and preparedness. Two of the positions are grant funded positions.

  All of these employees are trained in the National Incident Management System (NIMS) Training Program, specifically NIMS 700 and 800, and ICS 100 and 200. The Incident Command System is used during emergency situations and Emergency Operations Center activations. OEM staff are also trained in Fundamentals of Emergency Management, Emergency Planning, Exercise Design, Leadership and Influence, Decision Making and Problem Solving, Effective Communication and Developing and Managing Volunteers.

7.8 Funding Sources

The following funding sources provide grants for flood mitigation planning and project related activities:

- Hazard Mitigation Grant Program (HMGP) – HMGP is administered by FEMA and provides grants to states, tribes and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to natural disasters and to enable mitigation activities to be implemented as a community recovers from a disaster. Eligible projects include: elevating flood-prone homes or businesses; acquisition of flood-prone homes from willing owners and returning the property to open space; retrofitting buildings; and construction of floodwall systems to protect critical facilities.

- Pre-Disaster Mitigation (PDM) Program – The PDM program provides funds for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. The program provides technical and financial assistance to States and local governments to assist in the implementation of pre-disaster mitigation actions, which must be cost-effective and designed to reduce injuries, loss of life and damage and destruction of property.

- Public Health Emergency Preparedness – The PHEP program provides funds for health departments to build and strengthen their abilities to effectively respond to a range of public health threats, including infectious diseases, natural disasters, and biological, chemical, nuclear, and radiological events. Preparedness activities funded by the PHEP cooperative agreement are targeted specifically for the development of emergency-ready public health departments that are flexible and adaptable.

- Urban Areas Security Initiative – The UASI program assists high-threat, high-density Urban Areas in efforts to build and sustain the capabilities necessary to prevent, protect against, mitigate, respond to, and recover from acts of terrorism. The UASI program is intended to provide financial assistance to address the unique multi-discipline planning, organization,

equipment, training, and exercise needs of high-threat, high-density Urban Areas, and to assist these areas in building and sustaining capabilities to prevent, protect against, mitigate, respond to, and recover from threats or acts of terrorism.

- Flood Mitigation Assistance (FMA) Program – FMA provides funding to assist communities and states in implementing actions that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, or other National Flood Insurance Program (NFIP) insurable structures with a focus on repetitive loss properties. The NFIP enables property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. Three types of FMA grants are available to States and communities: 1) planning grants to prepare Flood Mitigation Plans; 2) project grants to implement measures to reduce flood losses, such as elevation, acquisition, or relocation of NFIP-insured structures; and 3) technical assistance grants for the State to help administer the FMA program and activities.

- Repetitive Flood Claims – The program provides funding to States and communities to reduce or eliminate the long-term risk of flood damage to structures insured under the NFIP that have had one or more claims for flood damages, and that cannot meet the requirements of the Flood Mitigation Assistance (FMA) program for either cost share or capacity to manage the activities. Eligible activities include: 1) acquisition of properties and either demolition or relocation of flood-prone structures, where the property is deed restricted for open space uses in perpetuity; 2) elevations; 3) dry flood-proofing of non-residential structures; and 4) minor localized flood control projects.

- Severe Repetitive Loss (SRL) - A SRL property is defined as a **residential property** that is covered under a NFIP flood insurance policy and: 1) that has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or 2) for which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. Eligible flood mitigation project activities under the SRL program include: 1) acquisition and demolition or relocation of at-risk structures and conversion of the property to open space; 2) elevation of existing structures to at least the base flood elevation; 3) minor physical localized flood reduction projects; and 4) dry flood-proofing for historic properties.

- Emergency Management Performance Grants (EMPG) – The EMPG program provides resources to state and local governments to develop an all-hazards planning approach to emergency management and to sustain and enhance all-hazards emergency management capabilities. Every State is eligible for a percentage of the available funds and is intended to sustain the core capabilities of the five (Prevention, Protection, Mitigation, Response, and Recovery) mission areas.

- Maryland's Community Resilience Grants - Maryland's Community Resilience Grants combine the funding previously available under CoastSmart and Green Infrastructure Resiliency Grant programs. Leveraging federal dollars with newly available state funds to address resiliency in Maryland, the state is better able to promote and support comprehensive, holistic planning and implementation projects through this new grant program. The grant program takes a holistic,

watershed-scale planning approach to address both water quality and quantity. Ideal projects will foster innovative adaptation strategies that ensure that Maryland communities are increasingly resilient to flood risks, work to ascertain that Bay and ocean waters meet living resource and human needs, and serve to enhance the protection and management of the state's resources. Projects should help communities more clearly communicate the risks associated with hazards in order to better protect citizens, infrastructure, and natural resources. Grants are made possible by funding provided by the State of Maryland, the NOAA, and the EPA.

Most State and Federal grant programs require local communities to provide at least part of the necessary project funding in real dollars or through "in-kind" services. While the percentage of local contribution varies from program to program, Local communities need to assess their financial capability and resources to implement their hazard mitigation action plans. Howard County can meet match requirements through various funding sources.

- Funding through taxing authority

  The County has the ability to fund mitigation projects through its taxing authority. The County receives United States - Housing and Urban Development's Community Development Block Grants. It also has the authority to incur debt through general obligation bonds, special tax bonds, and revenue bonds.

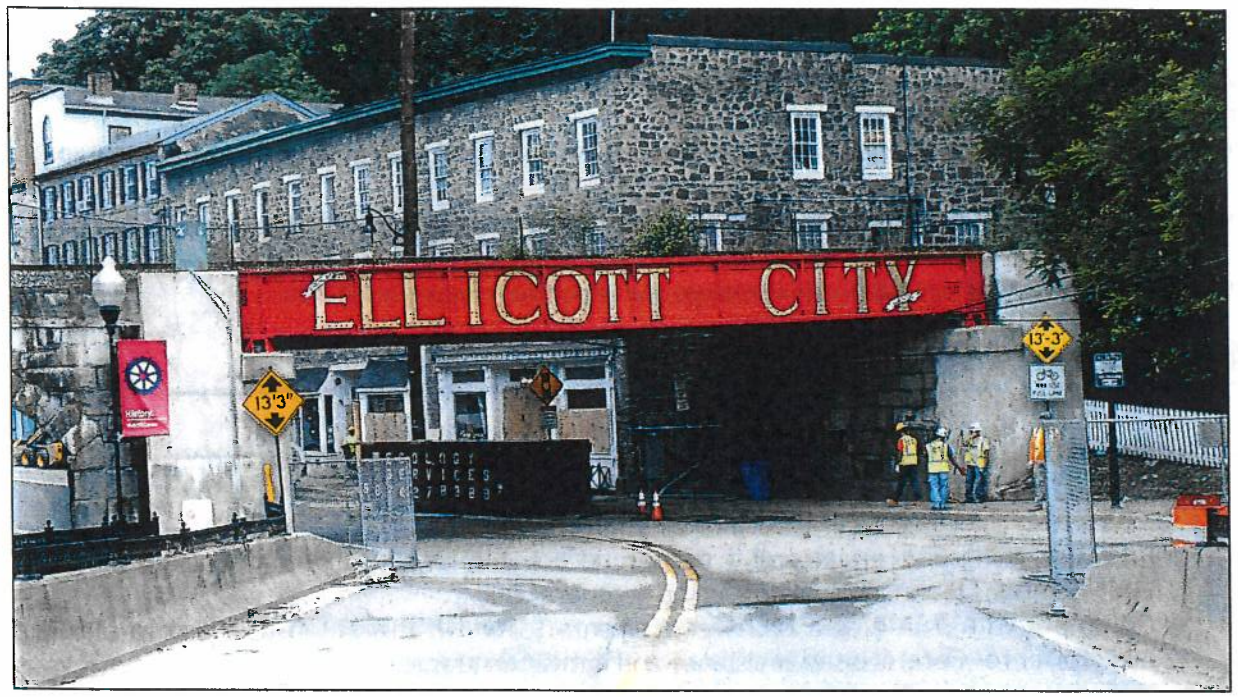
  Howard County also charges fees for water, sewer, and trash services. Gas and electric services are provided by private companies. Although impact fees are not charged to homebuyers for the new homes, the County does levy development excise taxes on new developments.

- Annual Budgets

  The 2019 Year Capital Improvement Program (CIP) was approved by the County Council and is allotted $198,855,000 for infrastructure planning, bridge repairs, and other large-scale projects. The projected five-year Capital Improvement Program for FY 2019-2024 is $ 5,235,826,000 [135].

[135] Howard County Government, Fiscal Year 2019 Howard County Capital Budget, available at https://www.howardcountymd.gov/LinkClick.aspx?fileticket=ZMxSb3mef2M%3d&portalid=0.

CHAPTER 8 - PLAN MONITORING AND MAINTENANCE



8.1 IFR Requirements for NHMP Monitoring and Maintenance

Requirement §201.6(c)(4)(i): *[The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle*

Requirement §201.6(c)(4)(ii): *[The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.*

Requirement §201.6(c)(4)(iii): *[The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.*

8.2 Update Process Summary

Upon completion, the plan will be submitted to MEMA and FEMA for review and approval in Fall 2018. The HMP will also be formally adopted by the County Council in late-Fall 2018. Once the HMP is adopted by the County Council, it will be sent for review and approval by both MEMA and FEMA in late-Fall 2018. This County Hazard Mitigation Plan Update is intended to be a 'living document'. Plan adoption is not considered the final step in the planning process, but rather as a first step to 'realization'. The plan monitoring and maintenance schedule is a cycle of events that

involve periodic review, adjustments, and improvement. This Chapter establishes a method to monitor how the Plan will be evaluated and maintained in the future.

8.3 Distribution

This 2018 NHMP Update will be posted on Howard County's Department of Fire and Rescue Services (DFRS) website under the OEM tab. Notices of the website's availability have been distributed to the following groups:

- The Federal and State agencies that were notified and invited to participate in the HMP's development;
- The organizations, agencies, and elected officials who received notices of public meetings; and,
- Citizens who attended public meetings and provided contact information.

8.4 Monitoring & Progress Reports

This 2018 HMP Update will be monitored by the County for several related purposes:

1. Maintain the currency of hazard and risk information.
2. Ensure mitigation projects and actions reflect the priorities of the County, the Joint HMP/FMP Steering Committee, and the general public.
3. Comply with FEMA and MEMA requirements for HMP maintenance, and to maintain eligibility for Federal disaster assistance and mitigation grants.

OEM is responsible for coordinating the JSC, and the Committee shall monitor and maintain the HMP Update. OEM and the JSC shall continuously monitor the HMP for the purposes noted above and with respect to the update triggers discussed in Section 8.5 below.

Upon adoption of this plan, OEM will annually convene a meeting of representatives from the JSC to discuss and determine implementation accomplishments and/or implementation obstacles and recommended solutions. Although the individuals filling the positions may change from year to year, future Joint Steering Committee members will continue to be comprised of the same departments and organizations involved in this current update.

An annual report form is included at the end of this Chapter for each high priority County project, to provide an update to the County on the status of their mitigation projects. This form will be distributed to the appropriate lead agency, requesting them to document the status of each hazard mitigation action taken falling under their jurisdiction. Each action proposed in the Mitigation Plan will be categorized as one of the following: completed, in progress, not started, modified, or cancelled. The JSC will assist OEM to prepare a status report of the mitigation actions based on the annual report forms. The OEM's status report of the mitigation actions, based on the annual report forms, will also be sent to MEMA and FEMA Region 3 for reporting and documentation purposes.

8.5 Circumstances to Initiate HMP Review and Updates

Circumstances or conditions under which Howard County will initiate NHMP reviews and updates.

1. On the recommendation of the County Executive, or on its own initiative, the County may initiate an NHMP review at any time.
2. At approximately the one-year anniversary of the NHMP's re-adoption, and approximately at the same anniversary every year thereafter.
3. After a natural hazard event that appears to significantly change the apparent risk to County assets, operations and/or citizens.
4. When activities within the County, region or State significantly alter the potential effects of natural hazards on County assets, operations and/or citizens. Examples include completed mitigation projects that reduce risk, actions or circumstances that increase risk.

In addition to the circumstances listed above, revisions that warrant changing the text of this NHMP or incorporating new information may be prompted by a number of circumstances, including identification of specific new mitigation projects, completion of several mitigation actions, or requirements for qualifying for specific funding. Minor revisions may be handled by addenda.

Major comprehensive review of and revisions to the Howard County NHMP will be conducted on a five-year cycle. Anticipated adoption of this plan will be in Fall 2018, and the NHMP will enter its next review cycle in 2022, with adoption of revisions anticipated by early 2023. The JSC will reconvene to conduct the comprehensive evaluation and revision to include the identification and prioritization of additional mitigation action items as required.

8.6 Benefit-Cost Analysis

A benefit-cost analysis determines the cost effectiveness of a project to minimize damage or prevent damage from future hazard events. By determining the benefit-cost of the proposed mitigation project, it will provide the communities, as well as project developers, with additional knowledge about the feasibility of the proposed mitigation alternative. If the costs outweigh the benefits, then other alternatives that are more effective can be identified to accomplish the Plan's goals.

8.7 Continued Public Involvement

The preparation of this Plan has involved the public throughout the process through public meetings and via newspapers, the Internet, and social media. Howard County is dedicated to continuing to solicit public participation during the five-year update as required by FEMA. Copies of the Natural Hazard Mitigation Plan Update will be provided to the public libraries and be placed on the County's website, along with a mechanism for submission for comments. Additionally, annual update meetings should be open to the public, and an advertising and outreach campaign undertaken to encourage the public to attend and provide comment.

Upon adoption of the updated 2018 NHMP, the public will be notified of any substantial changes to the document prior to the next scheduled update in early 2023. Any changes proposed by the JSC that are considered significant, will be distributed to the list of stakeholders identified in Chapter 3, *Planning Process*. The JSC will then review all suggested changes and make recommendations for revisions to the plan as deemed appropriate and/or necessary.

8.8 Plan Adoption

Adoption by the Local Governing Body

Requirement §201.6(c)(5): *[The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., County Commission).*

Include adoption resolution from Howard County here.

Hazard Mitigation Plan
Sample Annual Report Form

Progress Report Period _____ to _____
Next Plan Update _____
Project Title_____ Project ID #_____

Project Type: (select one)
County Project_____ Municipal Project _____
Responsible County Agency(ies) or Municipality _____
Address: _____
Contact: _____
Title: _____
Phone: _____
Email: _____

Project Description:
Project Status (select one)
Completed ____ In Progress ____ Not started/delayed ____ Modified ____ Cancelled ____

How many people were protected by this action? _____
Were there any structures mitigated? If so, how many? _____
Explain:

Obstacles/challenges/delays incurred:

_____

_____

Method to resolve obstacle/challenge/delay:

_____

_____

Next steps to be accomplished over the next reporting period:

_____

_____

Other comments:

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APPENDIX A: MEETINGS

VISION
PLANNING & CONSULTING, LLC

Howard County
2017 Hazard Mitigation & Flood Mitigation Plan Update

Steering Committee Meeting #1
Agenda
Date: December 7, 2017
Time: 2:00-4:00pm

Introductions
- Howard County Bureau of Environmental Services
- Howard County Office of Emergency Management
- Consultants – VPC

Project Overview Presentation
A.1.Purpose and background
A.2.Key players
A.3.Planning process
A.4.Hazards and definitions
A.5.Risk Assessment and GIS Data

A.6.Plan integration
A.7.Existing County Plans and Reports

A.8.Mitigation Actions

A.9.Implementation Plan

A.10. Project schedule
1.0 Meetings – Steering Committee/Stakeholders and Public
- Progress to date

Goals and Objectives Exercise
(1) Review 2010 Flood Mitigation Plan Goals and Objectives

(2) Review 2012 Hazard Mitigation Plan Goals and Objectives

(3) Discuss additional Goals and Objectives

Open Discussion
(4) Hot Topics

VISION
PLANNING & CONSULTING, LLC

SIGN-IN SHEET
Howard County Hazard Mitigation & Flood Mitigation Plan Update

1st Steering Committee Meeting
December 7th, 2017 2:00-4:00pm

Name	Phone	Email	Agency
Amanda Faul		afaul@howardcountymd.gov	OEM
Mike Hinson	x5911	mhinson@howa...	OEM
Rocco Severo	x 3680	RSevero@howard...	Police
Stephen Hardesty	6509	shardesty@howard...	DFRS
Brian Cleary	6455	bcleary@howard.	DPW BES-SWM
Bill Seiger	410-337-1871	William.Seiger@maryland.gov	Citizen / MDE
Andrew Estrain	301-537-7941	aestrain@vision-pc.net	VPC
Chris Meyer		Cmeyer@howardcountymd.gov	OEM
Dave Keane	x 1676	dkeane@howardcountymd.gov	R+P/NR
Mark Richmond	x 6413	msrichmond@howardcountymd.gov	DPW-BES-SWM
Ashley Sanovitz	410 963 4277	asanovitz@vision-pc.net	VPC

2018 Howard County Hazard Mitigation/Flood Mitigation Plan Update
Steering Committee Meeting #1
December 7, 2017 – 2:00pm-4:00pm
Ligon Building, 3450 Courthouse Drive, Ellicott City, MD

Meeting Summary by Andrew Estrain, Vision Planning and Consulting

Attendees were given a brief introduction to the Consulting firm Howard County has contracted for the Flood and Hazard Mitigation Plan Update process, Vision Planning and Consulting (VPC). VPC representatives working on the project, Ashley and Andrew, introduced themselves and introductions for the members of the steering committee in attendance were given. VPC presented and discussed the project purpose and background, key players, steps in the planning process, county hazards, a risk assessment preview, plan integration efforts, future mitigation action development, project schedule, future meetings, and existing County HMP and FMP goals and objectives,

VPC worked with Committee members to examine and refine each of the goals and objectives laid out in the previous plans for both the Flood Mitigation Plan and the Natural Hazard Mitigation Plan. Each goal and objective was evaluated for clarity, cohesiveness, and relevance. Terminology was discussed, and suggestions made to help the plan, goals, and objectives become more actionable and be more comprehensible to the responsible implementing agencies and to the general public. These goals and objectives will be sent to the steering committee members to give those who could not attend a chance for additional review and comment.

The format of the two public meetings is still undetermined, but is important. OEM's desire is that those in attendance at the public meetings should be from throughout the entire County, as this is a countywide planning process. VPC will work with OEM and DPW/Stormwater Management to identify the best format and location for the public meetings.

Next steps include drafting the updated goals and objectives based on today's meeting, and an update upon receiving comments from the steering committee; performing GIS analysis and the risk assessment; beginning to develop mitigation actions; finalizing plan integration; the second steering committee meeting; and determining the format and location of the first public meeting.

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Howard County
Hazard Mitigation/Flood Mitigation Plan Update

Steering Committee Meeting #2
Draft Agenda
Date: February 2018 TBD
Time: TBD

Review Hazard Identification and Risk Assessment
(1) Hazus analysis
(2) Flood
(3) Other hazards
(4) HIRA summary
(5) Hazard prioritization

Goals / Actions Review
1.0 Discussion and finalization of 2018 Goals and Objectives
2.0 Examine 2012 HMP and FMP mitigation actions and review current status (in progress, completed, ongoing, etc.)

Open Discussion
- Solicit input on risks from flood and other hazards

Questions

Next Steps
- Public Meeting (TBD)
- Past mitigation action finalization
- Develop new mitigation actions

Adjournment

VISION
PLANNING & CONSULTING, LLC

SIGN-IN SHEET
Howard County Hazard Mitigation & Flood Mitigation Plan Update

2nd Steering Committee Meeting
February 6th, 2018 2:00-4:00pm

Name	Phone	Email	Agency
DAVID KEANE	410.313.1676	dkeane@howardcountymd.gov	HCR+P
Mark S. Richmond	410-313-6413	msrichmond@howardcountymd.gov	HC SWM
BRIAN E CLEARY	410-313-1455	bcleary@howard...	HC SWM
Ashley Sauerwisley	888 872 9626	asauerwisley@vision-pc.net	VPC
M. Ke Hinson	410-313-5911	mhinson@howardcountymd.gov	OEM
Kris Jagarapu	410.313.7272	KJagarapu@howardcountymd.gov	H.C. DPW/ Highways
Don mock	410-313-3948	dmock@howardcountymd.gov	H.C. DILP

VISION
PLANNING & CONSULTING, LLC

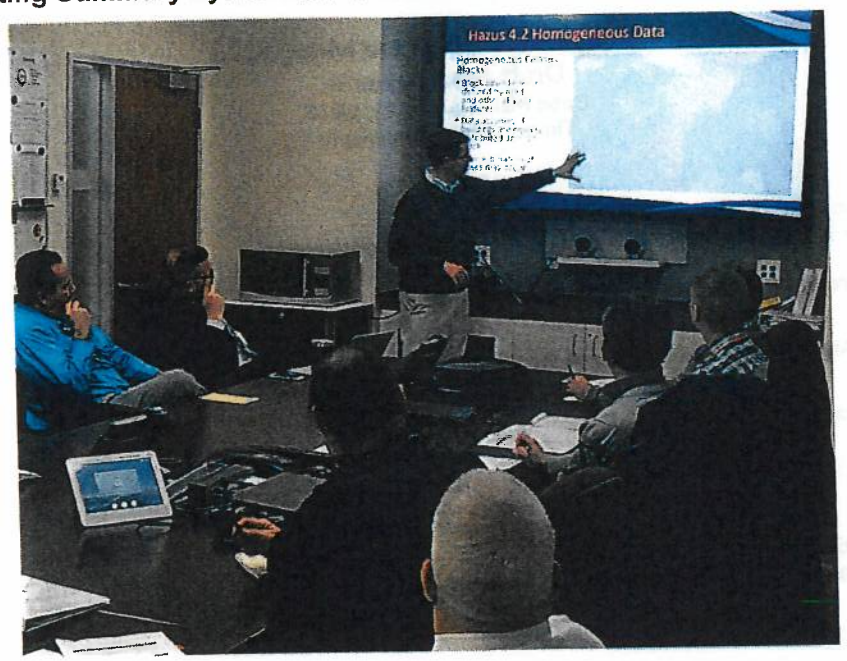
SIGN-IN SHEET
Howard County Hazard Mitigation & Flood Mitigation Plan Update

2nd Steering Committee Meeting
February 6th, 2018 2:00-4:00pm

Name	Phone	Email	Agency
Andrew Estrain		aestrain@vision-pc-net	VPC
Debra Srinivasan		dsrinivasan@vision-pc.net	VPC
ZACHARY BACCALA		zbaccala@verizon.net	Ecological Park Management
Rocco Sovero	4103133660	RSovero@howardcountymd.gov	HCPD
Stephen M Hardesty	410-313-6509	Shardesty@howardcountymd.gov	DFRS
Amanda Faul		afaul@howardcountymd.gov	OEM
Chris Meyer		CMeyer@howardcountymd.gov	OEM

2018 Howard County Hazard Mitigation/Flood Mitigation Plan Update
Steering Committee Meeting #2
February 6, 2018 – 2:00pm-4:00pm
Ligon Building, 3450 Courthouse Drive, Ellicott City, MD

Meeting Summary by Andrew Estrain, Vision Planning and Consulting



The Steering Committee was presented with the initial findings of the Vulnerability and Risk Assessment by Zach Baccala, a member of the VPC Team. This presentation provided information on HAZUS and information on the various hazards Howard County could potentially face. Mr. Baccala discussed the process for generating the 1% and .02% chance flood area, and maps to illustrate the county's flood hazard areas.

Using HAZUS 4.2, the total number of exposed structures and damaged buildings was estimated for a 100-year and 500-year flood, for the county, and for three specific communities. Dollar amounts were also assigned for the potential losses associated with a serious flooding event, where total losses were estimated around $67 million for a 100-year event, and over $120 million for a 500-year event. Similar maps and exposure estimates were also generated for earthquakes and hurricanes.

VPC discussed the integration of the Howard County 2017 HIRA, which was used to determine the hazard risk ranking for county, determined based on likelihood, impact, warning time, and duration of a hazard event. Flooding is the highest ranked hazard in the county.

A final review of goals and objectives was then held to gather input or recommendations on the content and verbiage. Additionally, mitigation actions from the previous plans were reviewed to determine current status (in progress, completed, deferred), relevance, and feasibility.

Next steps include finalizing the updated goals and objectives, developing new mitigation actions for review at the next Steering Committee meeting, and hosting the first public meeting, as well as the third Steering Committee meeting.

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Howard County
Hazard Mitigation/Flood Mitigation Plan Update

Steering Committee Meeting #3
Draft Agenda
Date: March 21, 2018
Time: 1:00-3:00pm

2018 Actions Review
1.0 Examine New Mitigation Actions that Address Goals and Objectives

Discuss Preliminary Questionnaire Results

Develop Additional Mitigation Actions

Open Discussion

Questions

Next meeting
- Mitigation Action Finalization
- Prioritize Mitigation Actions
- Implementation Strategy

Next Steps

Adjournment

VISION
PLANNING & CONSULTING, LLC

SIGN-IN SHEET
Howard County Hazard Mitigation & Flood Mitigation Plan Update

3rd Steering Committee Meeting
April 3rd, 2018 2:00-4:00pm

Name	Phone	Email	Agency
Mike Hinson	5911	mhinson@hoc...	OEM
Peter Conrad	4352	pconrad@	DPZ
Stephen Hardesty	6000	Shardesty@howardcountymdgov	DFRS
David Keane	1676	dkeane@howardcountymd.gov	DRP
BRIAN F CLEARY	6455	bcleary@howardcountymd.gov	DPW
Mark S. Richmond	6413	msrichmond@howardcountymd.gov	DPW
Debra Swanson		dswanson@vhb-pc.net	VPC
Don mock	3948	dmock@howardcountymd.gov	DILP
Rocco Sovero	36080	RSOVERO@howardcountymd.gov	HCPD
Chris Meyer	x5913	cmeyer@howardcountymd.gov	OEM
Ashley Samansky		asamansky@vhb-pc.net	VPC

2018 Howard County Hazard Mitigation/Flood Mitigation Plan Update
Steering Committee Meeting #3
April 3, 2018 – 2:00pm-4:00pm
Ligon Building, 3450 Courthouse Drive, Ellicott City, MD

Meeting Summary by Andrew Estrain, Vision Planning and Consulting

Attendees were first provided with the project's progress to date. The Steering Committee was presented with the results of the public poll/questionnaire developed and disseminated by VPC. This poll included questions that were designed to gather information and viewpoints of county residents regarding their property's vulnerability to natural hazards. It is specifically intended to identify common damages and potential mitigations that may have been overlooked.

Examples of poll questions include:
1.0 How at risk is your property to flooding/winter storms/hurricanes/wind events?
2.0 Has your property experienced flooding/winter storms/hurricanes/wind events more than three times in the past five years?
3.0 What type of property damage do you typically find after a hazard event?
4.0 Have you taken any actions to avoid future damages and loss from natural hazards?

VPC then had a brainstorming session with the Steering Committee to determine additional new mitigation actions based on results of the public poll. Several new mitigation actions were developed, and appropriate content and verbiage finalized. The Steering Committee also provided input on lead agency and potential funding sources related to the newly developed mitigation actions.

Next steps include finalizing and prioritizing hazard mitigation actions, developing an implementation plan, and hosting the fourth Steering Committee meeting and second public meeting.

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Howard County Flood Mitigation Plan

Steering Committee Meeting #4
Draft Agenda

Date: May 16, 2018
Time: 2:00pm – 4:00pm

Mitigation Actions
1.0 Mitigation Action Finalization

2.0 Prioritize Mitigation Actions

Open Discussion

Questions

Next Steps
- Public Meeting – 5/17/2018
- Finalization of Draft Report(s)

Adjournment

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SIGN-IN SHEET
Howard County Hazard Mitigation & Flood Mitigation Plan Update
4th Steering Committee Meeting
May 16th, 2018 2:00pm-4:00pm

Name	Phone	Email	Agency
Andrew Estrain	888-VPC-9626	aestrain@visionpc.net	VPC
Mark S. Richmond	410-313-6413	msrichmond@howardcountymd.gov	How Co. DPW-SLWM
David Keane	410.313.1676	dkeane@howardcountymd.gov.	How. Co Rec+Parks
Bill Saiger	410-537-3921	William.Saiger@maryland.gov	MDE/ HoCo resident
Debra Srinivasan	240 893 8719	dsrinivasan@vision-pc.net	VPC
Ashley Samonisky	888-VPC-9626	asamonisky@vision-pc.net	VPC
Stephen Hardesty	410-812-5962	Shardesty@howardcountymd.gov	HCDFRS
Chris Meyer	410-313-5913	Cmeyer@howardcountymd.gov	OEM
Sean Herbaugh	410-381-3470	Sean.Herbaugh@columbiaassociation.org	CA
Phil Nichols	410-313-2051	pnichols@howardcounty.gov	H&G Admin
Peter Conrad	410-313-4352	pconrad@howardcountymd.gov	DPZ
Lindsay DeMarzo	410 313 4374	LDEMarzo@howardcountymd.gov	Community Sust.
Mike Hinson	x5911	mhinson@ho...	OEM
Don mock	410-313-3949	dmock@howardcountymd.gov	DILP

2018 Howard County Hazard Mitigation/Flood Mitigation Plan Update
Steering Committee Meeting #4
May 16, 2018 – 2:00pm-4:00pm
Ligon Building, 3450 Courthouse Drive, Ellicott City, MD

Meeting Summary by Ashley Samonisky, Vision Planning and Consulting

Vision Planning and Consulting (VPC) representative Ashley Samonisky, led an exercise to finalize and prioritize the list of mitigation actions for the Flood and Hazard Mitigation Plans, which had been emailed out prior to the meeting to ensure the Committee had sufficient time for review.

Each action item was discussed to determine phrasing, efficacy, and implementation methods. Some action items were combined for clarification and efficiency. HMP actions relating to flooding were removed as they were elaborated on in the Flood Mitigation Plan. Recently completed actions were also removed.

An implementation plan was developed to determine Lead Agency, Timeline, Estimated cost and potential Funding Sources for each action item. Additionally, VPC then discussed the prioritization rubric which was based on Life/Safety, Technical/Administrative Difficulty, and Cost. As Life/Safety is the main goal of mitigation actions, it received a weight double that of the other considerations.

VPC worked with Committee members to examine and prioritize mitigation actions for both the Flood Mitigation Plan and the Natural Hazard Mitigation Plan. Newly developed actions, as well as those carried forward from the previous plans, were evaluated and given a score based on their projected cost, the difficulty in performing or implementing the action, and the scale of area the action would protect (one street, one neighborhood, countywide, etc.). Actions were then ranked based on the prioritization score.

Next steps include assembling the draft report for county and public review, and hosting the second and final public meeting.

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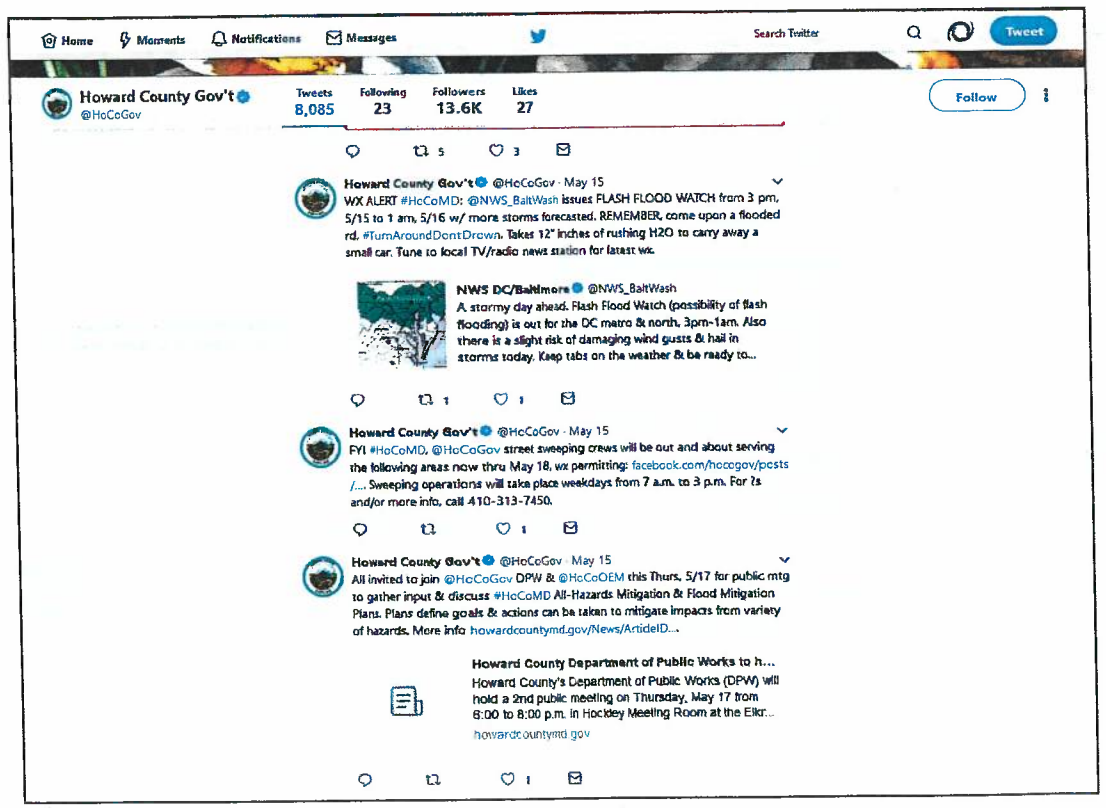
APPENDIX B: PRESS RELEASES, NOTICES, AND PUBLIC PARTICIPATION

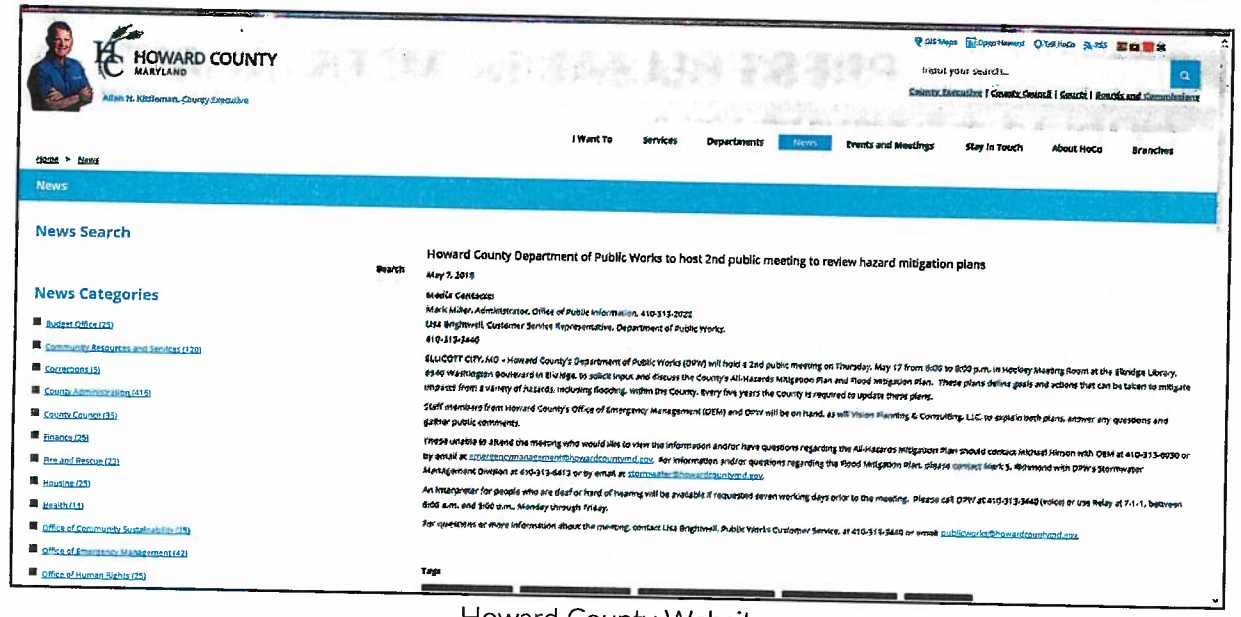
A requirement of the planning process is to not only solicit input from the public and stakeholders in developing the plans, but to keep them informed on the entire process as well.

Requirement §201.6(c)(1): *The Plan must document the planning process, including how it was prepared and who was involved in the process for each jurisdiction.*

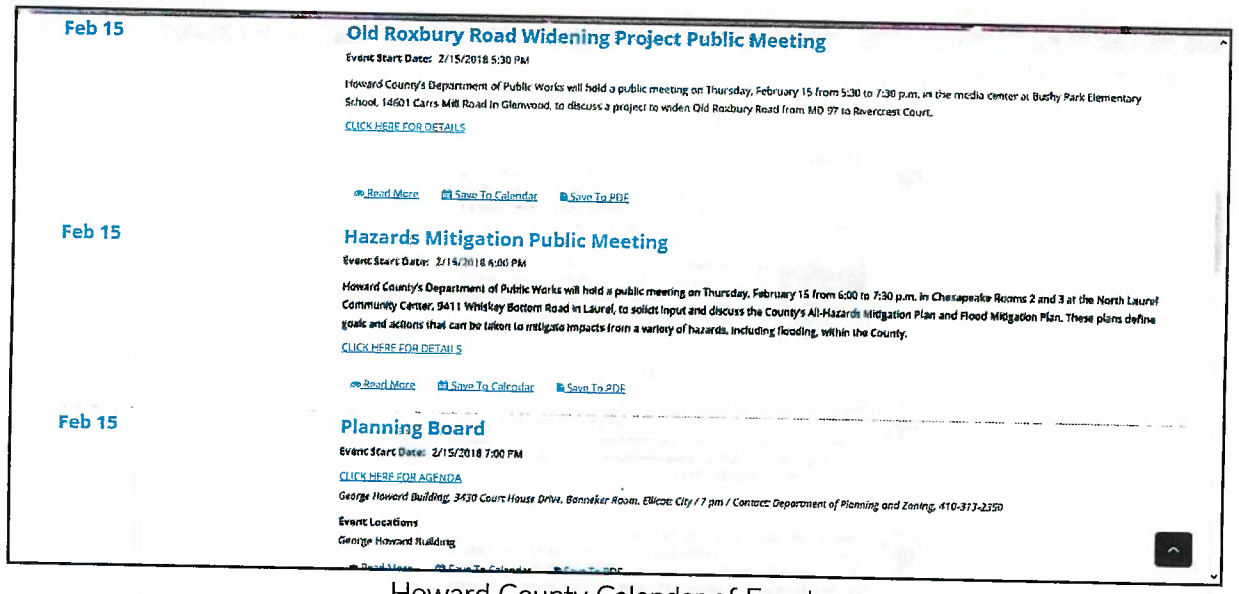
Notices regarding meetings were distributed through the County Website, Social Media, and Press outlets. Howard County Government, and OEM both maintain a Twitter Page as well as a Facebook. Notices regarding the Planning process and meetings were distributed through the County PIO Office which has distribution channels including newspaper, television, and partnering agencies. Samples of these informational releases and invitations are included below.



Howard County Twitter Page



Howard County Website



Howard County Calendar of Events

Howard County Government
News Release

Office of Public Information
3430 Courthouse Drive
Ellicott City, Maryland, 21043

410-313-2022 / FAX 410-313-3390 / www.howardcountymd.gov

Mark Miller, Administrator
msmiller@howardcountymd.gov

May 7, 2018

Media Contacts:
Mark Miller, Administrator, Office of Public Information, 410-313-2022
Lisa Brightwell, Customer Service Representative, Department of Public Works, 410-313-3440

Howard County Department of Public Works to host 2nd public meeting to review hazard mitigation plans

ELLICOTT CITY, MD – Howard County's Department of Public Works (DPW) will hold a 2nd public meeting on Thursday, May 17 from 6:00 to 8:00 p.m. in Hockley Meeting Room at the Elkridge Library, 6540 Washington Boulevard in Elkridge, to solicit input and discuss the County's All-Hazards Mitigation Plan and Flood Mitigation Plan. These plans define goals and actions that can be taken to mitigate impacts from a variety of hazards, including flooding, within the County. Every five years the County is required to update these plans.

Staff members from Howard County's Office of Emergency Management (OEM) and DPW will be on hand, as will Vision Planning & Consulting, LLC, to explain both plans, answer any questions and gather public comments.

Those unable to attend the meeting who would like to view the information and/or have questions regarding the All-Hazards Mitigation Plan should contact Michael Hinson with OEM at 410-313-6030 or by email at emergencymanagement@howardcountymd.gov. For information and/or questions regarding the Flood Mitigation Plan, please contact Mark S. Richmond with DPW's Stormwater Management Division at 410-313-6413 or by email at stormwater@howardcountymd.gov.

An interpreter for people who are deaf or hard of hearing will be available if requested seven working days prior to the meeting. Please call DPW at 410-313-3440 (voice) or use Relay at 7-1-1, between 8:00 a.m. and 5:00 p.m., Monday through Friday.

For questions or more information about the meeting, contact Lisa Brightwell, Public Works Customer Service, at 410-313-3440 or email publicworks@howardcountymd.gov.

###

Howard County Press Release

Participation with the public was solicited through two avenues: a property owner/resident survey and public meetings. Agendas and Summaries for each of the two public meetings are included below. A sample of the public survey and flood related results are included in Appendix D.

VISION
PLANNING & CONSULTING, LLC

Howard County
2018 Hazard Mitigation & Flood Mitigation Plan Update

Public Meeting #1
Date: February 15, 2018
Time: 6:00-7:30pm

Introductions

- Howard County Bureau of Environmental Services
- Howard County Office of Emergency Management
- Consultants – VPC

Project Overview Presentation

(1) Purpose and background
(2) Key players
(3) Planning process
(4) Hazards and definitions
(5) Risk Assessment and GIS Data

(6) Plan integration

1.0 Meetings – Steering Committee/Stakeholders and Public

HIRA

- Hazus analysis
- Flood
- Other hazards
- HIRA summary
- Review Hazard Prioritization Results

Open Discussion

- Hot Topics

- Flood-Related Issues

Questions

Next Steps

Adjournment

2018 Howard County Hazard Mitigation/Flood Mitigation Plan Update
Public Meeting #1
February 15, 2018 – 6:00pm-8:00pm
North Laurel Community Center, 9411 Whiskey Bottom Road, Laurel, MD

Meeting Summary by Andrew Estrain, Vision Planning and Consulting

VPC presented to county residents in attendance the purpose, background, and key players of the project. VPC team member, Ashley Samonisky, then discussed the initial findings of the Vulnerability and Risk Assessment including definitions used throughout the project and information on the various hazards Howard County could potentially face. This involved discussing the process used for generating the 1% and .02% chance flood area, and providing maps to illustrate the county's flood hazard areas.

Ms. Samonisky then discussed estimates regarding flood losses and vulnerability, including the estimated total number of exposed structures and damaged buildings during a 100-year and 500-year flood, for the county, and for three specific communities. Dollar amounts were also assigned for the potential losses associated with a serious flooding event, where total losses were estimated around $67 million for a 100-year event, and over $120 million for a 500-year event. Similar maps and exposure estimates were also generated for earthquakes and hurricanes.

VPC discussed the integration of the Howard County 2017 HIRA, which was used to determine the hazard risk ranking for county, determined based on likelihood, impact, warning time, and duration of a hazard event. Flooding is the highest ranked hazard in the county.

Draft goals and objectives were then provided, along with the mitigation action categories that newly developed mitigation actions will be based around. Finally, VPC explained an implementation plan will lead to prioritizing actions based on social, administrative, economic, and other factors. A Q&A session for the public was then held.

The public was then asked to observe a map of frequently flooded roads in the county, and identify roads and areas that do flood that may not already be represented on the map.

VISION
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SIGN-IN SHEET
Howard County Hazard Mitigation & Flood Mitigation Plan Update

1st Public Open House
February 15th, 2018 6:00-7:30pm

Name	Phone	Email	Address
Mark Richmond	410-313-6413	mrichmond@howardcountymd.gov	6751 Columbia Gateway Dr, Col., MD
David Keane	410.313.1676	dkeane@howardcountymd.gov	7120 Oakland Mills Rd Columbia, MD 21046
BRIAN F CLEARY	410.313.6455	bcleary@howardcountymd.gov	6751 Columbia Gateway
Stephen M Hardesty	410.313-6509	Shardesty@howardcountymd.gov	6751 Columbia Gateway #401
Mike Hinson	410-313-5911	mhinson@	3430 Court House Drive 21043
Mark DeLuca	410 313 4414	MDeluca@howardcountymd.gov	6751 Columbia Gateway Drive
Phil Nichols	1 1 2016	pnichols@	3430 Court House Drive 2104
Andrew Estrain	301 537 7947	aestrain@vision-pc.net	8171 Maple Lawn Blvd. Suite 245, Fulton, MD
Ashley Szamocki	888 8729626	aszamocki@vision-pc.net	" " "
Tyler Sinnamon	888 8729626	dsinnamon@vision-pc.net	" " "

HOWARD COUNTY MARYLAND

VISION
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Howard County
Hazard Mitigation/Flood Mitigation Plan Update
Public Open House #2
Draft Agenda
Date: 5/17/2018
Time: 6:00-8:00pm

Goals and Objectives
- Review 2018 Goals and Objectives

Mitigation Actions Review
1.0 Discussion of 2018 Actions
2.0 Explanation of Prioritization Process

Open Discussion
- Additional recommended actions

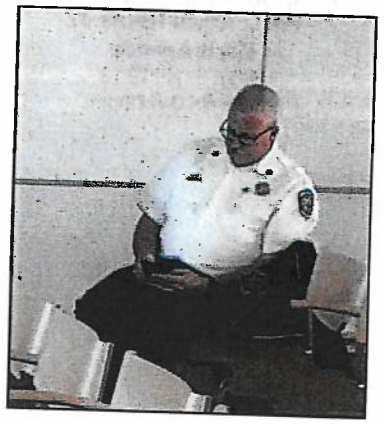
Questions

Next Steps
-

Adjournment

2018 Howard County Hazard Mitigation/Flood Mitigation Plan Update
Public Meeting #2
May 17, 2018 – 6:00pm-8:00pm
Howard County Library System, Laurel Branch, 6540 Washington Blvd., Elkridge, MD

Meeting Summary by Andrew Estrain, Vision Planning and Consulting


The public was presented basic findings of the Vulnerability and Risk Assessment, including information on the flood hazards that different areas of Howard County could potentially face. This involved identifying and discussing major flood hazard areas in the county, the most damaging tributaries in areas with the highest estimated total losses, and critical facilities in the county vulnerable to flooding. the process used for generating the 1% and .02% chance flood area, and providing maps to illustrate the county's flood hazard areas.

VPC discussed the integration of other county plans, as well as the Howard County 2017 HIRA, which was used to determine the hazard risk ranking for county. Hazard risk rankings were determined based on likelihood, impact, warning time, and duration of that hazard event. Flooding is the highest ranked hazard in the county.

The Flood Mitigation and Hazard Mitigation Plans goals and objectives were then presented, along with the mitigation action categories that hazard mitigation actions are created around. VPC then explained an implementation plan will lead to prioritizing and ranking the mitigation actions based on social, administrative, economic, and other factors.

Attendees were then provided a sample of hazard mitigation actions, specifically, the highest ranked actions from both the Flood Mitigation and Hazard Mitigation Plan. A Q&A session for the public was then held.

VISION
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SIGN-IN SHEET
Howard County Hazard Mitigation & Flood Mitigation Plan Update

2nd Public Open House
May 17th, 2018 6:00-7:30pm

Name	Phone	Email	Address
Andrew Strain	888-VPC-9626	astrain@vision-pc.net	VPC
~~Aidan~~ Craig Wilson	301-602-7234	Cork wilson@gmail.com	8320 Academy RD
Aidan Wilson	443-878-4731	224awilson@gmail.com	8320 Academy RD
Mark Richmond	410-313-6413	mrichmond@howardcountymd.gov	6751 Columbia Gateway Dr, Columbia
Stephen Hardesty	410-812-9962	Shardesty@howardcountymd.gov	6214 HANOVER RD Hanover MD 21076
Mike Hinson	410-313-5911	mhinson@howardcountymd.gov	3430 Court House Drive 21043
Ashley Samonitsky	888 VPC 9626	asamonitsky@vision-pc.net	VPC
BRIAN CLEARY	410-313-6455	bcleary@howardcountymd.gov	6751 Columbia Gateway Dr. Columbia

HOWARD COUNTY MARYLAND

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APPENDIX C: ACRONYMS

AEOC – Alternate EOC
BFE - Base Flood Elevations
BMP – Best Management Practices
BWI - Baltimore Washington International Thurgood Marshall Airport
CFR – Code of Federal Regulations
CRS – Community Ratings System
CSA - Combined Statistical Area
DEM – Digital Elevation Model
DFRS – Department of Fire and Rescue Services
DILP – Department of Inspections, Licensing, and Permits
DMA2K - Disaster Mitigation Act of 2000
DPW – Department of Public Works
DPZ – Department of Planning and Zoning
DRP – Department of Recreation and Parks
EAP - Emergency Action Plan
EAS - Emergency Alert System
EMnet - Emergency Management Network
EMPG - Emergency Management Performance Grants
EOC – Emergency Operations Center
EOP - Emergency Operations Plan
EPA - Environmental Protection Agency
ESF - Emergency Support Functions
FEMA – Federal Emergency Management Agency
FIRM - Flood Insurance Rate Map
FIS – Flood Insurance Study
FMA - Flood Mitigation Assistance Program
FMP – Flood Mitigation Plan
GBS - General Building Stock
GIS – Geographic Information System
HCPD - Howard County Police Department
HIRA – Hazard Identification and Risk Assessment
HMGP - Hazard Mitigation Grant Program
HMP – Hazard Mitigation Plan
IA - Individual Assistance
ICS - Incident Command System
JSC – Joint Steering Committee
LOMA - Letter of Map Amendment
LOMR - Letter of Map Revision
MARC - Maryland Area Regional Commuter
MDE – Maryland Department of the Environment
MEMA – Maryland Emergency Management Agency
MEMAC - Maryland Emergency Management Assistance Compact
MGS - Maryland Geological Survey
MSA - Metropolitan Statistical Area
MSD - Maryland School for the Deaf
MTA - Maryland Transit Administration
NAWAS - National Warning System
NFIP – National Flood Insurance Program
NIMS - National Incident Management System
NPDES - National Pollutant Discharge Elimination System
NWS - National Weather Service
OEM – Office of Emergency Management
PA - Public Assistance
PDM - Pre-Disaster Mitigation Program
PDSI - Palmer Drought Severity Index
PGA - Peak Ground Acceleration
PIO – Public Information Office
PSAP - Public Safety Answering Point
RL - Repetitive Loss
RTA - Regional Transportation Agency
SHA – State Highway Administration
SRL - Severe Repetitive Loss
SWMD - Storm Water Management Division
THIRA – Threat Hazard Identification and Risk Assessment
UASI - Urban Area Security Initiative
USGS - United States Geological Survey
VPC – Vision Planning and Consulting
WUI - Wildland-Urban Interface
WSSC - Washington Suburban Sanitary Commission
WWTP - Waste Water Treatment Plant

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APPENDIX D: COMMUNITY SURVEY RESULTS

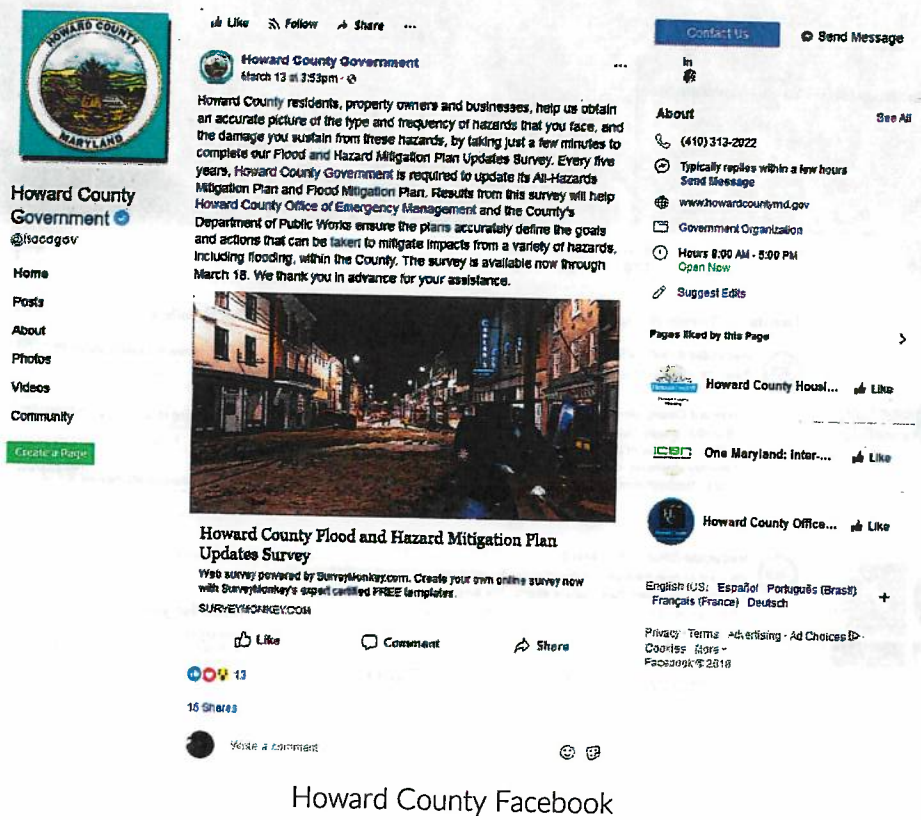
The Community Survey was released through multiple County channels and was left open for a period of two weeks. A total of 160 responses were received, with 75% of all responses being received in the first 5 days of release.

Posting	Date	Time
Survey placed on HoCo OEM website	3/1/18	1:25 PM
Survey posted on OEM Facebook	3/2/18	10:00 AM
Survey posted on OEM Nextdoor Account	3/2/18	10:36 AM
Survey posted on OEM Twitter	3/2/18	10:36 AM
Survey posted on Howard County Gov Facebook Account	3/13/18	3:53 PM
Survey posted on Howard County Gov Twitter Account	3/13/18	3:53 PM

Samples of the survey release announcement are included below.

Howard County OEM Twitter

Howard County Twitter



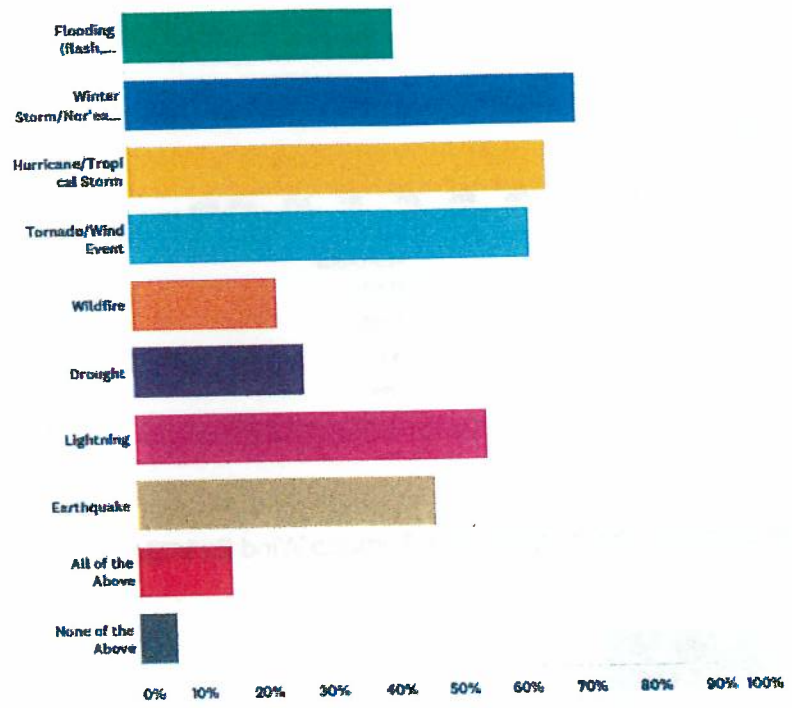
Howard County Facebook

A sample of the questionnaire results are included in the sections below.

Howard County Flood and Hazard Mitigation Plan Updates SurveyMonkey

Q2 Is your property vulnerable to the following hazards? (Check all that apply)

Answered: 158 Skipped: 2

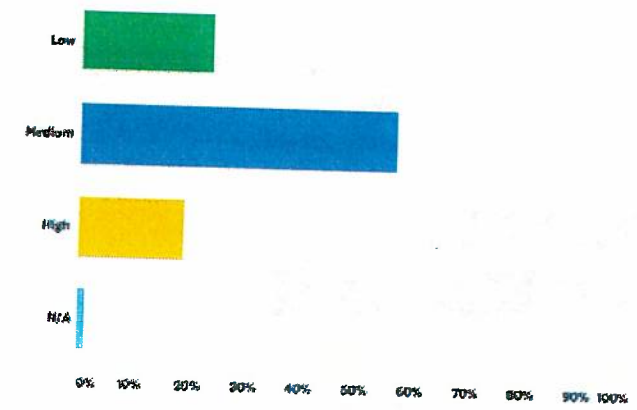


ANSWER CHOICES	RESPONSES	
Flooding (flash, stormwater)	41.14%	65
Winter Storm/Nor'easter	69.62%	110
Hurricane/Tropical Storm	64.56%	102
Tornado/Wind Event	62.03%	98
Wildfire	22.78%	36
Drought	26.58%	42
Lightning	54.43%	86
Earthquake	46.20%	73
All of the Above	14.56%	23
None of the Above	5.70%	9

2 / 22

Q4 How at-risk is your property to a Winter Storm/Nor'easter?

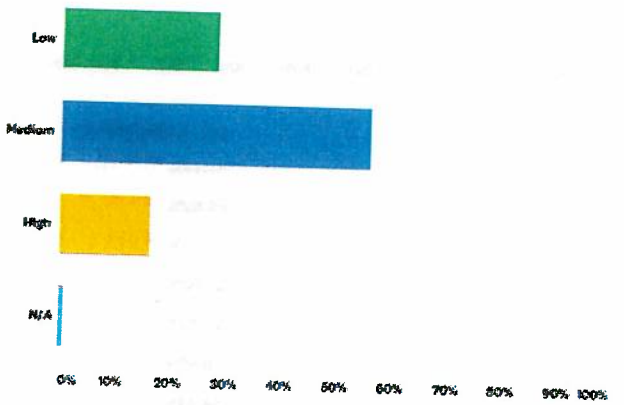
Answered: 159 Skipped: 1



ANSWER CHOICES	RESPONSES	
Low	23.27%	37
Medium	56.60%	90
High	18.87%	30
N/A	1.26%	2
TOTAL		159

Q6 How at-risk is your property to a Tornado/Wind Event?

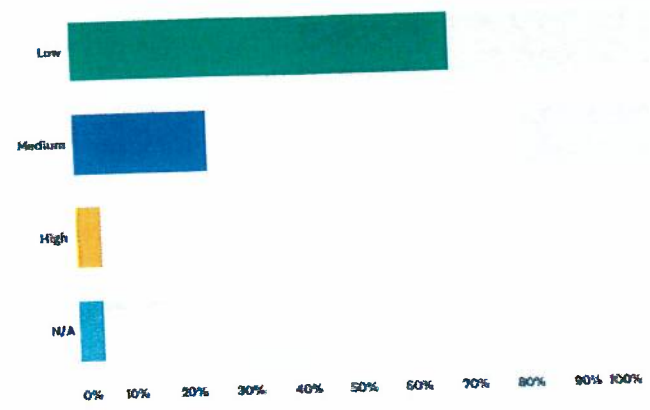
Answered: 159 Skipped: 1



ANSWER CHOICES	RESPONSES	
Low	27.67%	44
Medium	56.35%	88
High	16.35%	26
N/A	0.63%	1
TOTAL		159

Q9 How at-risk is your property to an Earthquake?

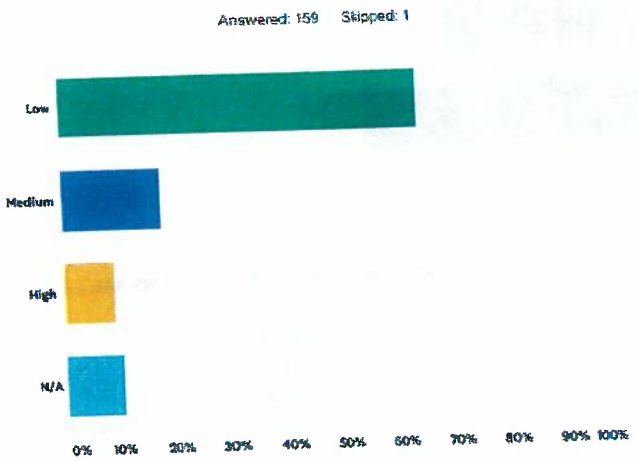
Answered: 159 Skipped: 1



ANSWER CHOICES	RESPONSES	
Low	67.30%	107
Medium	23.90%	38
High	4.40%	7
N/A	4.40%	7
TOTAL		159

Q10 How at-risk is your property to a Wildfire?

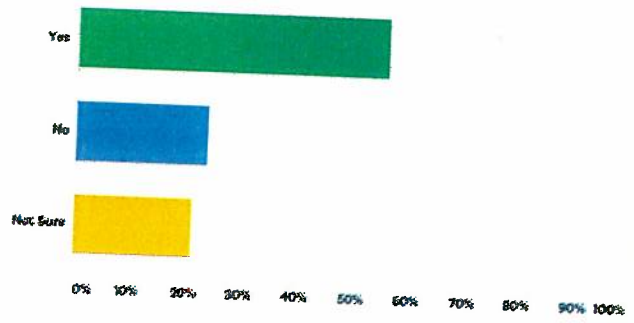
Answered: 159 Skipped: 1



ANSWER CHOICES	RESPONSES	
Low	63.52%	101
Medium	17.61%	28
High	8.81%	14
N/A	10.06%	16
TOTAL		159

Q12 Has your property experienced a Winter Storm/Nor'easter more than three times in the past 5 years?

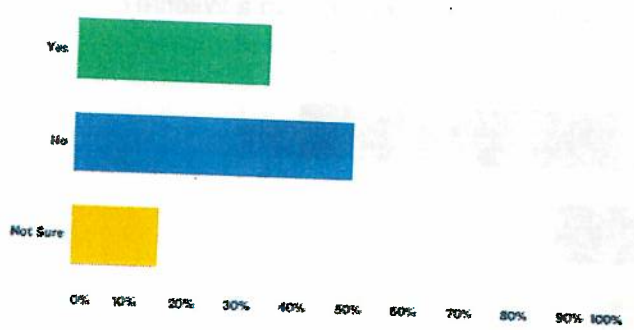
Answered: 148 Skipped: 12



ANSWER CHOICES	RESPONSES	
Yes	56.41%	82
No	23.65%	35
Not Sure	20.95%	31
TOTAL		148

Q14 Has your property experienced a Tornado/Wind Event more than three times in the past 5 years?

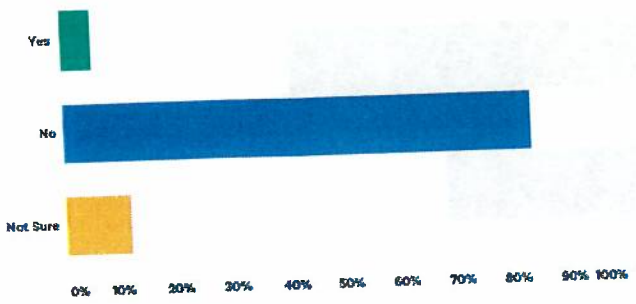
Answered: 148 Skipped: 12



ANSWER CHOICES	RESPONSES	
Yes	34.46%	51
No	50.00%	74
Not Sure	15.54%	23
TOTAL		148

Q17 Has your property experienced an earthquake more than three times in the past 5 years?

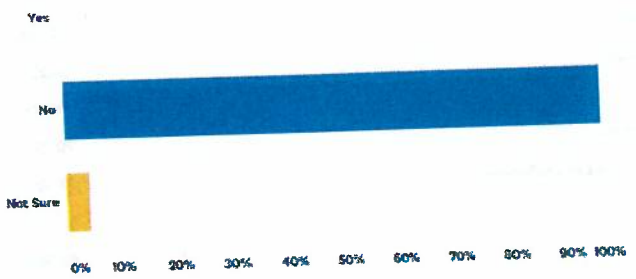
Answered: 148 Skipped: 12



ANSWER CHOICES	RESPONSES	
Yes	5.41%	8
No	83.11%	123
Not Sure	11.49%	17
TOTAL		148

Q18 Has your property experienced a wildfire more than three times in the past 5 years?

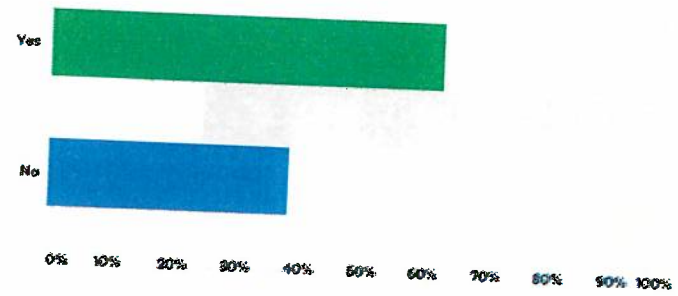
Answered: 150 Skipped: 10



ANSWER CHOICES	RESPONSES	
Yes	0.00%	0
No	96.00%	144
Not Sure	4.00%	6
TOTAL		150

Q20 Have you taken any actions to avoid future damages and loss from natural hazards?

Answered: 117 Skipped: 43



ANSWER CHOICES	RESPONSES	
Yes	62.39%	73
No	37.61%	44
TOTAL		117

What type of property damage do you typically find after a hazard event?

ANSWER CHOICES	RESPONSES	
Architectural feature damage (spires, lintels, cornices, railings)	15.32%	17
Damage to secondary buildings (shed, garage, boat house)	25.23%	28
Damaged Masonry (fireplace, stairs)	24.32%	27
Damaged/rotting wood features (exterior)	30.63%	34
Damaged/rotting wood features (interior)	16.22%	18
Finished (or first) floor flooding	21.62%	24
Loss of vegetation (trees, shrubs, gardens)	70.27%	78
Plumbing, sewer, or septic damages, issues or challenges	27.93%	31
Roof/shingle damage	63.06%	70
Siding/exterior damage	60.36%	67
Soil washout or erosion	66.67%	74
Standing water on property (around buildings)	56.76%	63
Structural or Foundation Damage	33.33%	37
Utility damage (hvac, electrical, natural gas)	36.94%	41
Window/Door damage	28.83%	32

APPENDIX E: FLOOD MITIGATION ACTIONS

Flood Mitigation Action Prioritization and Implementation Table

Mitigation				Prioritization				Implementation			
Action ID	Project Description	Hazard(s) Mitigated	Lead Agency	Life/Safety Impact	Admin/Tech Support	Cost Ranking	Total	Funding Source	Est. Cost	Timeline	Action Category
Ongoing/In Progress Actions (From Previous Plan)											
1	Continue to enforce Subdivision and Land Development Regulations, namely Section 16.115 which prohibits clearing, grading, paving and construction activity in the 100-year flood plain, and Section 16.116 which protects streams, wetlands, and steep slopes from future development.	Flooding	DPZ	2	5	5	12	County Funds	Staff Time	Ongoing	Preventative Measures
2	Continue to enforce the incorporation of State and local storm water management regulations and progressive techniques into all development plans.	Flooding	DPZ	6	5	5	16	County Funds	Staff Time	Ongoing	Preventative Measures
3	Continue to administer the Forest Mitigation Program to establish new forests in parkland and along streams and rivers, to protect against erosion and uprooting trees	Flooding	DRP	2	5	5	12	Forest Conservation Fee in Lieu	Staff Time	Ongoing	Natural Resources
4	Continue to work with property owners to increase vegetation in riparian buffers through the Plant-It-Green program, which consists of supplying free trees to plant adjacent to the streams to reduce velocity of storm water and to stabilize soil.	Flooding	DRP	2	5	3	10	County Funds; Watershed Protection and Restoration Fund; CoastSmart Grant	$50,000-100,000	Ongoing	Public Education and Outreach
5	Evaluate infrastructure on frequently flooded roadways to determine whether the roads/bridges/culverts need to be upgraded to lessen the frequency of flooding. Prioritize projects and seek funding.	Flooding	DPW - Bureau of Engineering, Transportation and Special Projects Division	6	5	5	16	County Funds	Staff Time for County roads; – County conveying information to SHA for State roads	Ongoing /As needed	Structural Projects

Mitigation				Prioritization				Implementation			
Action ID	Project Description	Hazard(s) Mitigated	Lead Agency	Life/Safety Impact	Admin/Tech Support	Cost Ranking	Total	Funding Source	Est. Cost	Timeline	Action Category
6	When beaver dams are identified and located, continue to monitor the dams. Dismantle dams if they pose a flooding threat.	Flooding	DRP	2	5	5	12	County Funds	Staff Time	Ongoing /As needed	Natural Resources
7	Review and reevaluate the existing codes for County retaining walls.	Flooding	DILP	2	5	5	12	County Funds	Staff Time	Ongoing	Structural Projects
8	Assess all county-owned retaining walls to see if they need to be reinforced and prioritize that work.	Flooding	DPW - Bureau of Engineering, Transportation and Special Projects Division	2	5	5	12	County Funds	Staff Time	Ongoing	Structural Projects
9	Evaluate the new FEMA floodplain, including non-structure hazards within 100 feet of the flood zone.	Flooding	DPW SWMD, Department of Technology and Comm. Services	2	5	5	12	County Funds	Staff Time	Ongoing	Preventative Measures
10	Inventory existing culverts that are maintained by the Department of Public Works, Bureau of Highways and create an addressable GIS layer.	Flooding	DPW, Bureaus of Highways; Engineering, Department of Technology and Comm. Services, GIS Unit	2	5	5	12	County Funds	Staff Time	Ongoing	Structural Projects
11	Continue to work on a number of issues related to floodplain identification and mapping risk; responsible floodplain management; and flood insurance. Continue to ensure compliance with the National Flood Insurance Program.	Flooding	DPZ, DPW, DILP	2	5	5	12	County Funds	Staff Time	Ongoing	Preventative Measures

Mitigation				Prioritization				Implementation			
Action ID	Project Description	Hazard(s) Mitigated	Lead Agency	Life/Safety Impact	Admin/Tech. Support	Cost Ranking	Total	Funding Source	Est. Cost	Timeline	Action Category
12	Identify and pursue incentives to mitigate private and public properties from flood hazards through the following techniques: elevation, acquisition/demolition and dry/wet floodproofing	Flooding	OEM; SWMD; DPZ	6	5	5	16	County Funds	Staff Time	Ongoing	Property Protection
New Actions											
13	Ensure reconstruction activities are compliant with NFIP substantial damage/improvement requirements and existing codes.	Flooding	DILP	2	5	5	12	County Funds	Staff Time	Ongoing	Preventative Measures
14	Conduct sampling and analysis of public drinking water supply sources, in flooded areas, immediately after a major (100yr) flood event and issue boil water advisories as needed.	Flooding	Health Dept	10	5	5	20	County Funds	Staff Time	As needed	Public Education and Outreach
15	Notify the public when the County conducts sampling and analysis of public drinking water supply sources to raise awareness for private property owners who may wish to analyze their drinking water.	Flooding	Health Dept; PIO	10	5	5	20	County Funds	Staff Time	As Needed	Public Education and Outreach
16	Assess County-owned flood/channel walls after a major flood inundation event to determine if the structural integrity of any wall may be compromised and recommend repairs as needed to reduce the chances of wall failure.	Flooding	DPW - Transportation and Special Projects	6	5	5	16	County Funds	Staff Time	As Needed	Structural Projects
17	Assess, implement, and maintain stream restoration and bank stabilization techniques on County-controlled property to reduce bank erosion, as needed.	Flooding	DPW SWMD	2	5	5	12	County Funds	Staff Time	Ongoing	Natural Resources
18	Assess the use of environmental site design projects to increase stormwater capacity and public education.	Flooding	DPW/OEM; DPZ; DRP; Office of Community Sustainability	2	5	5	12	CoastSmart Grant; Watershed Protection and Restoration	Staff Time	Ongoing	Public Education and Outreach

Mitigation				Prioritization				Implementation			
Action ID	Project Description	Hazard(s) Mitigated	Lead Agency	Life/Safety Impact	Admin/Tech Support	Cost Ranking	Total	Funding Source	Est. Cost	Timeline	Action Category
								Fund; County Funds			
19	Establish a debris monitoring plan to monitor and remove significant debris blockages to minimize debris accumulation within the county-owned stream channels.	Flooding, Tornado/Wind Storm, Winter Storm/Nor'easter	DPW	2	5	5	12	County Funds	Staff Time	Ongoing	Preventative Measures
20	Integrate relevant flood mitigation considerations from other studies into the overall county flood mitigation strategy as applicable.	Flooding	DPW, OEM	2	5	5	12	County Funds	Staff Time	Ongoing	Preventative Measures
21	Identify all designated historic properties that are located in the County's 100-year floodplains.	Flooding	OEM, DPZ - Hist Pres.	2	3	3	8	MHT; FEMA HMA; County Funds	Staff Time	1-2 years	Preventative Measures
22	Collect structural elevation-related data for historic buildings/structures in the floodplain, including but not limited to, elevation of the first floor, lowest opening, and lowest adjacent grade, and incorporate that data into the appropriate existing County GIS layer(s).	Flooding	DPZ - Hist Pres.	2	3	3	8	County Funds	Staff Time	Ongoing	Preventative Measures
23	Assess the vulnerability historic and cultural resources located in the 100-year floodplain, and determine appropriate mitigation techniques that account for historic integrity, significance, and designation.	Flooding	OEM; DPZ - Hist Pres.	2	3	3	8	County Funds	Staff Time	Ongoing	Preventative Measures

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+MP Adjudication Matrix

CR6-2019

Commenter #	Comment	Treatment
1	The loss of $5,000-$65,000 attributed to industrial to commercial business interruption, for a 500 year. hurricane, seems incorrect (i.e. consider the business interruption costs to APL, and many of the companies in the county if a hurricane strikes). Also, institutional losses aren't explicitly addressed.	Feedback was passed on to the Contractor. Response: "It is important to keep in mind that Hazus is a regional loss estimation tool, and we did not do a site-specific building analysis. When Hazus models a probabilistic hurricane, it analyzes more than 300,000 modeled storm tracks and calculates the losses for all storms that could potentially impact that area. From those modeled storms it calculates losses associated with return periods. What this means is that a 500yr hurricane track might not touch the county at all, so it is not safe to assume that certain blocks or areas would experience significant damage over other areas. – I'll double check the numbers when I return but I'm pretty confident that those are the numbers it reported. Accuracy at the level they suggested can only be achieved through site-specific analysis.
1	In the cost-benefit analysis (e.g. p. 142, 163), I couldn't find a clear identification of benefits and how they are measured, including the time period for computing benefits. This is important for assessing the merits of project strategies, building codes, etc.	The cost benefit analysis is done at the project level which is not covered in this plan. When selecting projects in the future, we will assess the cost benefit on a per project basis when determining viability.
1	Vulnerability curves are crucial to the accuracy and reliability of any risk analysis. However, it seems that no efforts were made to input adequate vulnerability functions (p. 108-109): "Unfortunately for this study, accurate data concerning wind vulnerability is slim. In most instances, this information is not publicly available as private insurance covers wind damage except in the most extreme circumstances".	We have noted that this is an area where we can improve this plan in the future. We have also noted that we should seek to include an insurance industry professional in the stakeholder group in the future as they may have better access to industry data than is publicly available.
1	A lack of information about types of structures in Howard County is mentioned (p. 109, 115). Nevertheless, an accurate assessment of the number and characteristics of the building typologies in the County, especially including a reliable estimate of building value, is crucial for the estimation of loss for any hazard. This was not apparently conducted.	We used NFIP and Hazus data for these estimation functions. We recognize and referenced the limitation on data. This is on the list for future consideration for a more detailed assessment.
1	It's not immediately clear why the hurricane risk with an estimated average annual loss (AAL) of $9.8M is ranked 3 (Table 5.20 and 5.21 p. 119), while flood with a lower AAL = $4.4M (Hazus projection), is ranked 1.	The ranking includes more than the annual loss estimation. You can find more data about the methodology used in our Hazard Identification and Risk Assessment on ReadyHoCo.com

1	There's a potential inconsistency in the analysis of Hurricane Hazel (p. 117)? Hazel exhibits a maximum gust of 94 mph with a loss of $228M. The return period for gusts of 94 mph are between 100-300 years (ASCE 7-16). However, the loss calculated for the 500-year hurricane is $105M, which is half to that of Hazel (table 5.14, p. 115). The inconsistency should be addressed.	Feedback was passed along to contractor: As for the Hazel vs 500yr comparison, it is important to look at the areas being impacted by the wind. Peak winds do not mean peak damage, especially if those winds are in less populated areas, or areas with more wind-resistant buildings. Factors such as terrain and tree populations also play into the loss calculations. Hazel was also not modeled as a return period event, it was modeled as a historic storm using the actual tract of the system and wind speeds. I don't believe it is an appropriate comparison against a probabilistic 500yr storm for the reasons described above. I'll double check these results as well.
1	It seems that the report underestimates the potential devastation that could be caused by hurricanes on Howard County.	Noted, however, we used the most reliable data available to us given timing and budget constraints.
1	The report would benefit from providing an executive summary at the outset which includes e.g. statement of problem, objectives, methodology, timeline, criteria for cost/benefit analysis, findings, recommendations, etc. This would help readers to get an overall picture of the problem at the outset. As it is now written, it's very confusing. Pages 13-20 should be in an Appendix.	This plan must meet a strict set of federal standards in order to be accepted at the State and Federal levels. As such we chose to organize the plan in this manner as it is a best practice (as demonstrated by federal pre-approval on first review). However, an executive summary may be a good thing to add on the webpage where the document will be posted.
1	It'd also be helpful to include metrics of the economic performance of 2012 HMP (p.44) and the goals set.	We will note this and have our Stakeholder group discuss further at our annual review.
1	In p. 55, it's mentioned that $50M in losses only from 1950-2018, is this in 2018 dollars?	This is a total amount only, no calculation has been conducted for inflation. Included statement on this in the section.
1	The paragraph in p.57 may convey the idea that floods are disasters, while they're not if there's no exposure affected and also that flood-caused disasters are the costliest, but they are not, e.g. compared with hurricanes and tropical storms: see https://www.iii.org/fact-statistic/facts-statistics-us-catastrophes	The wording conveys the serious nature of flooding. It does not reference flooding being the costliest disaster.
1	The last paragraph in p.57 seems incorrect, "Riverine flooding generally occurs over a period of days or weeks. This type of flooding is what is generally referred to as the 100-year flood." The return period of a flood is the inverse annual probability of occurrence of an event.	The reference here was to denote that the "x"-year flood nomenclature generally refers to riverine flooding, not flash flooding. We will consider clarifying this in our annual review.
1	Are there statistics, or a reference to substantiate the statement in p. 67: "Winter storms are prevalent on a yearly basis for the County, but significant improvements to building codes, maintenance to structures, and weather forecasting has dramatically decreased the threat to people and property."?	We will discuss this further with the contractor.

1	Page 75 reads "Hurricanes, tropical storms, and typhoons are collectively known as tropical cyclones." But, hurricanes and typhoons are the same weather phenomenon.	Typhoons was removed
1	Page 80: "A downburst, or a sub-set of thunderstorms" is not clear.	A two sentence description of a downburst was added provide description.
1	Page 93: "The likelihood of significant earthquake damage in Howard County is low since the probability of the area being stricken by an earthquake is relatively low as compared to other parts of the country." Moreover "Because of the very low risk associated with this hazard, a simple risk assessment was completed for earthquakes". The explanation in this paragraph doesn't seem enough to justify a simple risk assessment. A more careful analysis must be presented, probably the analysis of a hypothetical event could be useful for planning and decision making.	The analysis of earthquakes was done as part of the Hazard Identification and Risk Assessment available at ReadyHoCo.com
1	Page 97: it may be helpful to provide a defined (quantitative?) definition of impact in order to inform the mitigation plan, e.g. in terms of severity, timeframe, etc.	Impact is defined in the HIRA if you could just copy from that and add it here that would be great. See page 100 for risk/impact scoring tool.
1	Page 107, "For Howard County, the most significant potential effect of hurricanes and tropical storms is flooding.", but wind from severe storms or hurricanes must not be neglected.	Noted
1	Page 107: a reference is needed to substantia the statement: "the occurrences of tornados is increasing".	Citation added
1	Page 108: "The overall low probability of severe wildfires in the region indicates the County is not particularly vulnerable to this hazard." Was it determined whether there are specific "pockets" in the County where this hazard could be potentially more significant?	This will be discussed further at our annual review to see if that information is available.
1	Page 111: It is not immediately clear how the "average annual flood claim" was computed; more detail on the methodology, including the discount rate assumed, should be provided.	The explanation for AAFC is at the top of Page 112. Other points to be noted for annual review.
1	The report rightly states that "a detailed site-specific risk assessment should be conducted using information such as structural characteristics, physical surroundings, and occupancies" I can help in this task.	Noted.
1	The plan for ensuring public participation with news release and summaries of the public meetings presented (p. 185), is mostly one directional and thus tends to be limited. Given the strategic goal of "integrating community to planning efforts" a lot more could be done in terms of engaging the steering committee and community to capture their needs and preferences.	Noted. It is a goal to incorporate more active participation from the community in future planning efforts.

1	In the Strategic Plan (pp. 129-130), goal 4 calls for a platform to integrate plans and include other stakeholders in the process. The methodology of Shared Vision Planning (SVP) is well suited to be such a platform. Among other features, SVP conducts running virtual exercises, which are simulated emergencies where, say the steering committee and other county officials, must respond to "virtual emergencies" and plan building becomes a practice exercise that allows the key stakeholders to work together prior to emergency. It keeps plans and people afresh on what to do in an emergency as well as meeting the goals of "integrating", synchronizing "appropriate departments, stakeholder agencies, and jurisdictions", holding "formal training and exercise program", and improving the functions of the various departments (EOC and DOC) that are activated when emergency strikes.	Noted.
2	Page 40: AirTran no longer operates as an independent airline. It was acquired by Southwest and ceased operations at the end of 2014. It might also be useful to mention BWI's capability to service relief flights in the event of catastrophe.	Accepted. Contractor was asked to remove AirTran
2	Page 40-41: The reliance (some might say over-reliance) of the county's residents on automobile transportation could be highlighted. In the event of an areal disaster such as an earthquake or hurricane, this could be a significant issue, and preplanning of methods for managing traffic and keeping supply routes open might be worthwhile.	Agreed. This over-reliance, and the planning for it are dealt with in the Emergency Operations Plan and the Howard County Evacuation Plan
2	Page 89: Should include the lightning strike/fire/firefighter LoD fatality in Clarksville in 2018	Comment was not incorporated - the LoD fatality is still under investigation
2	Page 99: Should update risk score for flooding based on 2018 data and NOAA/NWS predictions of increased frequency of heavy rainfall events here. Also, the likelihood of a word case earthquake may be significantly overestimated. A score of 1-2 might be more appropriate.	Noted. The HIRA is being updated in 2019.

2	From a natural disaster perspective, the potential impact of severe flooding that leads to a failure of the Rocky Gorge dam (or a cascading event resulting from the failure of the Brighton Dam) on Scaggsville and North Laurel should be at least mentioned, and mitigation should include enhanced plans for mutual aid given that Prince George's County and Anne Arundel County will be dealing with their own catastrophic impacts from such an event. The Centennial Lake, Lake Elkhorn, and Wilde Lake dams might deserve similar consideration. The Liberty Reservoir dam, although not in the County's jurisdiction, needs to at least be monitored during severe events as a failure could result in catastrophic flooding in Ellicott City with very little notice—mitigation could incorporate ties to IPAWS and the planned emergency warning system. Unexpected failures of reservoir containment have led to significant issues downstream in other jurisdictions; since these can be triggered by areal flooding, mitigation measures should therefore be considered in this plan. Prior risk assessments of dams themselves have not always been predictive.	Dam failure is a man-made hazard and doesn't fall under the Natural Hazards Mitigation Plan. Is addressed in the Hazard Identification and Risk Assessment, and will be covered under the Man-Made Hazard Mitigation Plan that will be developed in 2019
2	I didn't see a mention that some natural disasters can cascade into issues with hazardous materials. An inventory of significant hazmat sites and preplanning for hazmat issues in the face of natural disasters should be incorporated into mitigation planning. We may not have the level of issue that the Gulf Coast experienced this summer, but it needs to be considered.	Hazardous Materials Release/Spill is a man-made hazard and doesn't fall under the Natural Hazards Mitigation Plan. Is addressed in the Hazard Identification and Risk Assessment, and will be covered under the Man-Made Hazard Mitigation Plan that will be developed in 2019. Responding to Haz Mat hazards is covered in our Emergency Operations Plan
2	A mitigation action that should be considered beyond ReadyHoCo Outreach is the prior establishment of a force of vetted volunteers (Volunteers in Public Service or similar program) who can provide a basic level of support in areas such as first aid response, traffic management, collection delivery of donated relief supplies, coordination of debris removal, supplementary communications, and other needs in order to reduce the strain on the County's resources. The past two flash floods in Ellicott City have seen effective and well-intentioned groups arising spontaneously, but preplanned coordination with County resources would make them even more effective.	Agreed that Volunteer & Donations Management is important. This is currently a part of our Emergency Operations Plan and our Recovery Plan. We do not view volunteer management to be a mitigation function, instead we view it as a response/recovery function and have addressed it in those plans.