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Section 2
Executive Summary

On October 30, 2000, the President signed into law the Disaster Mitigation Act of 2000, also known as DMA2K. Among its other features, DMA2K established a requirement that in order to remain eligible for federal disaster assistance and grant funds, local and State governments must develop and adopt Hazard Mitigation Plans (HMPs). On February 26, 2002, the Federal Emergency Management Agency (FEMA) published an Interim Final Rule (IFR) that set forth the guidance and regulations under which HMPs are to be developed. The IFR provides detailed descriptions of both the planning process that States and localities are required to observe, and the composition of the HMP itself. The original version of the County HMP was approved by the Maryland Emergency Management Agency (MEMA) and FEMA in 2005, and was subsequently adopted by the Anne Arundel County Council. The IFR related to mitigation planning specifies that local jurisdictions must update their HMPs every five years. This document represents the County's second update.

Hazard mitigation is defined as any substantial action taken to reduce or eliminate the long-term risk to human life and property from the effects of natural hazards in a community. This 2018 HMP update consisted of a comprehensive evaluation of the HMP, including hazard profiles, risk assessment, mitigation goals, strategies, mitigation projects; local comprehensive plans, development, zoning, and construction codes; and studies, reports, policies, programs, and standard practices that support local hazard mitigation efforts.

Contact information for the Anne Arundel County Government official submitting this Hazard Mitigation Plan update is:

Anne Arundel County Office of Emergency Management
Henry L. Hein Public Service Building
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Glen Burnie, MD 21060
Telephone: 410.222.0600

2.1 How the Plan is Organized

The 2018 version of the Anne Arundel County HMP follows the structure provided in the Interim Final Rule [IFR]. The HMP has nine sections and six Appendices (A-F).

Section 1	Table of Contents
Section 2	Executive Summary
Section 3	Background
Section 4	Approval and Adoption
Section 5	Planning Process
Section 6	Hazard Identification, Profiling, and Ranking
Section 7	Risk Assessment
Section 8	Mitigation Strategy
Section 9	Plan Monitoring and Maintenance
Appendix A	National Flood Insurance Program Claims Data and Maps
Appendix B	Mitigation Planning Committee Meeting Minutes
Appendix C	Public Notice Documents and Meeting Minutes
Appendix D	Adoption Resolutions for Anne Arundel County and Highland Beach
Appendix E	FEMA Approval Letters
Appendix F	Key Terms
Appendix G	Anne Arundel County High Risk Area Flood Maps

There are references to the Interim Final Rule (IFR) throughout the updated document. Where possible, these provide specific section and subsection notations to aid the review process.

2.2 Background Information on the Plan

The purpose of the 2018 HMP update is to establish priorities and actions that reduce or eliminate long-term risk to human life and property through an assessment of commonly recognized natural hazards affecting the County; the development of mitigation actions and projects to reduce potential losses from future disasters in the community; and the establishment of a coordinated process to adopt and implement hazard mitigation goals, strategies, and actions through local comprehensive planning and practices which meets the needs of the community. This document includes the type, location, extent and future probability of natural hazards affecting Anne Arundel County; a risk assessment that describes the potential for damage and future losses to human life, property, and critical infrastructure; a set of goals, objectives, strategies and actions that will guide the County in adopting local ordinances and policies to reduce future risks and potential losses from natural hazards in the community; and a detailed plan for implementing, monitoring, and updating the HMP. The 2018 HMP update focuses on the natural hazards that pose the greatest risk and potential for damages and losses to human life, property, and critical infrastructure in the County. These hazards are riverine and coastal floods, hurricane winds, tornadoes, and winter storms. The 2018 HMP update provides additional data on other types of natural hazards that have the potential of affecting the County including dam failure and release, severe thunderstorms and hail, extreme heat, drought, earthquake, and erosion. To narrow the focus of the 2018 HMP update, the Hazard Mitigation Planning Committee (HMPC) performed a numerical hazard ranking process to identify the natural hazards of greatest concern. The results of the hazard ranking analysis are shown in Table 6.4-1.

2.3 Hazards and Risks

Hazards

Sections 6 and 7 of this HMP update include a detailed description of the process that was used to assess and prioritize Anne Arundel County's risks from natural hazards, quantitative risk assessments for the County as a whole, and more detailed assessments for certain asset classes. The most recent prior (2012) HMP update process identified twelve hazards that the HMPC determined should be included in the initial hazard identification and risk assessment. These are carried over to the present 2018 HMP update. These hazards include:

1. Riverine flooding
2. Coastal flooding
3. Dam failure and release
4. Hurricane, tropical storm and nor'easter
5. Drought
6. Earthquakes
7. Extreme heat
8. Severe thunderstorm and hailstorm
9. Severe winter storm
10. Tornado
11. Wildfire and urban interface fire
12. Erosion

For each of these hazards, the profiles in Section 6 include:

- Description of the Hazard
- Location and Extent of the Hazard
- Severity of the Hazard
- Impact on Life and Property
- Occurrences of the Hazard

Risks

Risk is a numerical calculation of potential future damages. Although the range of events from erosion to winter storms all have some potential to affect the County, the hazard ranking determined that the flood, hurricane wind, tornado and winter storm hazards would be included in the more detailed risk assessment in Section 7 because of either their prevalence and/or potential to cause greater damage and losses. See Section 6.4 for additional details about the criteria used to rank each hazard and the complete results of the hazard ranking. Section 7 includes details about calculation methodologies and results of the risk assessment, which are summarized in Table 2.3-1.

Table 2.3-1
Summary of Anne Arundel County Flood, Hurricane Wind, Tornado and Severe Winter Storm Risks by Asset and Hazard Type (100-year horizon)

Asset	Hazard	Risk (100-year horizon)
Residential Repetitive Loss properties	Floods	$2,039,989
Most built assets; populations	Hurricane wind (physical damage)	$464,470,004
Most built assets; populations	Tornado wind (life safety)	$23,528,949
Many built assets; infrastructure	Severe Winter Storm	$9,934,091

2.4 Summary of Goals, Objectives, Strategies and Actions

Section 8 of this document describes Anne Arundel County's priorities for mitigation actions. The section prioritizes the actions, describes the funding required, potential sources of funding, and the estimated timing of the action. The section also includes the County's hazard mitigation goals, objectives, and strategies.

Anne Arundel County's Hazard Mitigation Goals

1. Protect residents and minimize loss of human life and damage to property from natural hazards affecting the County
2. Increase public awareness to hazard mitigation and natural hazards affecting the community
3. Build community resilience through the adoption of building, construction, and development standards for existing and new development and critical infrastructure
4. Build local capacity and commitment to adapt to the natural hazards and changing conditions affecting the community
5. Prioritize funding for hazard mitigation projects that maximizes the investment of County funded projects in high risk areas or for multi-hazard projects
6. Reduce the potential impact of natural disasters on the County's historic assets
7. Reduce the potential impact of natural disasters on the County's natural systems

Objectives and Strategies

Objectives are well-defined intermediate points in the process of achieving goals. Strategies are specific courses of action to achieve the objectives. Anne Arundel County mitigation planning objectives are found in Section 8.3 *Mitigation Objectives and Strategies.*

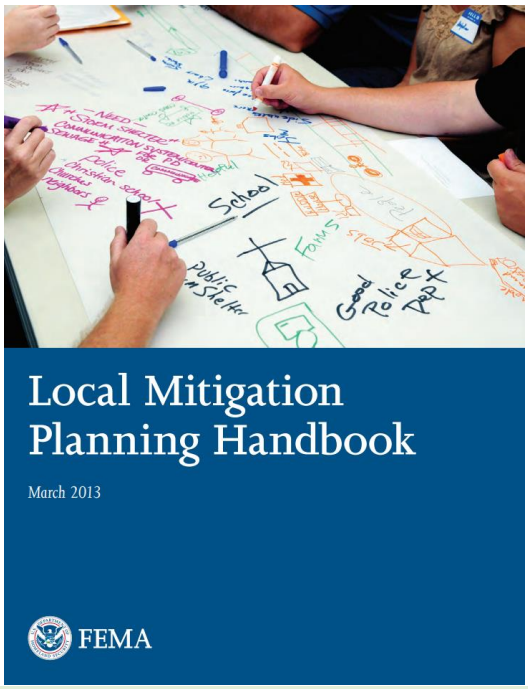
Action Items for the Anne Arundel County

The 2018 Mitigation Action Plan was updated to reflect the County's current priorities for specific activities to achieve the seven goals. The fourteen Action Items included in the HMP update are described in Section 8.4, and listed in Table 8.4-2. This part of Section 8 includes information about the parties responsible for implementing the actions, and about potential sources of funding for mitigation activities. This section also integrates specific hazard mitigation projects that have been identified and scoped in accordance with the requirements of the STAPLEE criteria. The 2018 HMP update process included a detailed review of the Action Plan and County mitigation strategies. The section incorporates and highlights changes in these HMP elements.

2.5 The Planning Process

Section 5 provides details about the process that was used to develop this HMP update. The process closely followed the guidance in the FEMA "386" series of planning guidance, which recommends a four-stage process for developing mitigation plans.

1. Organize the Planning Process and Resources – This step focuses on assembling the resources needed for a successful mitigation planning process. This includes securing technical expertise, defining the planning area, and identifying key individuals, agencies, neighboring jurisdictions, businesses, and/or other stakeholders to participate in the process. This step includes ensuring opportunities for the public to comment on the plan.



2. Assess Risks and Capabilities – This step identifies the characteristics and potential consequences of hazards, including what hazards might impact the planning area, and what people, property, or other assets may be vulnerable County and jurisdictional capabilities for reducing risks are evaluated, and potential gaps are identified. The following areas are examined: planning and regulatory; administrative and technical; financial; and education and outreach.

3. Develop a Mitigation Strategy – The County develops priorities and long-term strategies for avoiding or minimizing the undesired effects of disasters. The mitigation strategy addresses how the mitigation actions will be implemented and administered.

4. Adopt and Implement the Plan – This step is focused on how the County will implement various aspects of the plan, specifically mitigation projects and strategies. This step also establishes a plan review and maintenance process that ensures the plan remains a "living document", i.e. that it is relevant and useful to planners to decisions makers, and that it continuously reflects natural hazard risks to the jurisdictions.

2.6 Approval and Adoption Processes

Section 4 discusses approval and adoption of the updated HMP. The Anne Arundel County Council was responsible for approving and adopting the 2018 version of the document. The Council reviewed and approved the HMP update on INSERT DATE WHEN KNOWN. Because it is a separate, incorporated jurisdiction, the Town of Highland Beach was responsible for separately adopting the HMP. The Town adopted the updated document on INSERT DATE WHEN KNOWN.

2.7 Implementation Process

The implementation process is described as part of the specific actions in the Mitigation Strategy section.

2.8 Monitoring and Updating the Plan

Section 9 (Plan Monitoring and Maintenance) describes the schedule and procedures for ensuring that the HMP stays current. The section identifies when the HMP must be updated, who is responsible for monitoring the document and ensuring that the update procedures are implemented. This section provides a combination of cyclical dates (oriented toward FEMA requirements) and triggering events that will initiate amendments and updates to the HMP. A representative from the Anne Arundel County Office of Emergency Management (OEM) is responsible for monitoring the document and initiating the periodic update process.

Section 3
Background

Contents of this Section

3.1 Introduction

In the year 2000, the U.S. Congress passed legislation known as the *Disaster Mitigation Act of 2000.* Also called *DMA2K,* the legislation established a requirement that jurisdictions nationwide must develop and implement natural Hazard Mitigation Plans in order to remain eligible for various FEMA grant programs, including those that provide funding for hazard mitigation projects. In 2004, FEMA and the Maryland Emergency Management Agency (MEMA) provided Anne Arundel County a grant to develop its first mitigation plan, or HMP. The 2004-2005 version of Anne Arundel County's HMP established the County's long-term strategy for reducing its risks from natural hazards. The first version of the HMP was approved by MEMA and FEMA on December 7, 2004. On August 18, 2009, those same agencies again provided grant funds for Anne Arundel County to update its Hazard Mitigation Plan. The first HMP update was adopted by the County and approved by MEMA and FEMA in November 2012. In 2017, FEMA again provided the County with a mitigation program grant to support the HMP update process. This document represents the result of that effort.

3.1.1 Scope of the Plan

The original Anne Arundel County HMP was an effort on the part of the County to develop an all-hazards Countywide approach to disaster damage (risk) reduction. The County employed a FEMA-approved process to identify and assess all potential hazards that may affect the community and develop an Action Plan to address those hazards and the long-term risks they create.

The 2018 update process entailed a complete review of the 2012 version of the document, modifying and updating parts of each section as appropriate.

3.2 Anne Arundel County Government Organization and Objectives

3.2.1 Local Government

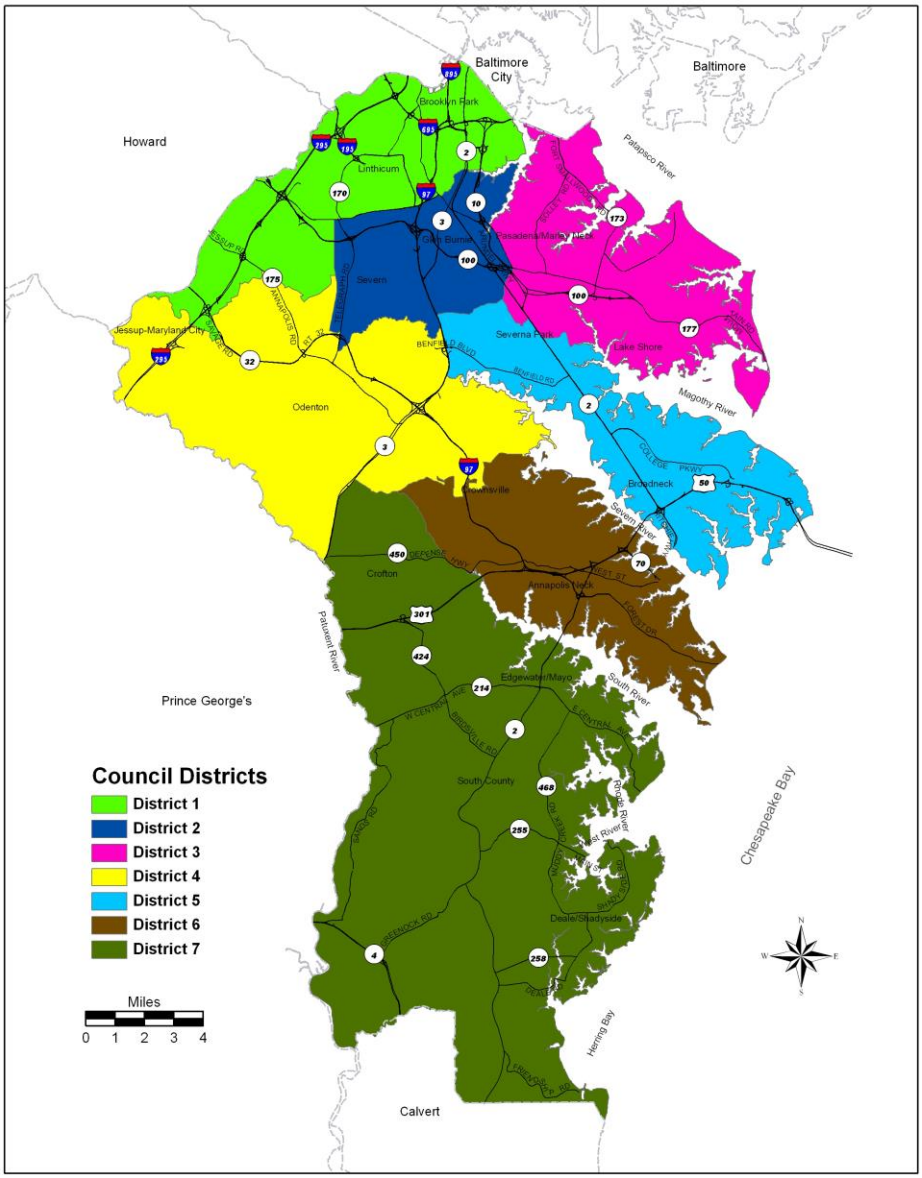
Since 1964, Anne Arundel County has had a charter form of government in accordance with State law. The County government is composed of a legislative branch, known as the County Council, and an Executive branch that is headed by the County Executive. The County Executive oversees the Executive branch of the government, which consists of various offices and departments. The Executive branch is charged with implementing County law and overseeing the operation of the County government. The County Executive is elected every four years and is limited to two terms.

- ### 3.2.2 County Council and Councilmanic Districts

The Anne Arundel County Council is the elected legislative body of the county and is vested with lawmaking power. The County Council may enact public local laws or ordinances for the County, and is authorized to repeal or amend local laws. The County Council may also provide for the enforcement of all ordinances and resolutions adopted by fines, penalties, and imprisonment, within the limits prescribed by law. The County Council, as the legislative branch, adopts ordinances and resolutions, and has all of the County's legislative powers. The County is divided into seven councilmanic districts, each of which elects a representative to the County Council (see Figure 3.2-1). The County Council has the exclusive power to enact, repeal, and amend all local public laws. Legislation must take the form of ordinances, most of which are subject to Executive veto. Five Council votes are necessary to override an Executive veto. The Council may also draft resolutions, which are not subject to Executive veto and may only be temporary or administrative in nature.

The Anne Arundel County Charter provides rules and procedures for the Anne Arundel County Council. The Anne Arundel County Charter requires the Council Chair to schedule a public hearing within 7 days for any new legislation, and the Anne Arundel County Council may not adopt any legislation until a public hearing is held. The legislative process provides an additional opportunity for public participation and input on the 2018 Hazard Mitigation Plan update once the legislation has been introduced to the Anne Arundel County Council. OEM will request to receive documentation of any public comments received during the public hearing, and will incorporate any key revisions to ensure the final Hazard Mitigation Plan meets the needs of the community. Any revisions will be submitted to MEMA and FEMA for final review and approval before the legislation is adopted.

Figure 3.2-1
Anne Arundel County Council Districts
Source: aacounty.org



• 3.2.3 Planning, Regulatory, and Technical Partners

The County identified the Planning, Regulatory and Technical partners and stakeholders based on their expertise and authority to adopt local ordinances, regulate development, implement mitigation strategies, and provide technical guidance throughout the planning and update process of the Hazard Mitigation Plan (HMP). The Planning, Regulatory, and Technical partners and stakeholders also have authority to expand existing policies and programs to achieve the mitigation strategies identified in the 2018 HMP update, and

work collaboratively at the local and regional level to adopt and implement mitigation strategies that complements and supports one another to meet the overall hazard mitigation needs of the community.

The Planning, Regulatory, and Technical partners and stakeholders having the expertise and authority to adopt ordinances, regulate development, expand upon existing policies and programs, provide technical guidance, and implement best management practices for the mitigation strategies and actions identified in the 2018 HMP update include:

The **Office of Planning and Zoning (OPZ)** is responsible for planning the physical growth and development of Anne Arundel County. OPZ is responsible for updating and revising the general development plan (GDP); updating the rules governing subdivision and development of property; reviewing and revising the zoning laws that regulate use of property; and administering the County's subdivision code and the zoning ordinance. OPZ is dedicated to managing Anne Arundel County's development in an efficient and equitable manner, balancing the interests of diverse parties. OPZ provides information to the public concerning the planning and development activities within the County. OPZ works in partnership with the Department of Inspections and Permits and Department of Public Works to operate the Customer Service and Intake Center. OPZ is also involved in many other planning activities that assist in implementing the adopted policies of the General Development Plan. These activities include participation in the planning and update of the Anne Arundel County Master Plan for Water Supply and Sewerage Systems (WSMP), the Anne Arundel County Transportation Plan, and in the revitalization of older communities. The Planning Advisory Board (PAB) is a charter mandated body consisting of seven citizens responsible for reviewing and advising OPZ on all county plans and making recommendations on the capital budget, OPZ policies and program development. OPZ is also responsible for administering programs to protect County resources. These programs include the Historic & Archaeological Resource Program and the Critical Area Program. The programs are responsible for historic and archaeological site review prior to development, and regulatory tasks to administer Critical Area compliance.

The **Department of Inspections and Permits** provides the citizens of Anne Arundel County with the highest inspection standards consistent with the adopted codes and regulations. Their work is accomplished through the consistent and equitable application of regulations in the built and natural environment, through plans review, inspections, enforcement, and the issuance of permits and licenses. The County is a participant in the National Flood Insurance Program (NFIP) and has adopted a local ordinance to manage development and minimize future flood damage on properties within the 100-year floodplain. The Department of Inspections and Permits is responsible for administering and implementing both the Building and Construction Code and the Floodplain Management program for the County. The Department of Inspections and Permits uses both the Building and Construction Code and FEMA floodplain maps to review applications and ensure development within the floodplain meets the local building standards and the local floodplain program requirements. More information about the County's Floodplain Management Program can be found in Section 5.5 in Other Local Planning Mechanisms.

The **Department of Public Works (DPW)** is responsible for updating the Anne Arundel County Master Plan for Water Supply and Sewerage Systems (WSMP). The WSMP serves as an important and effective document, addressing and implementing the goals and policies of the County's General Development Plan, documenting existing water resources and wastewater treatment capacities, identifying needed mechanisms to meet future demand and guiding development within the County by setting the criteria for which public and private water and sewer services are provided. The WSMP reflects the land use policies of the 2009 GDP, Small Area Plans, Town Center Plans and related planning policies. DPW is comprised of 4 Bureaus:

Bureau of Engineering, Bureau of Highways, Bureau of Utility Operations, and Bureau of Waste Management Services. The Bureau of Engineering is responsible for the design, support, and oversight of construction projects within the County's Capital Improvement Program and engineering support for the Watershed Protection and Restoration Program. Capital projects include roadway upgrades, solid waste facilities, landfill infrastructure, police and fire infrastructure, stream restorations, and other stormwater management infrastructure. The County's CIP is a 5 year program that consists of over $2 billion in capital projects that includes roadway upgrades, solid waste facilities, landfill infrastructure, police and fire infrastructure, stream restorations, and other stormwater management infrastructure. The Bureau of Highways manages, operates, and maintains the County's road infrastructure in a productive, efficient and environmentally responsible manner, providing high quality service to the citizens of Anne Arundel County. The Bureau of Highways is responsible for all maintenance activities associated with the County's 6,851 roads or approximately 1,815 centerline miles of the County's roadway system. The Bureau of Utility Operations provides customers with the highest quality services at the lowest possible cost by being environmentally responsible, safe, efficient, and cost effective. Each year, the Bureau produces, treats, and safely delivers nearly 12 billion gallons of public water to more than 119,230 properties and collects and treats 13 billion gallons of wastewater from our 127,453 customers. The Bureau of Waste Management Services is responsible for the curbside collection of trash and recycling for more than 165,000 customers, and the management, maintenance, oversight, and preservation of the Millersville Landfill. Waste Management Services also oversees the Northern, Central, and Southern recycling centers, as well as special programs like Household Hazardous Waste events and Special Collections.

3.2.4 Administrative, Financial, and Outreach Partners

The County identified the Administrative, Financial, and Outreach partners and stakeholders with expertise and authority to support hazard mitigation planning throughout the planning and update process. The Administrative, Financial, and Outreach partners and stakeholders work collaboratively with the Planning, Regulatory and Technical partners and stakeholders at the local level to implement mitigation strategies to meet the overall hazard mitigation needs of the community.

The Administrative, Financial, and Outreach planning partners and stakeholders with the expertise and authority to support hazard mitigation activities include:

The **Office of Law** provides all legal services for the County. The Office of Law provides legal services to all County offices, departments, boards, commissions, and agencies; and the County Council; drafts and facilitates local legislation to adopt local ordinances that regulate development, and assists County departments and agencies in implementing and enforcing mitigation strategies, and to expand existing policies and programs to implement best management mitigation strategies of the HMP. The Office of Law issues advice and opinions on legal questions affecting the interests of the County. It reviews all deeds, bonds, contracts, and other legal papers involving the County's interests. The Office handles civil litigation in which the County or its officers and employees are involved.

The **Office of Central Services** is responsible for Administrative Buildings, Libraries, Police and Fire Stations, Senior Centers, and Health Centers throughout the County. One of their primary functions is to assist County Agencies in their procurement activities for goods and services. The Fleet Administration is responsible for vehicle maintenance of Police vehicles, ambulances, Fire Trucks, Senior Citizen vans, dump trucks, and snow plow equipment. Risk Management services the County's insurance needs, handles all claims, sets workplace safety standards, and works with commercial markets for all other coverage.

The **Public Information Officer** (PIO) is the lead media contact. The PIO serves as a liaison between the media and Anne Arundel County Office of Emergency Management to provide concise and accurate information to the public through the news media and other mechanisms. The PIO coordinates and serves as the primary point of contact for all media releases from the Office of Emergency Management and the Emergency Operation Center. The PIO develops and disseminates complete, accurate, and consistent information about life safety procedures, public health advisories and emergencies, relief and assistance programs, and other vital information to the community in affected areas. The PIO coordinates messaging with other County and non-County Public Information Officers.

3.2.5 Incorporated and Unincorporated Jurisdictions

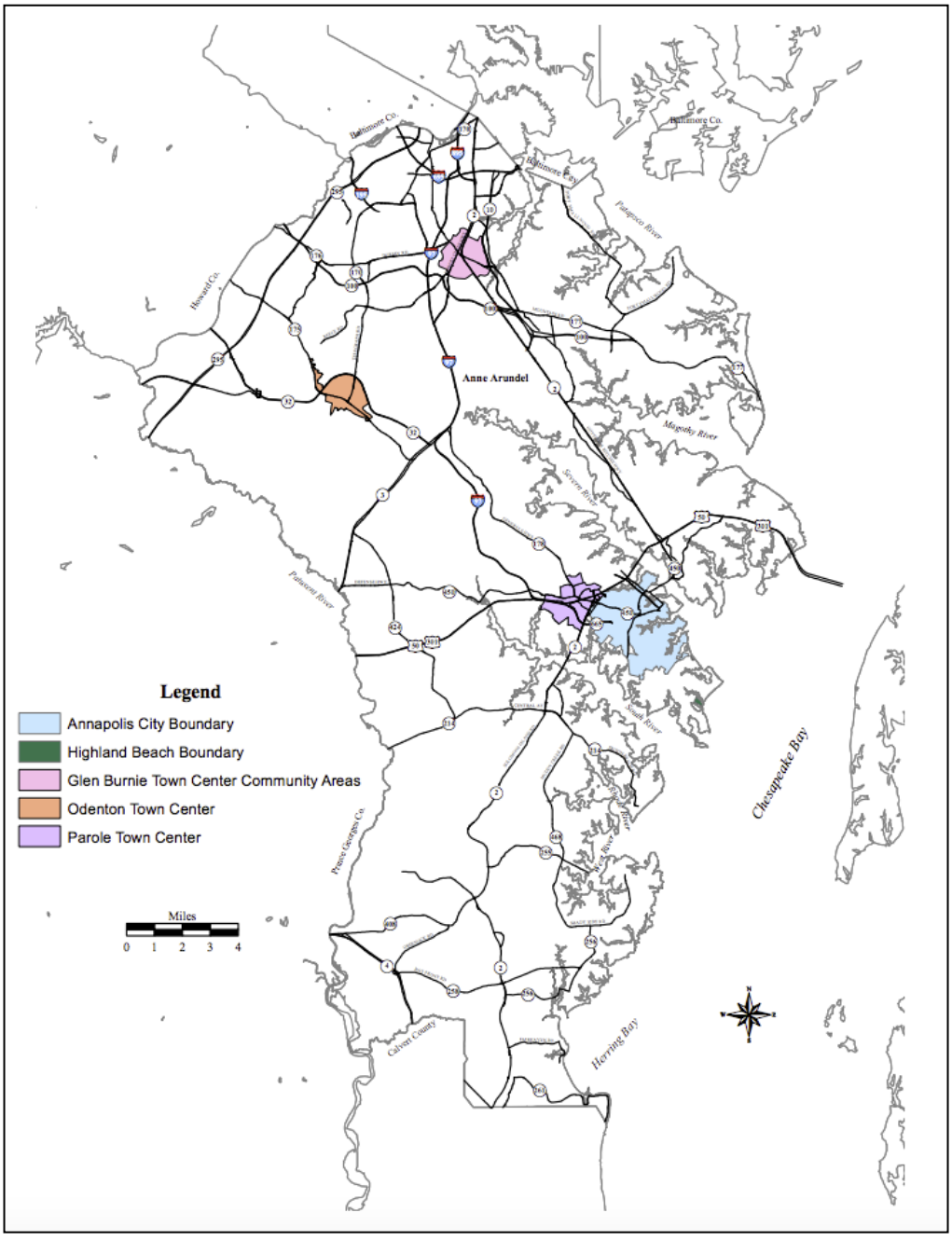
There are only two incorporated communities within Anne Arundel County. These are Annapolis and Highland Beach. Annapolis has independent land use authority and has developed and updated its own HMP. Highland Beach is included in the County HMP.

The **City of Annapolis (the City)** is a municipal body that has the power to execute municipal functions within the boundaries of the City of Annapolis, Maryland. The City has the authority to adopt local ordinances, regulate development, and implement mitigation strategies that are independent of Anne Arundel County (the County). The City and County have the ability to coordinate and integrate efforts when support or resources are needed to respond or recover from a disaster or a declared local, regional, or national civil emergency. The relationship between the coordination of efforts between the City and the County is further outlined in the Emergency Operations Plan, Basic Plan and Emergency Support Functions (ESFs), of the Anne Arundel County Office of Emergency Management, 2019 Edition.

Highland Beach has zoning authority only. The community has a Commission that performs reviews for compliance of established zoning standards such as the appearance of a structure, setbacks, and improvement of roads. In all other matters, the County is the primary agent. Highland Beach is subject to County coastal floodplain and grading requirements. The County is responsible for issuing and reviewing permits. Because the County is primarily responsible for the types of structures and the location of those structures, as well as enforcing County standards, it is the County's position that this HMP is sufficient to cover Highland Beach. Therefore, as an incorporated jurisdiction in Anne Arundel County, the Town of Highland Beach must also approve the updated HMP with its own resolution.

In addition, a number of entities within the County are commonly perceived to be independent areas such as Parole, Glen Burnie, and Odenton. These are in fact unincorporated entities for which the County provides services (See Figure 3.2-2).

Figure 3.2-2
Anne Arundel County Incorporated Jurisdictions and Unincorporated Town Centers



3.3 Background Information about Anne Arundel County

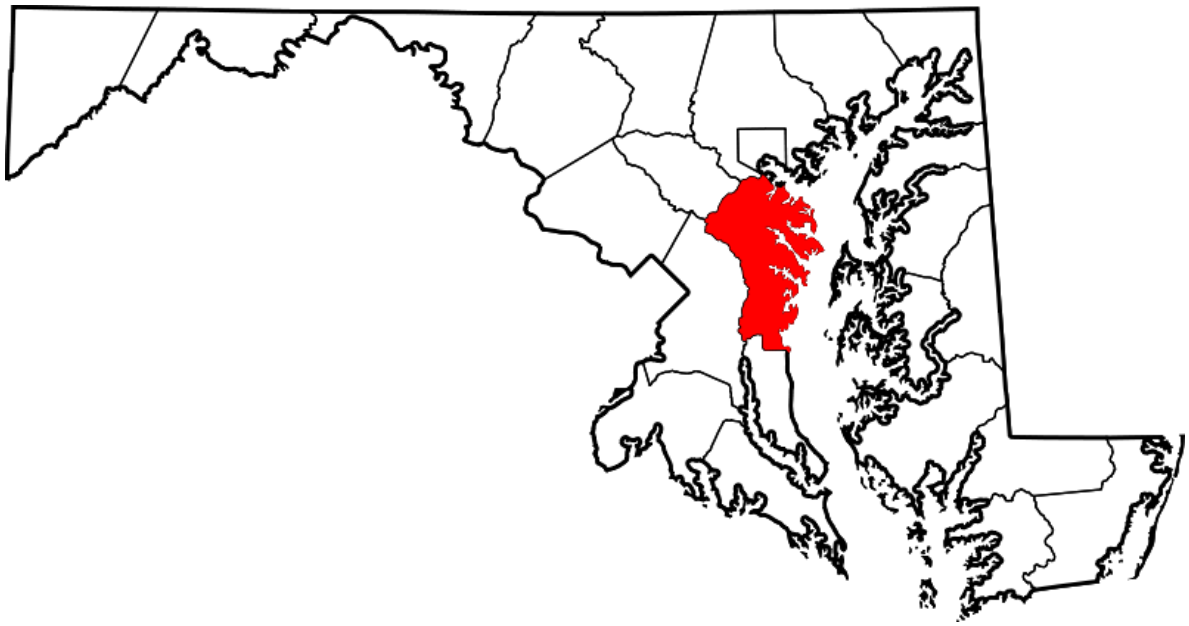
Prior to addressing the natural hazards to which Anne Arundel County is exposed, this HMP presents a brief overview of the jurisdiction, describing its geography, history, climate, transportation, community assets, and population and growth.

3.3.1 Geography

Anne Arundel County is located on the western shore of the Chesapeake Bay. The County's 533 miles of shoreline constitute more coastline than any other part of Maryland. According to the U.S. Census Bureau, the County has a total area of 588 square miles. Of that, 416 square miles is land and 172 square miles is water.

The elevation of the County ranges from sea level in the eastern portion of the County to 317 feet in the western part. Over thousands of years, a series of peninsulas fanning out from the higher elevations in the west has formed due to deposition from numerous creeks and rivers.

Figure 3.3-1
Anne Arundel County Location Map, State of Maryland
Source: Wiki Commons, 2007



3.3.2 History of the County

The area that would become Anne Arundel County has a long history of human habitation. Prehistoric people were drawn to the area by its abundant animal and plant life, and its access to fresh water and the Chesapeake Bay. Native Americans are known to have lived in Anne Arundel County as far back as 11,000 B.C. Beginning about 12,000 years ago, Native Americans quarried material for making high quality stone tools and projectile points from the Magothy Quartzite Quarry near Pasadena. This quarry may have spawned a vast and long-lived trading network among native peoples.

In addition, Native Americans found the 533 miles of shoreline offered an excellent location for seasonal harvesting of oysters and fish from the Chesapeake Bay. Evidence of this activity, dating from 500 A. D. to 1400 A. D., is found in numerous oyster shell middens found along the Bay and its tributaries.

The area geographical position, within a larger regional system of migratory and trade routes, created the first trails and footpaths, which later became the early transportation routes of the County's European settlers. By the time of the first European settlement however, native Algonquin tribes had virtually abandoned the present day area of the County because of raids by the warlike Susquahannocks from the north.

In 1649, Protestant Governor William Stone approached a group of Virginia Puritans and offered them land and guaranteed freedoms in the colony of Maryland. Several hundred of these settlers subsequently arrived at the mouth of the Severn River and established a settlement they called "Providence" or "Severn" in present-day Anne Arundel County. Their dispersed hamlet was centered on the north shore of the Severn River, but by the 1660s it had shifted to Acton's Cove across the river at the present site of Annapolis.

By 1650, enough settlers had moved into the area to warrant designation as a County, which was interchangeably known as Providence or Anne Arundel in its early years. Although London Town served as the original seat of County government, Providence quickly became the population center of the County and the colony. In 1695, the Governor moved the capital of Maryland from St. Mary's to Anne Arundel Town, later renamed "Annapolis" in honor of Princess Anne, daughter of Queen Mary. Annapolis remained the capital and seat of government when Statehood was achieved on April 28, 1788.

European settlements throughout the Chesapeake colonies relied upon tobacco as their main cash crop. The soils and climate were favorable, but tobacco had several limitations that proved important in the history of the County. Due to the labor-intensive nature of the crop, farmers were forced to rely on slaves and indentured servants. To meet these labor requirements, a 1664 law sanctioned slavery. Because crop rotation was not practiced during this time period, fertile soils were rapidly depleted, affecting the quality and quantity of the harvest. Although many marginal farmers were forced to relocate, the population of the County tripled between 1700 and 1750, from 4,100 to 12,520.

After the Revolutionary War, Baltimore City's harbor greatly increased the economic importance of the City. Concurrently, because of its proximity to Baltimore City, the economy of northern Anne Arundel County began to change from agrarian to industrial. Iron ore outcrops, timber, and water resources promoted the rise of an iron smelting industry early in the 18th century. Puddling furnaces and roughing mills for converting pig iron into bars operated until wood and iron ore were depleted. Many of the local furnaces ceased to exist afterwards.

Within a century, the area had become a regional transportation center for delivering goods. In addition to water transportation, a road system was developed soon after settlement in the late 17th century, becoming more complex by the early 18th century. The routes of several early colonial roads continue to be used to this day. For instance, Crain Highway (Route 3) follows the path of an important colonial roadway stretching from Philadelphia to Williamsburg; Annapolis Road (Route 175) connected Annapolis with Frederick and beyond, and Generals Highway (Route 178) stretched from Annapolis to Baltimore.

In 1840 the Annapolis & Elkridge Railroad was completed, linking northern Anne Arundel County to the Baltimore & Ohio Railroad. The advent of the railroad in the County was crucial to its development as many crossroad villages or small railroad station communities sprung up. These nodes of development frequently included stores, post offices, blacksmith shops, schools, and a handful of residences. By 1868 the Baltimore & Potomac (B & P) Railroad connected Baltimore and Washington, D.C. This line was later absorbed by the Pennsylvania Railroad and is presently used by Amtrak. In 1887 the Annapolis and Baltimore Short Line Railroad (renamed the Baltimore and Annapolis Short Line Railroad in 1894 and the Washington, Baltimore and Annapolis Railroad in the early 20th century) was constructed. It formed a 22-mile link between Baltimore and Annapolis; it was the most direct route between the two cities and quickly superseded the longer Annapolis and Elkridge Railroad line. Today this line serves as a poplar hiking-biking trail.

The reliance on tobacco as the major cash crop was lessening throughout the County during the nineteenth century, but it took the socioeconomic changes brought on by the Civil War to finally force local farmers to diversify. Maryland's Fourth Constitution, adopted on November 1, 1864, freed the remaining slaves throughout the State. As this labor source disappeared, farmers in the southern portion of the County increasingly shifted to crops such as corn, wheat, hay, and fruit though tobacco was, and is, still grown. Seafood and associated industries such as shucking houses also became significant factors in the economy of that area. Farmers in the northern portion of the County discovered that the prevalent sandy soils were ideal for truck farming. Eastern European families living in Baltimore were transported to the farms to harvest the fruits and vegetables. Initially, Baltimore was the primary market, but over time Anne Arundel County peas, beans, strawberries and cantaloupes became famous throughout the eastern seaboard. Canning and fertilizer plants were opened in northern Anne Arundel County in support of the truck farming.

Through the efforts of Secretary of the Navy George Bancroft, the Naval School was established without Congressional funding at a 10-acre Army post named Fort Severn in Annapolis, Maryland, on October 10, 1845. In 1850 the Naval School became the United States Naval Academy. A new curriculum went into effect requiring midshipmen to study at the Academy for four years and to train aboard ships each summer. That format remains the basis of the curriculum to this day. As the U.S. Navy grew over the years, the Academy expanded. The campus of 10 acres increased to 338. The original student body of 50 midshipmen grew to a brigade size of 4,000. Modern granite buildings replaced the old wooden structures of Fort Severn.

By the late 1800s, steamboats plied the Chesapeake Bay, transporting produce, oysters, crabs, and fish to commercial markets and passengers to recreational opportunities. The numerous steamship lines provided another important means of transporting people and commercial goods to and from Baltimore and elsewhere. These steamers continued to provide service until after the Great Depression.

In the late 1880s, recreation became a major business throughout the County with the opening of numerous summer resorts along the Chesapeake Bay. These resorts, for bathing and relaxation, became popular destinations with hotels, picnic pavilions, and amusement parks. Readily available rail and steamboat access from Baltimore and Washington brought visitors to the area's resorts.

In 1893, Major Charles R. Douglass, the son of abolitionist Frederick Douglass, established Highland Beach as an exclusive resort for African Americans. Many prominent African Americans, including Booker T. Washington, Paul Laurence Dunbar and Mary Church Terrell, either visited or owned homes in the community.

In 1899, the U. S. Revenue Cutter Service built a station for the repair of lifeboats at Arundel Cove on Curtis Creek. The Cutter Service became the U. S. Coast Guard in 1915 and its facility on Curtis Creek was expanded to include shipbuilding and a repair yard. Known as the U. S. Coast Guard Yard, Curtis Bay, it was a leader in wooden ship production prior to World War II. During the war, the facility converted to steel vessel construction. Due to its significant role in maritime and military history, the Yard was listed in the National Register of Historic Places in 1983.

Increased industrialization in the County began during World War II and the national movement towards suburban living that followed the war caused significant changes to occur in Anne Arundel County. Major employers such as National Plastics Corporation (now Nevamar) and Westinghouse relocated to the County.

Fort George G. Meade was established during World War I to train troops for battle in France, but was greatly expanded during World War II. The influence of this land use on western Anne Arundel County was further expanded in the 1950s with the establishment of the National Security Agency on a portion of Fort Meade's property.

The growing predominance of the automobile in the early 20th century brought significant impacts to the County. In 1941, the State Roads Commission purchased a privately-owned ferry service, and shifted its western terminal from King George Street in Annapolis to Sandy Point. Increased post-World War II development brought excessive traffic congestion for those individuals trying to reach the Eastern Shore. In 1949, construction of the Chesapeake Bay Bridge was begun. It was completed in 1952, officially opening to the public for a toll of $1.40.

Using the local Log Inn Road, the State expanded this route into a multi-lane highway, known as John Hanson Highway, or Route 50. Today, this area serves as a major transportation crossroads for the region, a factor that has made it a magnet for commercial, economic, and residential development. Completed in 1954, the Baltimore Washington Parkway was designed as a defense highway and alternative commuter route. Today it remains a scenic corridor between Washington, D.C. and Baltimore; however, it also serves the purpose intended by its planners in providing access to government installations and residential communities of commuters along its route. The area's strategic location generated the need for another major highway project in the mid-20th century: the Baltimore beltway and the Harbor Tunnel Thruway (Route 895), completed in the 1970s. Interstate 97 was the product of the Baltimore-Annapolis Transportation Study (BATS) that started in 1978. Although several corridors were studied, a westerly corridor was chosen because it served both local and interregional traffic.

In the 1940s, the Baltimore Aviation Commission selected northern Anne Arundel County as the site for a new metropolitan airport. The Commission obtained 3,200 acres of farmland just south of Linthicum. In 1947 construction began for the Friendship International Airport. The name was changed to Baltimore Washington International (BWI) Airport in 1973, and subsequently updated again to the Baltimore Washington International Thurgood Marshall Airport. As BWI Airport has grown, the surrounding region has become a magnet for business and industry.

Because of the County's location adjacent to the Chesapeake Bay, it has developed over time into an enclave of development and commercial activities. Commercial seafood harvesting, recreational fishing and recreational boating provide a host of economic opportunities. The traditional watermen of the area are slowly disappearing

because of a general decline in the water quality and available seafood in the Chesapeake Bay. However, the area is thriving economically as the loss of traditional watermen is being offset by a dramatic increase in sport fishing and recreational motor and sail boating activities. In addition, numerous world-class boat yards and sailing centers draw visitors from a wide area. The population of the County tripled in the decades between 1940 and 1960 from 68,375 to 206,634 with approximately 70% of the population living north of the South River.

3.3.3 Climate

Anne Arundel County's climate is generally moderate. It varies in the summer from mild to hot, and in the winter it is typically moderate. The highest average temperatures occur in July, averaging in the mid-to-upper 80s. Low temperatures tend to occur in January, the coldest month, averaging in the 20s.[1]

Table 3.3-1
Anne Arundel County Temperature and Precipitation by Month

Month	Normal Maximum Temperature	Normal Minimum Temperature	Normal Monthly Precipitation (inches)
January	44	29	3.31
February	48	31	2.95
March	57	38	4.53
April	68	47	3.66
May	77	57	4.21
June	86	67	4.17
July	89	71	4.57
August	87	71	3.90
September	81	64	4.76
October	69	52	3.90
November	59	42	3.82
December	48	33	3.54
Annual	68	50	3.94

3.3.4 Transportation

Anne Arundel County is a suburban jurisdiction with identified town centers, extended commercial districts along its major arterial highways such as MD 2 and MD 3, and low- and medium-density residential uses in other areas. As a suburban jurisdiction located between the two major urban centers of Washington, D.C. and Baltimore, the transportation investments (both highways and transit) have been made to support travel between those areas through the County.

Highway facilities that carry traffic within the County experience significant travel demand in part because of existing development patterns and densities. The relatively low residential densities over much of the County make it difficult to support mass transit opportunities and tend to result in longer vehicle trips. The County's highway network consists of approximately 4,850 lane miles of roads and is the predominant mode of travel used by residents and employees in the County.

[1] https://www.usclimatedata.com/climate/annapolis/maryland/united-states/usmd0585

Baltimore Washington Marshall International Airport accommodates over 21 million passengers annually and is the largest airport in the State. Owned by the State of Maryland and operated by the Maryland Aviation Administration (MAA) the airport is located in Linthicum, approximately 10 miles south of Baltimore and 30 miles north of Washington, D.C. Close proximity to the Baltimore/Washington Parkway, Fort Meade and NSA have helped make the airport one of the biggest economic engines in Maryland, serving the federal government, technical, hospitality and tourism industries.

- ### 3.3.5 Community Assets

  - Critical Facilities and Infrastructure

Critical facilities are those facilities that provide essential services to the community and must be functional after a hazard event. Anne Arundel County considers the following facilities to be critical: hospitals, fire stations, police stations and public shelters. Table 3.3-2 is a list of facilities that the County has designated as critical, current as of July 2019. There are no critical facilities in Highland Beach.

Table 3.3-2
Anne Arundel County Critical Facilities
Source: Anne Arundel County Office of Emergency Management (current as of August 2019)

Facility Name	Address	Jurisdiction	ZIP Code
Anne Arundel Medical Center	2001 Medical Parkway	Annapolis	21401
Baltimore Washington Medical Ctr.	301 Hospital Drive	Glen Burnie	21061
Fire Station 10	3725 Mountain Road	Pasadena	21122
Fire Station 11	7549 Solley Road	Glen Burnie	21060
Fire Station 12	161 Ritchie Highway	Severna Park	21146
Fire Station 13	8506 Ft. Smallwood Road	Pasadena	21123
Fire Station 17	1505 Ritchie Highway	Arnold	21012
Fire Station 18	7726 Baltimore Annapolis Blvd.	Glen Burnie	21060
Fire Station 19	1411 Cape St. Claire Road	Annapolis	21401
Fire Station 2	529 Londontown Road	Edgewater	21037
Fire Station 20	4642 Mountain Road	Pasadena	21122
Fire Station 21	1367 Dorsey Road	Hanover	21076
Fire Station 22	551 Pure Water Way	Edgewater	21037
Fire Station 23	960 Ritchie Highway	Arnold	21146
Fire Station 26	7880 South Crain Highway	Glen Burnie	21061
Fire Station 27	3498 Laurel Ft. Meade Road	Laurel	20724
Fire Station 28	1425 Annapolis Road	Odenton	21113
Fire Station 29	7891 Max Blobs Park Road	Jessup	20794
Fire Station 3	3123 Riva Road	Riva	21140

Facility Name	Address	Jurisdiction	ZIP Code
Fire Station 30	304 Mountain Road	Pasadena	21122
Fire Station 31	5100 Ritchie Highway	Brooklyn	21225
Fire Station 32	309 Camp Meade Road S	Linthicum	21090
Fire Station 33	15 Central Avenue	Glen Burnie	21061
Fire Station 34	4 Broadview Boulevard	Glen Burnie	21061
Fire Station 4	7870 Telegraph Road	Severn	21144
Fire Station 40	121 Jennifer Road	Annapolis	21401
Fire Station 41	6270 Shady Side Road	Shady Side	20764
Fire Station 42	6007 Drum Point Road	Deale	20751
Fire Station 5	1300 Waugh Chapel Road	Gambrills	21054
Fire Station 6	391 Hall Road	Crownsville	21032
Fire Station 7	2380 Davidsonville Road	Gambrills	21054
Fire Station 8	991 Bay Ridge Road	Annapolis	21403
Fire Station 9	6165 Solomons Island Road	Lothian	20711
Annapolis High School	2700 Riva Road	Annapolis	21401
Meade High School	1100 Clark Road	Fort Meade	20755
Northeast High School	1121 Duvall Highway	Pasadena	21122
Severna Park High School	60 Robinson Road	Severna Park	21146
Southern High School	4400 Solomon Island Road	Harwood	20776
Eastern District Police Station	3700 Mountain Road	Pasadena	21122
Northern District Police Station	939 Hammonds Lane	Baltimore	21225
Southern District Police Station	35 Stepney's Lane	Edgewater	21037
Western District Police Station	8273 Telegraph Road	Severn	21113

- Total Exposure

The total net worth of the building stock in Anne Arundel County is estimated to be $61.37 billion. Obviously not all of these assets are at equal risk from the effects of natural hazards – this information is intended only as a general indication of the total value of potentially at-risk assets. Table 3.3-3 below shows the total exposure, by occupancy class. Information regarding the number of people and housing units is from the U.S Census Bureau (current 2015 and 2016, respectively). Data on the value of exposure was extracted from FEMA's HAZUS-MH tool, version MR 4. The HAZUS data was not available for the 2018 HMP update, so the values from the 2012 version of the document were brought to 2018 values using the U.S. Bureau of Labor Statistics on-line inflation calculator. The resulting values should be considered estimates only, because they do not reflect additional building or loss of building stock since the last version of HAZUS data.

Table 3.3-3
Anne Arundel County Population, Housing Units, and Total Exposure ($ value) by Land Use Category

Category	Value
People	564,195 (1)
Housing Units	219,319 (2)
Residential	$50.02 billion
Commercial	$10.70 billion
Industrial	$4.60 billion
Education Exposure	$4.32 billion
Government	$2.85 billion
Agriculture	$134 million
Religious	$4.41 billion

(1) 2015 population per U.S. Census
(2) U.S. Census American Community Survey, estimates for 2010 - 2016

3.3.6 Population and Growth of the Planning Area

Table 3.3-4 summarizes population, household and employment statistics for Anne Arundel County, the Baltimore region, and the State of Maryland. These are also discussed briefly in the subsections below.

Table 3.3-4
Population, Household, and Labor Force Statistics and Projections
Source: County forecasts from Anne Arundel County Office of Planning & Zoning, Round 9 Forecasts, December 2017. Regional and State forecasts from the Maryland Department of Planning, Planning Data Services, January 2018

Population	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Anne Arundel Co.	562,867	572,340	582,566	594,303	608,928	621,771
Baltimore Region	2,737,800	2,800,350	2,851,950	2,897,800	2,934,300	2,989,250
Maryland	5,988,400	6,141,900	6,336,500	6,518,750	6,676,900	6,834,500
Households	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Anne Arundel Co.	207,338	210,959	217,565	224,575	231,253	237,951
Baltimore Region	1,056,650	1,092,312	1,124,857	1,152,507	1,171,750	1,195,769
Maryland	3,258,460	3,321,570	3,382,370	3,430,500	3,475,790	3,533,870
Employment	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Anne Arundel Co.	369,580	382,795	397,236	413,039	431,305	451,373
Baltimore Region	1,474,300	1,501,460	1,511,350	1,517,100	1,523,340	1,545,440
Maryland	3,258,460	3,321,570	3,382,370	3,430,500	3,475,790	3,533,870

Population

Anne Arundel County has seen steady increases in its population over the past fifteen to twenty years. Between 1990 and 2017, the population grew from 427,239 to 571,031, a 33.7% increase. [2] The County's rate of population increase has historically exceeded that of both the Baltimore region and the State of Maryland.

Current forecasts indicate moderate growth in the County's population will continue over the 30-year forecast period, but that the rate of growth will slowly begin to decline. The total County population is forecast to increase to 621,771 by the year 2040, representing a 10.1% increase from 2015 to 2040. This is slightly higher than the rate of population increase forecasted for the Baltimore region over the next few decades (9.1%). These figures were developed for the Transportation Cooperative Forecast. The population estimates are product of potential residential land use. Therefore, the forecast is predicated on residential holding capacity, which is in turn based on existing zoning and development regulations. Thus, as the amount of land remaining for development is gradually reduced, so does the projected population.

Households

Anne Arundel County continues to experience growth in households as well. The County experienced a 19.8% increase in households between 1990 and 2000, a higher rate of growth than in the Baltimore region or the State as a whole. Household growth is expected to continue over the next 30 years, based on County forecasts. Household growth in the Baltimore region is also expected to continue at a moderate pace, with forecasts indicating a 13.1 % increase in households from 2015 to 2040. As shown in Table 3.3-4, the number of households in Anne Arundel County is projected to increase by 14.7% over the same period.

Employment

Forecasts indicate County employment will increase by 22.2% between 2015 and 2040, compared to a 4.8% increase in the Baltimore region. Employment in Anne Arundel County is distributed across several general sectors. Major employers are shown in Table 3.3-5. [3]

Table 3.3-5
Major Anne Arundel County Employers

Employer	Sector	Number Employed
Fort George B. Meade	Public/Government	56,000
Anne Arundel County Public Schools	Public/Government	14,000
State of Maryland	Public/Government	12,132
BWI Marshall Airport	Public/Government	9,717
Anne Arundel County Government	Public/Government	5,190
U.S. Naval Academy	Public/Government	2,340

[2] http://worldpopulationreview.com/us-counties/md/anne-arundel-county-population/

[3] https://www.aaedc.org/business/county-profile/top-employers/

Employer	Sector	Number Employed
Anne Arundel Community College	Public/Government	1,939
U.S. Postal Service	Public/Government	600
U.S. Coast Guard Yard	Public/Government	598
Northrop Grumman	Private	8,465
Anne Arundel Health System	Private	4,000
Southwest Airlines	Private	4,835
Live! Casino and Hotel	Private	3,000
U. of Maryland Balt./Wash. Medical Center	Private	2,932
Booz Allen Hamilton	Private	2,100
Allegis Group	Private	1,500
CSC	Private	1,229

The Maryland Department of Licensing, Labor and Regulation (DLLR) provides statistics about employment across the State. For 2017, DLLR reporting indicates that the Anne Arundel County's average quarterly total employment was 273,090. Of this overall figure, government employment was 47,243 (17.3%), and all private sector employment was 225,847 (82.7%). Within private-sector employment, service-providing employment was 196,676 (72% of the County total), and goods-providing business employment was 29,170 (10.7% of the County total). [4]

Age and Gender Profile

Since the 2012 version of the Hazard Mitigation Plan, the U.S. Census modified and simplified the way it reports age and gender statistics. Anne Arundel County currently comprises 6.2% people under the age of five years, 22.4% under the age of 18 years, 14.1% over the age of 65 years, and 50.5% female.

Race Characteristics

Anne Arundel County is predominantly Caucasian, making up approximately 75% of the total racial composition, according to 2010 survey estimates from the U.S. Census Bureau. The next largest racial group was Black/African American persons, who comprise approximately 17%. All other races combined make up less than 7% of the County population.

Educational Attainment

One of the most beneficial assets to a local jurisdiction is a well-educated population. Census estimates show that approximately 91% of Anne Arundel County's population age 25 and over holds a high school diploma or a higher degree (American Community Survey). Table 3.3-6 provides a breakdown of education levels for Anne Arundel County and the State of Maryland.

[4] https://www.dllr.state.md.us/lmi/emppay/tab4anne42017.shtml

Table 3.3-6
Education Attainment
Source: 2016 American Community Survey, U.S. Census Bureau
Note: Counts for ages 25 years and older.

Jurisdiction	Less than H.S. Education	H.S. Diploma	Associate Degree	Bachelor's Degree	Graduate Degree
Anne Arundel Co	30,952	93,862	28,736	88,157	62,476
Maryland	410,756	1,030,305	259,899	838,733	717,979

Household Income

Anne Arundel County has a uniform distribution in terms of the number of households in each income bracket. Census estimates from 2016 indicate household incomes that are fairly evenly distributed within the six income classes selected. The County's mean household income in 2016 was estimated at $113,363.

Land Use and Development Trends

The 2009 General Development Plan (GDP) is the County's current long-range land use plan. It follows the same trends from the 1990s by continuing to concentrate new growth in specific target areas and in the Priority Funding Area (PFA), and maintaining the rural areas intact. The community favors most of these trends in support of preserving their community's character and historical integrity. The General Development Plan is being updated in 2018-20. At this time it is anticipated that new growth will primarily occur in PFAs and in specific targeted growth areas as identified in the GDP, and rural areas will experience minimal new growth.

Housing growth will continue in Anne Arundel County but is likely to slow, as is expected in a maturing jurisdiction. Currently, the housing distribution for Anne Arundel County is weighted toward townhomes (single family attached), followed by single-family detached and multifamily dwellings, based on new construction permits being issued. As shown in Table 3.3-7, between 2013 and 2017 the County issued 11,472 residential permits. Among these permits, 4,473 (39%) were for townhome units, 3,565 (31%) were for single-family detached units, and 3,240 (28%) were for multi-family units. During this period the Baltimore region as a whole saw 32,094 new residential permits, and Anne Arundel County accounted for 11,472 (36%) of these.

In the longer term, the land use planning priorities in the County are likely to gradually shift from a focus on new development to a focus on redevelopment and revitalization, as the County matures, and as vacant land for development becomes more scarce. While the existing development capacity is expected to be adequate to serve new growth over the 20-year horizon, any significant increases in capacity in the future would likely require shifts in existing land use policies. Along with these changes, a priority for both the short and long term is strategic planning for water resource protection and a focus on mitigation to address the impacts of existing and planned land uses on water resources. Additionally, strategic planning to ensure that adequate public facilities (schools, roads, public safety services) will be in place to serve new growth will be focused on in the near term.

Table 3.3-7
Anne Arundel County Residential Permits Issued (2013-2017)
Source: Baltimore Metropolitan Council Building Permit Data System.

Classification	Permits 2013	Permits 2014	Permits 2015	Permits 2016	Permits 2017
Single-family detached	700	687	606	713	859
Single-family attached	705	879	913	904	1,072
Two-family	8	18	16	58	20
Multi-family	439	535	1,060	635	571
Mobile homes	1	1	1	20	51
Other shelter	0	0	0	0	0
Mixed use	0	0	0	0	0
TOTAL	1,853	2,120	2,596	2,330	2,573

The 2009 Land Use Plan is shown in Figure 3.3-2. Development patterns are well established in most parts of the County. Higher density residential uses and most of the County's industrial and commercial land base is concentrated in the northern parts of the County and in Odenton, Severn, Maryland City, Crofton, and Parole. The rural land base still covers much of the Crownsville area and virtually all of South County with the exception of the Deale, Churchton, Shady Side, and Galesville communities. Low to medium density residential uses are spread throughout but are most predominant on the peninsulas (Lake Shore, Broadneck, Annapolis Neck, Edgewater and Mayo) and in Severna Park, Pasadena, Severn and Jessup. Table 3.3-7 provides general descriptions of the land use categories. Note that the notation on the upper right side of the map indicates "2009 Land Use Plan" – this refers to the plan document for which the map was created.

Figure 3.3-2
Land Uses in Anne Arundel County
(Source: Anne Arundel County Office of Planning and Zoning)

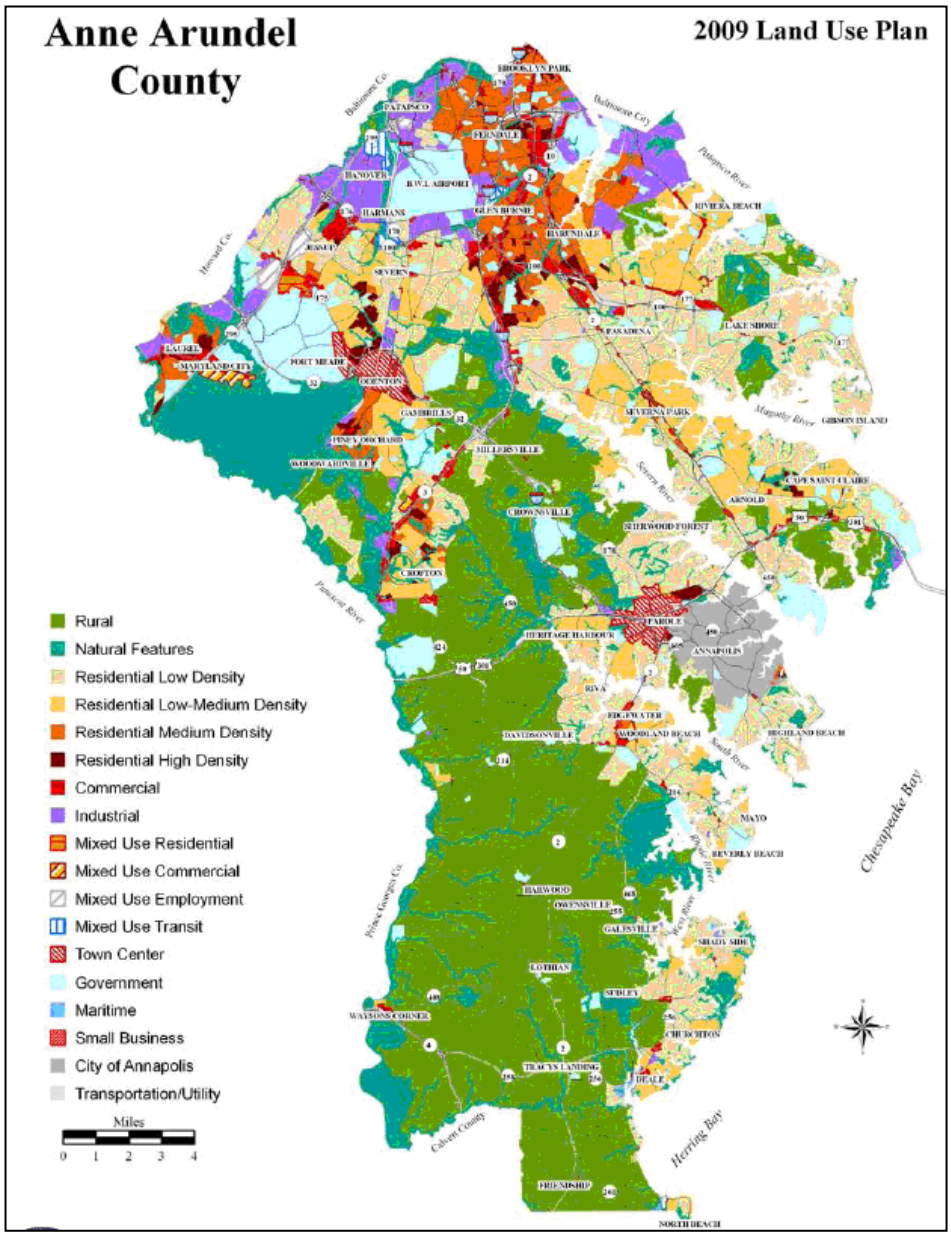


Table 3.3-8
Description of Land Use Plan Categories
Source: Anne Arundel County Office of Planning and Zoning

Land Use Plan Categories	Typical Uses	Corresponding Zoning Categories
Rural	Agricultural uses and single family detached homes.	RA, RLD
Residential Low Density	Single family detached homes.	R1, R2
Residential Low-Medium Density	Single family detached homes. (Townhouse and duplex units may be allowed as Special Exception or Conditional uses.)	R2, R5
Residential Medium Density	Single family detached, duplex, townhouse, and multifamily dwellings.	R5, R10
Residential High Density	Generally multifamily dwellings.	R15, R22
Commercial	Community retail, commercial office, general retail, and highway commercial uses.	C1, C2, C3, C4
Small Business	Community commercial uses, home occupations, and single family detached homes.	SB
Industrial	Industrial park, light industrial, and heavy industrial uses.	W1, W2, W3
Maritime	Community marinas, yacht clubs, commercial marinas.	MA1, MA2, MA3, MB, MC
Mixed Use Categories	A mix of residential, commercial, employment, and public uses.	MXD-R, MXD-C, MXD-E, MXD-T
Town Center	A mix of general commercial and multifamily residential uses. Also includes Odenton Growth Management Area.	TC, Odenton Growth Management Area districts
Natural Features	Passive use parks, conservation lands, floodplains and other environmental preservation areas.	OS (Open Space) typically, but any zoning may apply.
Government / Institutional	Land owned and used by Federal, State, or local governments, such as public schools, active use parks, and BWI Airport. May also include private institutional uses.	R1 typically, but any zoning may apply.
Transportation/Utility	Road and public utility rights-of-way.	Any zoning may apply.

3.4 Resiliency, Climate Change and Sea Level Rise Considerations

To ensure long-term viability, the Office of Planning and Zoning (OPZ) developed a Climate Change policies and strategies working draft that will be used as a framework for discussion purposes and inclusion in the Anne Arundel County General Development Plan update, Plan 2040. Several of the Climate Change policies and strategies have already been incorporated into sections of the draft Plan 2040. The policies and strategies will be made available for public review during the summer of 2020. The working draft identifies two fundamental approaches to addressing climate change, namely adaptation and mitigation. Adaptation reduces the vulnerability of people and property to the impacts from climate change, while mitigation refers to reducing emissions of greenhouse gases (GHG) and increasing storage of GHGs. The policies and strategies will ensure a cohesive approach in addressing climate change and resilience planning within the County, and in making recommendations on the type of projects that will be considered by the County in relation to natural resource management, public infrastructure, development regulations, emergency response, and operation of County facilities and critical infrastructure. The policies and strategies were developed based on three County reports and initiatives including the Sea Level Rise Strategic Plan (2011), Energy Efficiency and Conservation Plans (2009 and 2013), and the Climate Resilience Action strategy (2019 and ongoing).

In addition to the comprehensive planning, Anne Arundel County remains prepared and stands ready to work with local, State, and Federal partners, support agencies, and other organizations to address the current and future needs of our communities. The resiliency of the County depends upon effective leadership, implementation of local and regional Plans, coordination of resources and assets with our State, Federal, and local partners, and our ability to adapt to the changing environment and conditions affecting our communities. Anne Arundel County embraces an all hazards approach to comprehensive planning that is aimed to protect life, property, and reduce the potential for future losses and damage from the effects of natural hazards. Anne Arundel County will utilize the Emergency Operations Center (EOC) to assist with response and recovery efforts. Once activated, the Incident Commander will remain abreast of the hazards and changing conditions affecting our communities. The Incident Commander and our partner agencies will be responsible for collecting and assessing current information on the risks and hazards affecting the community, and taking steps to mitigate potential loss and damage to life, property, and critical infrastructure. The Office of Emergency Management maintains the capability of warning the public of hazards affecting our communities through mass notification systems and IPAWS. The County will utilize these systems as well as implement mutual aid agreements with neighboring jurisdictions to protect life, property, and critical infrastructure from all hazards affecting our communities.

Since coastal communities are most vulnerable to climate change and sea level rise, future updates of the HMP will focus on mitigation strategies and actions that assess the vulnerability of coastal communities to sea-level rise, coastal flooding, and nuisance flooding; incorporates the Climate Resilience Action strategies and actions into local comprehensive plans; improves resilience of critical infrastructure to flooding and the impacts of climate change; and identifies protective measures for cultural and historic resources to flooding, erosion, and sea level rise impacts.

Table 8.4-2 identifies the mitigation actions that will assist in building more resilient communities that have the ability to adapt to the changing hazards and conditions affecting the County including sea level rise and climate change. To that end, partners and stakeholders of the HMP will be responsible for incorporating the policies, and strategies of Resilience, Climate Change, or Sea Level Rise into their respective local plans, programs and initiatives. The vision for Resiliency, Climate Change, and Sea Level Rise outlined in this

section are under consideration by the County for local plan integration. For more information on incorporating the policies and strategies of Climate Change, refer to Section 3.4.4.

3.4.1 Resiliency

The State of Maryland Smart, Green and Growing Act of 2009 modernized the State's eight existing planning visions with 12 visions that reflect the State's aspiration to develop and implement sound growth and development policy. Eight of the twelve visions set forth in the Act speak directly to the preservation of natural resources and the environment:

1. Quality of Life and Sustainability: A high quality of life is achieved through universal stewardship of the land, water, and air resulting in sustainable communities and protection of the environment.
2. Community Design: Compact, mixed-use, walkable design consistent with existing community character and located near available or planned transit options is encouraged to ensure efficient use of land and transportation resources and preservation and enhancement of natural systems, open spaces, recreational areas, and historical, cultural, and archeological resources.
3. Infrastructure: Growth areas have the water resources and infrastructure to accommodate population and business expansion in an orderly, efficient, and environmentally sustainable manner.
4. Economic Development: Economic development and natural resource-based businesses that promote employment opportunities for all income levels within the capacity of the State's natural resources, public services, and public facilities are encouraged.
5. Environmental Protection: Land and water resources, including the Chesapeake and coastal bays, are carefully managed to restore and maintain healthy air and water, natural systems, and living resources.
6. Resource Conservation: Waterways, forests, agricultural areas, open space, natural systems, and scenic areas are conversed.
7. Stewardship: Government, business entities, and residents are responsible for the creation of sustainable communities by collaborating to balance efficient growth with resource protection.
8. Implementation: Strategies, policies, programs, and funding for growth and development, resource conservation, infrastructure, and transportation.

3.4.2 Climate Change

Given its location and very large extent of coast line, Anne Arundel County is keenly aware of the implications of climate change. The County's focus has been and will continue to be sea level rise caused by climate change. Sea level rise is discussed in some detail in the subsection immediately below this one. The County does not presently have any resources dedicated specifically to climate change issues, but does have a range of policies and activities that are tangentially related.

According to the Maryland Commission on Climate Change 2017 Annual Report, Maryland is facing consequences of climate change including, but not limited to:

1. Changes expected to negatively impact coastal, bay, and inland water quality parameters and potentially change the viable uses of surface water, such as irrigation, recreation, or human consumption

2. More frequent disruptions to urban and coastal infrastructure in Maryland caused by extreme weather events and sea level rise that may indirectly impact the economy of the region by restricting the flow of goods and affecting days worked
3. Common stressors experienced among ecosystems, agriculture, fisheries and forestry, such as those caused by general changes in temperature and precipitation regimes; increased extreme weather events; and increased pressures from weeds, diseases and pests
4. Changes in the severity, frequency, or distribution of human health issues which are affected either directly or indirectly by climate, including impacts on food and water supply, air quality, and extreme weather events; and
5. A higher probability of negative outcomes for individuals and communities inherently more sensitive or with a reduced adaptive capacity for responding to the impacts of climate change.

The County has various specific actions in Section 8 of this mitigation plan that are related to mitigating the effects of climate change, although they are categorized by natural hazard, not under the general heading of climate change.

Additionally, the Association of Climate Change Officers (ACCO) recently partnered with the State of Maryland to form the Maryland Climate Leadership Academy. The Academy's purpose is to advance the capacity of state and local government agencies, businesses, and other organizations to develop and implement sound climate change initiatives in order to ensure current and future public health, security and economic prosperity. A number of staff from the Office of Planning and Zoning participated in the Academy in 2019, and additional County staff will be participating in 2020. Two staff also completed the requirements to become a Certified Climate Change Professional through ACCO. The County's goal is for all staff to be well educated and informed of the science and the public policy implications of climate change.

3.4.3 Sea Level Rise

Anne Arundel County is acutely aware of the implications of sea level rise on the jurisdiction, and has been working for some years on various plans and efforts to fully understand its potential effects, and to develop strategies for addressing it comprehensively. One important basis of the County's efforts is the Sea Level Rise Strategic Plan (November 2011, Anne Arundel County Office of Planning and Zoning; prepared for the Maryland Chesapeake & Coastal Program, Coastal Communities Project). This section of the HMP is intended to summarize this document to provide context for the County's ongoing and emerging efforts to address climate change and sea level rise. Page 1 of the Strategic Plan states:

> Historical records indicate a relative sea level rise occurring along Maryland's coastal areas at a rate of one foot per 100 years, and it is predicted that this rate will continue into the foreseeable future or possibly accelerate due to a variety of factors. The County is therefore susceptible to the effects of climate change and sea level rise and has a need to better understand the scientific findings to date and their implications for the County. The County's *General Development Plan*, adopted in 2009, includes recommendations to develop a strategic plan for a phased implementation response to avoid or reduce sea level rise impacts to property, infrastructure, and other resources, and to establish policies to guide the relocation, extension or expansion of public infrastructure in at-risk areas.
>
> To this end, the County partnered with the Maryland Department of Natural Resources (DNR) through the Coastal Communities Initiative Program to conduct a study of potential sea level

rise impacts and develop adaptation strategies. The project included four major components: 1) a vulnerability assessment to identify potential areas impacted by sea level rise and develop inventories of resources at risk; 2) development of a framework for interagency strategic planning; 3) development of a strategic plan; and 4) public outreach and education to promote public awareness of sea level rise issues.

The Anne Arundel County Climate Resilience Action Strategy (2019 and on-going) is the product of that study. The Plan "summarizes the State's recent research and planning efforts related to sea level rise; discusses the key findings from the vulnerability assessment and other planning analysis; identifies the major planning issues for Anne Arundel County as related to sea level rise; and recommends future actions to protect resources and minimize impacts.

"Using the range of sea level rise projections recommended in the State's Climate Action Plan, the County undertook a study to gain a better understanding of its vulnerability to sea level rise in terms of both the locations that may be impacted and the resources that may be threatened. The results were published in 2010 in the Anne Arundel County Sea Level Rise Phase I Report: Vulnerability Assessment."

The Maryland Department of Natural Resources (DNR) assisted the County with technical modeling work based on LiDAR-based topographic data and the State's official shoreline data. The modeling determined land areas that may become inundated with water under various sea level projections. The model projected areas of inundation for two ranges of potential sea level rise: 0-2' and 0-5'. The modeling provides a partial basis for further planning and policy decisions related to the effects of sea level rise, including not only where these effects are likely to occur, but various metrics and data, as shown in the series of tables below. The tables in this Section were selected because of their specific relation to natural hazard risk, and eventual full incorporation into the HMP.

In the context of this HMP, it should be clearly understood that this information was developed about eight years ago, and various of the inputs have likely changed in the interim. Moreover, inundation projections are necessarily based on predictions about the degree of sea level rise, and this is by definition uncertain, and thus so are the results. The series of tables that follow should be understood in this context, and regarded only as a partial starting point for further development of policies and practices related to coastal flooding. Note that sections used verbatim from the Strategic Plan are indicated in fully-justified text sections below. The first table simply shows the land area inundated in the two inundation depth ranges. These values appear to be relatively small, given the extensive shoreline in the County.

Table 3.4.3-1
Anne Arundel County Land Areas Inundated by 0-2' and 0-5', in Acres by Type
(Source: 2011 Sea Level Rise Strategic Plan, Table 1, Page 5)

Type of Land Cover	0-2 ft Inundation	0-5 ft Inundation
Commercial	13	182
Forested Wetland	5	29
Industrial	4	27
Open Land	262	650
Open Wetland	622	964
Pasture/Hay	1	17
Residential 1-acre	24	116
Residential 1/2-acre	44	249
Residential 1/4-acre	66	332
Residential 1/8-acre	68	499
Residential 2-acre	78	381
Residential Woods	20	59
Row Crops	1	37
Transportation	7	70
Utility	1	7
Water	234	383
Woods	743	2,903
Total Acres	***2,193***	***6,905***

The next table provides several metrics related to sea level rise and the numbers and values of properties at risk. Note that the dollar figures are the assessed values of the properties, likely including the land value, not the dollar amount of damages expected in inundations in the two ranges.

Table 3.4.3-2
Anne Arundel County Land Areas Inundated by 0-2' and 0-5', Value Metrics
(Source: 2011 Sea Level Rise Strategic Plan, Table 2, Page 5)

	0-2 ft Inundation	0-5 ft Inundation
# of Properties at Risk	11,607	18,850
Average Assessment Value	$223,854	$202,018
Median Assessment Value	$143,027	$133,700
Total Assessment Value	***$2,904,959,889***	***$4,135,714,067***

The next table provides the numbers of "principal structures at risk", meaning the type of structure that predominates on a specific tract. Note again that the values do not express any detailed information about flood depths at individual properties, only the intersection of flood inundation limits and the parcels on which the structures are built.

Table 3.4.3-3
Anne Arundel County Land Areas Inundated by 0-2' and 0-5', Principal Structures at Risk
(Source: 2011 Sea Level Rise Strategic Plan, Table 3, Page 7)

Building Use Type	0-2 ft Inundation	0-5 ft Inundation
Commercial	13	62
Educational	0	2
Other Institutional	2	8
Place of Worship	0	2
Residential	125	2,324
Total	***140***	***2,398***

The final table in the series shows public infrastructure at risk from the two levels of inundation. The information does not provide an actual risk calculation, i.e. expected damages.

Table 3.4.3-4
Anne Arundel County Land Areas Inundated by 0-2' and 0-5', Public Infrastructure at Risk
(Source: 2011 Sea Level Rise Strategic Plan, Table 4, Page 8)

Facility	0-2 ft Inundation	0-5 ft Inundation
Water Lines (pipe length in feet)	26,684	53,729
Water Hydrants	2	9
Sewer Gravity Lines (pipe length in feet)	12,169	169,202
Sewer Force Mains (pipe length in feet)	21,602	137,663
Sewer Manholes	36	591
Sewer Pumping Stations	1	24
Storm Drain Pipes (pipe length in feet)	22,880	66,212
Stormwater Management Facilities	1	9

In addition to the range of buildings and infrastructure, the report includes some discussion about several specific community elements that are at risk of sea level rise: marinas, park lands, and historic and archaeological resources. The subsections about marinas and park lands are quoted verbatim from the report.

> **Marinas.** The marine industry is an important segment of the local economy in Anne Arundel County given its many miles of shoreline. Based on a recent inventory, there are 221 marinas currently operating in the County including community marinas, commercial marinas, and yacht clubs. The principal services that are provided at marinas are facilities for storing, launching, and hauling boats although other services often include fresh water supply for the docked boats, electric power, repair, fuel, grocery sales, marine supplies, hardware, restaurants, restrooms, tennis, swimming pools, ice, boat sales, boating schools, and sometimes motels. As would be expected, the majority of marinas are vulnerable to sea level rise under the scenarios analyzed, with 208 marinas vulnerable under the 0-2 foot scenario and all vulnerable under the 0-5 foot scenario.

Park Lands. Most of the public park properties vulnerable to sea level rise are County parks. Many are open natural areas, but the vulnerable properties also include active recreation parks with sports fields, public school recreation areas, and public piers. It appears that most of the physical infrastructure on park properties is located outside of the projected inundation areas. Still, future park development plans will need to take into consideration these potentially vulnerable areas. Of the 59 vulnerable park properties, 12 are located in South County, 11 in Deale/Shady Side, 8 in Edgewater/Mayo, 6 in the Lake Shore area, 5 on the Broadneck peninsula, and the remainder in other communities.

Archaeological and Historic Resources. A total of 371 archaeological sites are vulnerable under a 0-2 foot sea level rise scenario. The number rises to 422 in a 0-5 foot sea level rise. The 422 threatened sites account for nearly 30% of the total sites recorded in the County. Ninety-one of these sites date from the historic period (from the mid-seventeenth- ca. 1650, through the early twentieth century- ca. 1940), and 215 are from the prehistoric period (or, Native American sites that pre-date the arrival of Europeans to Anne Arundel County ca. 1650AD to ca. 8,000 BC). The remaining sites either contain both historic and prehistoric components or date to an unknown time period.Table G-5 provides information about the numbers of archaeological sites inundated by the two levels of sea level rise.

Table 3.4.3-5
Anne Arundel County Land Areas Inundated by 0-2' and 0-5', Archaeological Sites
(Source: 2011 Sea Level Rise Strategic Plan, Table 6, Page 10)

Cultural Affliation	0-2 ft Inundation	0-5 ft Inundation
Prehistoric	192	215
Historic	80	91
Prehistoric & Historic	43	52
Unknown	56	64
Total	*371*	*422*

Forty-seven recorded structures listed on the Maryland Inventory of Historic Properties (MIHP) may be vulnerable with 0-2 feet of sea level rise, while 74 are vulnerable with up to 5 foot of rise. These sites include historic buildings, bridges, lighthouses, and historic roads and districts, along with several Federal historic resources outside of the County's jurisdiction. Some of the recorded historic sites are historic districts that may contain multiple resources within a confined geographic area. Thus, while the table below indicates 12 historic districts may be vulnerable, the number of individual buildings and landscape features that are within those districts could number in the hundreds and may comprise a much larger threat.

Table 3.4.3-6
Anne Arundel County Land Areas Inundated by 0-2' and 0-5', Historic Properties
(Source: 2011 Sea Level Rise Strategic Plan, Table 7, Page 11)

Recorded Historic Sites*	0-2 ft Inundation	0-5 ft Inundation
Structures/Dwellings	12	26
Bridges	8	11
Lighthouses	4	4
Historic Roads	1	2
Historic Districts	12	12
Federal - US Coast Guard & US Navy resources	10	19
Total	*47*	*74*

Key Conclusions from the Vulnerability Assessment

The vulnerability assessment proved very valuable in enabling the County to better understand the level of threat posed by a future rise in sea level. Compared to other nearby jurisdictions such as Dorchester County, which has significantly large land areas that may become inundated, Anne Arundel County is fortunate in that its areas of potential vulnerability to sea level rise are not expansive, and the number of public and private facilities and structures that could be at risk is relatively small.

Nevertheless, the value of properties, infrastructure, and natural resources that could potentially be damaged or rendered unusable is significant, and to this end the County will pursue the next stages to determine what preventive planning measures and actions should be undertaken to minimize any damages or loss of important resources.

The key conclusions of the analysis which will help to guide the strategic planning process are summarized below.

- In terms of land cover, some of the most significant impacts of a rise in sea level will be a loss of wooded areas and open wetlands which are valuable components of the coastal ecosystem.
- A majority of the developed land in vulnerable areas is used for residential purposes, with primarily single family detached homes. Some homes may require elevation or relocation.
- With a sea level rise of less than two feet, impacts to principal structures may be relatively small. If a rise in sea level between two and five feet should occur, impacts may be much more significant with as many as 2,400 structures that could be damaged or require relocation.
- Structures at risk are located in most coastal communities, but the majority is located on the Deale/Shady Side peninsula.
- Local roads in many coastal communities may be impacted, particularly on the Lake Shore, Annapolis Neck, Mayo, and Deale peninsulas. However, the total amount of road miles is not large. Impacts would occur at a neighborhood level but could render some properties inaccessible.
- Impacts to public utility infrastructure are difficult to assess. Even if the surface land area is not permanently inundated, the higher water table associated with a rise in sea level may cause underground infrastructure including water supply and sewer lines and storm drains to malfunction or collapse. In terms of the quantity of public utility infrastructure, the amount that may be at risk is not large. But it is located in a more scattered pattern amongst almost all coastal communities, making planning for retrofits or alternatives more complex.

- Sewer pump stations in four of the County's public sewer service areas (Broadneck, Annapolis, Mayo-Glebe Heights, and Broadwater) are located in potential inundation areas under a sea level rise of between two feet and five feet.
- Several thousand properties that rely on individual water supply wells and onsite septic systems could be impacted by rising sea level causing septic systems to fail and wells to become contaminated by saltwater intrusion. In many cases, these properties are not within a feasible distance for connection to a public utility system, and may not be concentrated enough in density to allow installation of community well or septic systems as a viable alternative. This makes mitigation planning for such situations even more difficult.
- The marina industry will likely be the most impacted segment of the local economy since virtually every marina business could be impacted by a rise in sea level.
- As many as 46 County parks could be at least partially inundated in the future. Park development plans will need to take into consideration these potentially vulnerable areas.
- Over 400 archaeological sites may be susceptible to loss or damage due to sea level rise, as well as 80 historic properties. This is of particular concern to the County given the extremely high value of some of the archaeological finds discovered to date in the County. Strategic planning to prevent loss of these irreplaceable resources is a priority.
- Shoreline erosion has generally been slight along most of the County's coast, although many shoreline miles have experienced some degree of erosion. Very small areas of shoreline have experienced moderate to high rates of erosion. Significant areas of shoreline have protection mechanisms in place, but identification of additional areas in need of future protection is needed.

Initiatives to Address Vulnerability of Historic and Archaeological Resources

Because the Sea Level Rise Vulnerability Assessment indicated a large number of historic and archaeological sites that may be vulnerable to sea level rise impacts, as well as increased flooding due to climate change, the Office of Planning and Zoning has concentrated efforts toward these resources in recent years.

In 2015-17, a Hurricane Sandy Grant was awarded through the Maryland Historical Trust and National Park Service to excavate several endangered archaeological sites.

In 2016-17, the County participated with the City of Annapolis in the Weather It Together / Keeping History Above Water workgroup and conference which focused on cultural resouces mitigation for sea level rise.

In 2016-18, Hazard Mitigation Grant funds were obtained to identify and prioritize endangered historic and archaeological sites in the 100-year floodplain of three areas: Pasadena, Shady Side, and Jessup/Laurel/Maryland City. The assessment was conducted first as a desk audit using both archival research and spatial analysis with GIS. The audit resulted in modelling of high-potential/high-risk survey areas and a preliminary assessment of at-risk resources. Subsequently, field survey of prioritized areas of interest was conducted within the defined survey areas by both an archaeologist and also an architectural historian.

The archaeological field survey resulted in the registration and documentation of 11 new archaeology sites on the Maryland Archaeological Sites Survey, along with the submission of five updated

archaeology site forms to the Maryland Historical Trust. Limited Phase I survey of these sites was conducted with surface reconnaissance, with a couple including shovel test pit excavation. Additionally, as a result of the architectural field survey, five new Maryland Inventory of Historic Properties forms were submitted to the Maryland Historic Trust, and one survey district was also identified and recorded on the Maryland Inventory with pending documentation. Architectural resource data was also compiled during the windshield survey of Pasadena and Shady Side/Deale into a database using the MHT's Architectural Survey Form for Hazard Mitigation Planning to define the database fields.

Assessing Development Potential in Vulnerable Areas

Based on the analysis and conclusions to date, the County has determined that its immediate focus for sea level rise planning efforts will be more on reducing impacts and future losses to existing development and resources. Consideration for limiting or restricting the extent of future development in areas subject to flooding and to sea level rise will be completed during the comprehensive planning process of the General Development Plan update and as better estimates are obtained by the County on sea level rise projections. The existence of low- density zoning and development regulations currently in place are expected to limit the future development potential in areas vulnerable to flooding and to sea level rise. While a number of infill parcels or lots still exist in these areas, the County does not anticipate a surge of new subdivisions or major development applications within these areas. The County will consider legislation and other mitigation strategies and actions in areas prone to flooding and sea level rise that reduces potential losses and damages to life and property.

Existing Development Regulations in Vulnerable Areas

The County's subdivision code, zoning ordinance, and the General Development Plan govern land use and development in areas subject to flooding and to sea level rise. The State Critical Area regulations as well as FEMA floodplain regulations provide additional controls on future construction and development in vulnerable areas. Article 17, Title 8 establishes a 100-foot buffer for development and redevelopment on properties within the Critical Area from the mean high-water line of tidal waters, tributary streams, and tidal wetlands. An expanded buffer is required if there are contiguous slopes of 15% or greater; nontidal wetlands, nontidal wetlands of special State concern, and hydric soils or highly erodible soils. The establishment of these buffers along the shoreline serves as an on-going hazard mitigation action by the County that maintains the natural environment of a stream; protects riparian wildlife; establishes and maintains an area of transitional habitat between aquatic and terrestrial communities; minimizes adverse effects on wetlands, shorelines, stream banks, tidal water and aquatic resources; and provides for the removal or reduction of sediments, nutrients, and potentially harmful or toxic substances. The County will continue to explore scientific studies and implement best management practices to enhance local mitigation efforts and reduce potential damages and losses from future disasters.

FEMA Regulations

Floodplain management is regulated in Article 16 – Floodplain Management, Erosion and Sediment Control, and Stormwater Management in the Anne Arundel County Code as well as on official maps delineating the FEMA floodplain districts. As shown below, most of the sea level rise vulnerable areas are located within a delineated FEMA floodplain district, primarily the AE zone (tidal and non-tidal 100-year floodplain with known elevation). Therefore, the development and building requirements applied

within those districts will to some extent serve to lessen future sea level rise impacts to those properties. As with the Critical Area overlay, the floodplain management ordinance may provide another existing regulatory mechanism that can be used to apply additional protective measures for development within sea level rise vulnerable areas.

This offers some insight into the correlation between flood zone designations and risks from sea level rise.

Table 3.4.3-7
Anne Arundel County Potential Sea Level Rise Inundation in FEMA Flood Zones
(Source: 2011 Sea Level Rise Strategic Plan, Table 9, Page 23)

	0-2 ft Inundation	0-5 ft Inundation
Area of Inundation Inside FEMA Special Flood Hazard Areas (A, AE, and VE zones)	93 %	89 %
Inside FEMA A Zone	0 %	1 %
Inside FEMA AE Zone	94 %	94 %
Inside FEMA VE Zone	6 %	5 %

Sea Level Rise Strategic Plan Goals

In addition to the detailed vulnerability assessment and overall analysis, the Strategic Plan incorporates a series of goals and recommendations related to sea level rise. These are briefly summarized below, and the document is incorporated by reference. The HMP update includes an additional mitigation strategy that asserts that the County will work to incorporate these goals and strategies into that document. The County has requested that specific goals and recommendations that are included in the 2010-2011 Strategic Plan not be included in the HMP, as they have not been formally adopted or approved. The goals are by definition fairly general, and focus on the need to incorporate sea level rise considerations into County policies and activities, and to further study the issue going forward. The recommendations include a very detailed series of actions and policy updates that are aimed at increasing the level of technical knowledge about sea level rise and its effects, and in mitigating such effects on existing and future development. The goals are listed below, and the recommendations may be reviewed via the Strategic Plan.

1. Incorporate sea level rise planning into all related County functions.
2. Protect coastal ecosystems to reduce the impacts of sea level rise, coastal flooding and shoreline erosion.
3. Reduce sea level rise impacts to existing and future development.
4. Reduce potential impacts to public infrastructure serving existing communities and future development.
5. Ensure safe and adequate water supply and wastewater management for communities vulnerable to sea level rise impacts.
6. Protect significant cultural resources from loss or damage due to sea level rise impacts. Ensure that citizens in the County are educated and informed about sea level rise and have access to current information and resources.
7. Ensure that citizens in the County are educated and informed about sea level rise and have access to current information and resources.

3.4.4 Local Plan Integration

As explained briefly in this HMP, Anne Arundel County does not include any incorporated sub-jurisdictions within its boundaries, so there is no opportunity or need to integrate local plans. The City of Annapolis has its own HMP, but this is not integrated into the County Plan. The Office of Emergency Management (OEM) will remain the lead agency for coordination of future HMP updates and planning activities. As part of future reviews and updates, OEM will explore opportunities with our partners and key stakeholders on how to integrate the mitigation goals, strategies, actions and projects into respective local plans, programs and initiatives. The County intends to use the HMP, namely the actions and projects described in Table 8.4-2, as the local process for prioritizing and recommending hazard mitigation and risk reduction projects for consideration in the County's Capital Improvement Program. Assessment of the hazard mitigation and risk reduction projects identified in Table 8.4-2 will be completed by the OEM Deputy Director on an annual basis.

Section 4
Approval and Adoption

Contents of this Section

4.1 IFR Requirement for Approval and Adoption

44 CFR § 201.6 Local Mitigation Plans: *[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., City Council, County Commissioner, Tribal Council).*

4.2 Authority

Authority for the preparation of both the original Hazard Mitigation Plan (HMP) and both updates is derived from the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988, P.L. 93-288, as amended by the Disaster Mitigation Act of 2000, P.L. 106-390. The Disaster Mitigation Act of 2000 (DMA2K, and "the Act") required State and local governments to develop and formally adopt natural Hazard Mitigation Plans by November 2003 in order to be eligible to apply for Federal assistance under the HMGP. The Act was further amended to extend the planning requirement deadline to November 2004.

When the DMA 2000 was signed into law on October 30, 2000, the Robert T. Stafford Disaster Relief and Emergency Assistance Act was amended by adding a new section, 322 – Mitigation Planning. Section 322 places new emphasis on local mitigation planning. It requires local governments to develop and submit Hazard Mitigation Plans as a condition of receiving Hazard Mitigation Grant Program (HMGP) project grants and certain other types of FEMA assistance. An Interim Final Rule (IFR) for implementing Section 322 was published in the Federal Register, 44 CFR Parts 201 and 206, on February 26, 2002. The requirements for local HMPs, or Local Mitigation Plan Criteria, are found in part 201.6.

In addition to the requirement for approved HMPs, the DMA2K also requires communities to utilize a specific planning process developed for an all-hazards approach to mitigation planning. The four-step process is crucial to ensure that the effective planning by a community meets all the HMP content criteria required by the Act. The Act requires adoption by the local governing body and specifies a stringent review process, by which States and FEMA Regional Offices will review, evaluate and approve HMPs.

4.3 Approval and Adoption Process

Anne Arundel County submitted its original HMP to the Maryland Emergency Management Agency (MEMA) for review in late 2004. After FEMA and MEMA reviewed and approved the HMP, the Anne Arundel County Council

formally adopted the document. The incorporated Town of Highland Beach also approved and adopted the HMP. Section 5 provides details about public presentations for both the original HMP and updates.

Throughout the 2018 HMP update process, the HMPC and Stakeholders Group had opportunities to provide comments and feedback. The County submitted the initial draft of the update to MEMA for review and comment on INSERT DATE HERE. After addressing MEMA comments in the document, the HMP was resubmitted for final consideration and approval by MEMA and FEMA. FEMA provided a letter of Approval Pending Adoption on INSERT DATE HERE, and the document was forwarded to the Anne Arundel County Council for adoption, which occurred on INSERT DATE HERE. The adoption resolution is provided as Appendix D in the 2018 HMP update. Following adoption, the document was resubmitted to FEMA for final approval, which occurred on INSERT DATE HERE.

This section will be updated when the 2018 version of the HMP is updated and approved.

4.4 Adoption Resolution

The County Council adopted the 2018 HMP update on INSERT DATE HERE. The Resolution can be found in Appendix D. The Town of Highland Beach approved the HMP update on INSERT DATE HERE. The Resolution can also be found in Appendix D.

Section 5
Planning Process

Contents of this Section

As part of the 2012 Anne Arundel Hazard Mitigation Plan (HMP) update, portions of the original (HMP) were preserved, including some of the terms and language. The County made various decisions about adding and removing information from the original document. In many cases these changes are simply editorial in nature, and are not noted or highlighted specifically as changes.

In developing the first-generation HMP, the County established a committee to guide the process. During the 2012 update, the County decided to establish a core group (the Hazard Mitigation Planning Committee, or HMPC) and a Stakeholders group, which has carried over to the 2018 update, by consensus of the 2018 HMPC. The structure and some of the contents of the 2012 HMP have been retained for this update.

Anne Arundel County understands the importance of a public information, outreach, and stakeholder campaign in seeking participation, input, and involvement of the public and stakeholders throughout the planning and update process. The public information, outreach, and stakeholder campaign provides the public, planning committee members, and stakeholders with the opportunity to participate and provide input in hazard mitigation planning activities. The public is able to comment on proposed local mitigation projects and assist the County with prioritizing local mitigation projects to meet the needs of the community. The public information, outreach, and stakeholder campaign also allows planning committee members and stakeholders the opportunity to participate, provide input, and incorporate goals and strategies of the HMP into other local plans and planning tools to ensure the needs of the community can be met.
The County acknowledges a shortcoming in the 2018-2019 HMP update, in that there was inadequate coordination with quasi-public and private-sector organizations that could have provided additional input into the process, and various subject-specific parts of the updated document. The County affirms that this will be addressed in detail in the next update, with various organizations being identified early in the process, and engaged in providing input and reviewing drafts of the HMP as it is developed.
The Office of Emergency Management (OEM) agrees to retain documentation involving the public information, outreach, and stakeholder campaign including, but not limited to, press releases; website and social media postings; public participation and input at public meetings; and email communications with the public, planning committee members, and stakeholders until FEMA has granted final approval of the Hazard Mitigation Plan.

5.1 FEMA Requirements for the Planning Process

44 CFR § 201.6 Local Mitigation Plans* (b) *Planning process. An open public involvement process is essential to the development of an effective plan. 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 neighboring 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.

5.2 Federal Mitigation Planning Requirements

As mentioned in Section 4.2, the Disaster Mitigation Act of 2000 (The Act) requires State and local governments to develop and formally adopt natural Hazard Mitigation Plans in order to be eligible to apply for Federal assistance under the HMGP. The Act authorizes up to seven percent of HMGP funds available to a State after a disaster to be used for the development of State, Tribal, and local HMPs.

In addition to the Disaster Mitigation Act of 2000, further hazard mitigation planning requirements are set forth in six programs administered by FEMA. These are described below. Although slightly different, all programs outline the same basic planning process. Note that during the time the 2012 HMP update was conducted, FEMA initiated the HMA program integration, which aligned certain policies and timelines of the various mitigation programs. Five out of the six programs are grant programs available through DHS and FEMA as a part of the Hazard Mitigation Assistance (HMA) Unified Guidance. These HMA programs present a critical opportunity to reduce the risk to individuals and property from natural hazards while simultaneously reducing the reliance on Federal disaster funds. States, Territories, Indian Tribal governments, and communities are encouraged to take advantage of funding provided by HMA programs in both pre- and post-disaster timeframes.

Together, these programs provide significant opportunities to reduce or eliminate potential losses to State, Tribal, and local assets through hazard mitigation planning and project grant funding. Each HMA program was authorized by separate legislative action, and as such, each program differs slightly in scope and intent. The guidance applies to these programs: Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation Program (PDM), Flood Mitigation Assistance Program (FMA), Repetitive Flood Claims Program (RFC), and Severe Repetitive Loss Program (SRL). While the statutory origins of the programs differ, all share the common goal of reducing the risk of loss of life and property due to natural hazards.

With regard to Anne Arundel County, in general, the local government is a “sub-applicant”, i.e. an eligible entity that submits a sub-application for FEMA assistance to the Applicant. The “Applicant” in this case is the State of Maryland. If HMA funding is awarded, the sub-applicant becomes the “sub-grantee” and is responsible for managing the sub-

grant and complying with program requirements and other applicable Federal, State, Territorial, Tribal, and local laws and regulations. By incorporating the five programs, the HMA consolidates the common requirements for all programs and explains the unique elements of the programs in individual sections. This organization improves the clarity and ease of use of the guidance by presenting information common to all programs in general order of the grant life cycle.

- **Flood Mitigation Assistance Program (FMA).** To qualify to receive grant funds to implement projects that mitigate damage to floodprone structures, local jurisdictions must prepare Hazard Mitigation Plans (HMPs). HMPs must include specific elements and be prepared following the process outlined in the National Flood Insurance Program's (NFIP) Community Rating System.
- **Hazard Mitigation Grant Program (HMGP).** To qualify for post-disaster mitigation funds, local jurisdictions must have adopted an HMP that is approved by FEMA.
- **Pre-Disaster Mitigation Grant Program (PDM-C).** To qualify for pre-disaster mitigation funds, local jurisdictions must adopt an HMP that is approved by FEMA.
- **NFIP Community Rating System (CRS).** The CRS offers recognition to communities that exceed minimum requirements of the National Flood Insurance Program. Recognition comes in the form of discounts on flood insurance policies purchased by citizens. The CRS offers credit for HMPs that are prepared according to a multi-step process.
- **FEMA/NFIP Severe Repetitive Loss Program (SRL).** The SRL program was authorized by the Flood Insurance Reform Act of 2004 to provide funding to reduce or eliminate the long-term risk of flood damage to residential structures under the NFIP that have suffered repetitive losses. SRL properties have at least four NFIP claim payments over $5,000, with at least two of the claims within a 10-year period. SRL properties are also residential structures that have at least two separate claim payments made within a 10-year period with the cumulative amount of the building portion of the claims exceeding the value of the property.

5.3 Description of the Planning Process

5.3.1 How the Hazard Mitigation Plan was Prepared and Updated

The 2018 version of the County's HMP was prepared by the Office of Emergency Management (OEM). It was developed in accordance with the provisions of the Disaster Mitigation Act of 2000 (Public Law 106-390), the 44 Code of Federal Regulations Part 206, and the planning standards adopted by the Maryland Emergency Management Agency. It should also be noted that both the original County HMP and the updated HMP were prepared in accordance with the process established in the FEMA 386-series of mitigation planning *How-To* guides, as well as the requirements of the applicable section in the 44 CFR guidance. The process established in the guides comprises several steps, shown below in Figure 5.3.1-1.

Figure 5.3-1
FEMA's Hazard Mitigation Planning Process

The 386-series of guides provided the structure for the process that was used to develop and update the County HMP. Each section of this updated document includes specifics about how the FEMA mitigation planning requirements were met, as well as the process that was used to obtain and interpret data, determine and prioritize goals, strategies and actions, and implement and monitor elements of the HMP.

Public Information, Outreach and Stakeholder Campaign From the start of this update, the County developed a strategy that provided opportunity for sectors of the community to engage and become involved in the process or comment on the final product. This process helped to ensure a comprehensive and County-wide community approach was taken in developing this document.

After the 2018 first draft was completed, copies were distributed to the County Executive and the County Council for review and comment. Copies were also distributed to the HMPC and Stakeholders Group for review and comment.

A summary of the planning process to engage public involvement in the 2018 update included the following: one public presentation (Monday, June 4; see minutes and sign-in sheet in Appendix C), and one subsequent public outreach during the final draft stage. The June 4 public meeting was publicized by various means including the County website, the OEM webpage, and via Facebook. At these meetings, copies of the draft HMP were distributed, the HMP was explained, and questions were answered. Meeting dates and times were also placed on the County's Public Meeting Monthly Calendar. In addition, copies of the document were placed in libraries around the County for residents to examine with an OEM point of contact for comments and questions. Additionally, a copy of the 2018 first draft HMP was placed on the County Web site. The document was discussed at the HMPC meetings and committee members were encouraged to notify colleagues and the public through their own outreach initiatives.

The Office of Emergency Management undertook a public information, outreach, and stakeholder campaign to engage citizens in the planning and update of the HMP, and ensure the final product represented the needs of the community. The process involved issuing a public notice and announcement in the form of a press release to local print media on May 4, 2018; incorporating the public notice and announcement on the Anne Arundel County website news and events section on May 5, 2018; hosting a public meeting on Monday, June 4, 2018 at 6:30 p.m. at the Henry L. Hein Public Service Building; and placing copies of the 2018 HMP first draft at local libraries. These actions were taken to seek public involvement and input on key objectives of the HMP. The press release and information posted on the County's website included the following elements:

- The Office of Emergency Management's intent to update the Hazard Mitigation Plan (HMP);
- The purpose of the HMP update and Federal Mitigation Planning in order to remain eligible for certain kinds of federal aid and grants following natural disasters;
- The announcement of a public meeting on Monday, June 4, 2018 at the Henry L. Hein Public Service Building and invitation for the public to participate in the planning and update process of the HMP update.

The public meeting presented the key objectives of the 2018 HMP update, which included the following elements:

- An overview of the Federal requirements for receiving assistance following a disaster and purpose of doing the HMP update;
- The overall process of how the County is undertaking the 2018 update of the HMP;
- The main elements of a HMP update including Hazard Identification and Risk Assessment and Identification of local Mitigation Strategies;
- The types of natural hazards that are likely to impact the County for the 2018 HMP update as compared to the 2012 HMP;
- The potential effects and losses to property and life from the identified natural hazards;
- The number of claims made to the National Flood Insurance Program since 1977;
- The mitigation goals, strategies, actions and projects the County is considering for the 2018 HMP update that are targeted to reduce the potential of damages and losses to live and property from the identified natural hazards;
- The proposed monitoring and maintenance schedule of the 2018 HMP update; and
- Next steps related to local, State and Federal approval of the 2018 HMP update.

At the conclusion of the presentation, OEM staff and the consultant fielded several questions. The public was interested in knowing:

- where the County was in the process of the 2018 HMP update;
- whether the HMP considered other hazards such as terrorism and accidents; and
- what the relationship was between reports required by Medicare/Medicaid for a hospice facility for their emergency response planning versus hazard mitigation plans.

OEM staff responded to public input in the following manner:

- The material distributed during the public meeting was a first draft and it would likely take at least 6 weeks before the draft document would be ready to submit to MEMA for review;
- The 2012 HMP included twice as many hazards as compared to the 2018 HMP update. Man-made hazards such as terrorism were no longer required by FEMA and were subsequently dropped from the 2018 HMP update; and
- The only identifiable relationship between emergency response and hazard mitigation planning is the potential effects and losses of the natural hazards identified in the 2018 HMP update to property and life.

In addition to the above, the legislative process will provide additional opportunity for public participation and input once the legislation for the 2018 Hazard Mitigation Plan update has been introduced to the Anne Arundel County Council. The Anne Arundel County Charter requires the Council Chair to schedule a public hearing within 7 days for any new legislation, and the Anne Arundel County Council may not adopt any legislation until a public hearing is held. Since a public hearing is required before the legislation on the 2018 Hazard Mitigation Plan update can be adopted, the public will have additional opportunity to comment on the 2018 HMP update. OEM will request to receive documentation of any public comments received during the public hearing, and will incorporate any key revisions to ensure the final Hazard Mitigation Plan meets the needs of the community. Any revisions will be submitted to MEMA and FEMA for final review and approval before the legislation is adopted.

An Additional Note on the Hazard Mitigation Plan Update Process

As part of the 2018 HMP update, certain elements of the original document have been retained, and irrelevant or outdated information has been summarized or removed. In some cases the updated document includes cross-references to particular information in the original version of the document. For the current version, the focus has shifted to incorporating new hazard information, reevaluating the County risk assessment, and describing meetings and presentations held as part of the update. The HMPC re-evaluated the goals, actions, and strategies included in the most recent approved version of the HMP (2012) and updated each to show their status as completed, deleted, deferred or ongoing.

Step 1 Organize Resources

The County used a standardized approach to the HMP update, a process organized in three tiers:

1. Hazard Mitigation Planning Committee (HMPC)
2. Stakeholders Group
3. Anne Arundel County Council

As noted elsewhere, the Anne Arundel County HMP update was funded through a grant from FEMA. Early in the update process, the County secured the services of a professional planning consultant to facilitate the work.

5.3.2 Composition of the Hazard Mitigation Planning Committee

As part of the update, County officials from various departments were designated to be part of the HMPC. The Office of Emergency Management identified and engaged key stakeholders in the planning and update process of the Hazard Mitigation Plan. The stakeholders were selected based on their respective role and authority to: regulate land use and development of property within the floodplain; adopt local ordinances, policies, and procedures that support the goals and strategies of the 2018 HMP update; provide administrative and managerial support to engage public participation in the HMP update process; procure capital and grant funds necessary to support mitigation projects and programs within the County; incorporate the goals and strategies of hazard mitigation planning into local plans and other planning tools during routine updates; and expand on and improve existing policies, programs, and resources that support Hazard Mitigation Planning activities.

The HMPC included representatives from the Office of Planning and Zoning (OPZ), the Department of Inspections and Permits (I&P), the Department of Public Works (DPW), the Office of Central Services (OCS), the Public Information Officer (PIO), the Office of Law, and the Office of Emergency Management (OEM). A summary of the Departments and Offices with respect to their role and authority with local and regional hazard mitigation planning is described below.

The Office of Planning and Zoning is responsible for planning the physical growth, development, and land use in the County. OPZ has authority to update the County's general development plan (GDP); adopt local ordinances, policies, and procedures in land use governing subdivision of property, zoning or use of a property, Critical Area requirements, and protection of County resources including historic and archaeological sites. OPZ was identified as a key stakeholder in the update of the Hazard Mitigation Plan based on their respective role and authority to regulate land use and development of property; adopt local ordinances, policies and procedures that the support the goals

and strategies of the Hazard Mitigation Plan; and incorporate goals and strategies of the Hazard Mitigation Plan into local plans and planning tools during routine updates.

The Department of Inspections and Permits has authority to regulate land use activities through the adoption of local building, grading and site development codes; implementation of the local Floodplain Ordinance or floodplain management program; review of building, grading, and site development plans; and inspections, enforcement and issuance of permits and licenses. The Department of Inspections and Permits was identified as a key stakeholder in the update of the Hazard Mitigation Plan based on their respective role and authority to review plans and issue building, grading, and site development permits; inspect, regulate, and enforce building, grading, and site development requirements within the floodplain; implement the local floodplain management program; and adopt local ordinances, policies and procedures that support the goals and strategies of the Hazard Mitigation Plan.

The Department of Public Works is responsible for updating and implementing the County's Master Plan for Water Supply and Sewerage Systems (WSMP). The WSMP reflects the land use policies the 2009 GDP, Small Area Plans, Town Center Plans and related planning policies. The WSMP identifies the mechanisms needed to meet future demand and guide development within the County by establishing criteria for which public and private water and sewer services can be provided. DPW was identified as a key stakeholder in the update of the Hazard Mitigation Plan based on their respective role and authority to incorporate the goals and strategies of the Hazard Mitigation Plan into the WSMP and other planning tools during routine updates; adopt local ordinances, policies and procedures that support the goals and strategies of the Hazard Mitigation Plan; and ensure the design and construction of public hazard mitigation planning projects within the County's Capital Improvement Program.

The Public Information Officer (PIO) serves as the liaison between the Anne Arundel County Office of Emergency Management and the media in disseminating press releases to the news media that seeks public involvement and input on hazard mitigation planning. The PIO is responsible for drafting press releases, responding to media inquiries, and participating in public meetings to field media questions. The PIO is also responsible for coordinating messaging with other County and non-County Public Information Officers.

The Office of Central Services is responsible for providing administrative and managerial support by assisting HMPC representatives, County Departments and Offices with procurement activities related to the 2018 HMP update. The Office of Central Services is also responsible for administering and managing the County's fleet of vehicles, County buildings and facilities, and providing risk management services that meets the County's insurance needs by handling all claims, setting workplace safety standards, and working with commercial markets for all other coverage.

The Office of Law provides legal services to all County offices, departments, boards, commissions, agencies, and the County Council. The Office drafts and facilitates local legislation to regulate land use and development of property within the floodplain as well as other areas of the County; issues advice and opinions on legal questions affecting the interests of the County and reviews all deeds, bonds, contracts, and other legal papers involving the County's interests.

The Office of Emergency Management is responsible for implementing a comprehensive emergency management program that is aimed to prevent, protect, mitigate, respond, and recover from natural and man-made hazards that threaten the lives or property of citizens of the County. The Emergency Operations Center (EOC) allows proper coordination of resources and assets among local, State, and Federal partners to mitigate the effects of hazards on the community. OEM is also responsible for educating the public about emergency preparedness, mitigation strategies, and disaster recovery systems.

A full description of the roles and responsibilities of the Departments and Offices is included in Section 3.2.3 of the 2018 HMP update.

The HMPC is comprised of the following individuals:

Table 5.3-1
Anne Arundel County 2018 Hazard Mitigation Plan Update
Hazard Mitigation Planning Committee

Committee Member	Title	Organization	Interest in Hazard Mitigation Planning			
			Local	Regional	Neighboring Jurisdiction	Other
Christina Cornwell	Deputy Director	Anne Arundel County Office of Emergency Management	√	√		
Bill Bryant*	Assistant Director	Anne Arundel County Department of Inspections and Permits	√			
Lynn Miller*	Assistant Planning and Zoning Officer	Anne Arundel County Office of Planning and Zoning	√			
Karen Henry*	Assistant Director	Anne Arundel County Department of Public Works	√			
Nancy Noonan	Deputy Central Services Officer	Anne Arundel County Office of Central Services	√			
Jason Fetterman	Attorney	Anne Arundel County Office of Law	√			
Owen McEvoy	Public Information Officer	Anne Arundel County Office of Public Information	√			

5.3.3 Hazard Mitigation Planning Committee Meeting Schedule

The HMPC and the consultant hired by the County were responsible for completing the HMP update and all of its component sections. The HMPC met two times during the HMP update process. These meetings took place at the Anne Arundel County Office of Emergency Management. See Appendix C for all meeting minutes and list of attendees.

Meeting 1 **March 9, 2018**
Meeting 2 **June 4, 2018**

A key part of the HMP update process was that the HMPC reviewed the document as it was developed, provided feedback, and approved draft and final versions of the document.

5.3.4 Composition of the Stakeholders Group

The stakeholders group was engaged early in the planning and update process as the 2018 first draft HMP was being developed. The composition of the stakeholders group included representatives from local, regional, State, and Federal agencies, public and private, and from neighboring communities with a vested interest in the 2018 HMP update, or who have programs or constituent groups that would be affected by mitigation activities or projects.

The 2018 Stakeholders Group was provided with regular updates on the planning process, and were requested to review the document at key points during its development. The HMPC determined the initial composition of the

Stakeholder group. Table 5.3-2 provides the names, titles, and representation of the various members of the Stakeholder group. A representative from the Town of Highland Beach was included in the group with the same responsibilities as other group members. This provided the opportunity for the Town to review and provide feedback necessary to include in the HMP and mitigation efforts.

As drafts of the updated HMP were prepared, OEM advised members of the Stakeholder group about the status of the update, and provided a general summary of changes via email. Stakeholders were offered the opportunity to review sections and provide comments, and needed only to advise the County and its consultant if they wished to do so. The group was requested to provide feedback through email or by telephoning the Anne Arundel County POC, Christina Cornwell or a member of the consultant team. The consultant was responsible for compiling the comments and including them in edited versions of the HMP. These groups and the outreach effort are described in Section 5.4.

Table 5.3-2
Anne Arundel County Hazard Mitigation Plan, Stakeholders Group

Stakeholder	Title	Organization	Interest in Hazard Mitigation Planning			
			Local	Regional	Neighboring Jurisdiction	Other
J. Kevin Aftung	Director	Anne Arundel County Office of Emergency Management	√	√		
Debbie Saylor	Emergency Management	Anne Arundel County Department of Health	√	√		
Jeffrey McClendon	Emergency Manager	Fort George G. Meade	√	√		
Lynn Miller	Assistant Planning & Zoning Officer	Anne Arundel County Office of Planning and Zoning*	√			
Dave Myers	Principal Agent, Agriculture	University of Maryland Cooperative Extension Service	√			**Academia**
Nancy Schrum	Director	County Executive Office, Constituent Services	√			
John Lane	Fire Marshal	Anne Arundel County Fire Department	√			
Doyle Batten	Supervisor of School Security	Anne Arundel County Public Schools	√			
Rick Napolitano	Director	Anne Arundel County Office of Information Technology	√			
Herbert Hasenpusch	Police Captain	Anne Arundel County Police Department	√	√		
Betsey LaBroad	Chief of Park Operations	Anne Arundel County Department of Recreation and Parks	√			
Brittany Jones	External Affairs Specialist	BG&E	√	√		**Private industry**
Joanie Appel	Geographic Information System Specialist	Anne Arundel County Office of Information Technology	√			
John Czajkowski	District Manager	Anne Arundel County Soil Conservation	√	√		

		District				
William H. Sanders III	Mayor	City of Highland Beach			√	
David Mandell	Deputy Director	City of Annapolis Emergency Management			√	
David McMillian	Director	City of Baltimore Office of Emergency Management			√	
Jay Ringgold	Director	Baltimore County Office of Emergency Management			√	
Alfred Jeffrey	Director	Calvert County Office of Emergency Management			√	
Rick Ayers	Director	Harford County Office of Emergency Management			√	
Mike Hinson	Director	Howard County Office of Emergency Management			√	
Courtney Mariette	Regional Planner	Prince George's County Office of Emergency Management			√	

Step 2 Identify Hazards and Assess Risks

In accordance with general mitigation planning practice, as well as the process FEMA established in its Planning *How-To* series of guides, the risk assessment formed the basis of the original HMP by identifying and characterizing vulnerabilities across the County. As noted earlier, this part of the original document met FEMA requirements, with the result that the HMP was approved by MEMA and FEMA Region III. However, during the 2012 update process, the County recognized that there were several opportunities for improvement in the next-generation document. The HMP was updated to include more detailed risk calculations, which supported the County's process for identifying and prioritizing mitigation actions and strategies. This updated structure is retained in the 2018 HMP update.

As required by FEMA rules and guidance, Sections 6 and 7 of this HMP:

- Identify the natural hazards that are most likely to affect the County
- Describe how often hazards are expected to impact the County
- Explain the expected severity and extent of the impacts
- Describe what areas of the County are likely to be affected
- Estimate expected future losses if the risk is not mitigated

1.1.1 Identifying Hazards

Early in the first update process (2012), the HMPC recommended significant edits to the original hazard identification and profiling sections of the original HMP. The reason for this is to reduce the emphasis on low probability and man-made disasters and to focus on the most probable natural hazard events. The original list of hazards was modified to include only the following:

1. Riverine flooding
2. Coastal flooding
3. Dam failure and release
4. Drought
5. Earthquake
6. Extreme heat
7. Hurricane, tropical storm and nor'easter
8. Severe thunderstorm and hailstorm
9. Severe winter storm
10. Tornado
11. Wildfire, urban interface fire
12. Erosion

During its first meeting, the 2018 HMPC determined by consensus that this same list of hazards would be retained for the 2018 update. Each of these hazards is addressed in detail in Section 6, which includes discussions of hazard history and occurrences, severity and extent of the hazards, and expected probabilities. The subsections are structured to closely parallel FEMA requirements from the Interim Final Rule and subsequent guidance and regulations.

1.1.2 Assessing Risks

During the first HMP update (2012), the HMPC determined that detailed, quantitative risk assessments would be completed for four of the most significant hazards in the master list. These include flooding, hurricane wind, tornadoes and winter storms. In each case, Section 7 includes estimates of potential losses. The 2018 HMP update retains this approach and updates the risk assessments based on the most current data available.

Step 3 Develop Mitigation Strategies

The Mitigation Strategies process in the 2018 HMP update process included several phases:

1. HMPC reviewed goals, objectives, strategies and actions from the original HMP.
2. HMPC and consultant determined the status of each strategy and action from the original HMP.
3. Subject-matter experts and County officials met repeatedly to identify and develop technical information for additional hazard mitigation actions and strategies.
4. Subject-matter experts made a general assessment of the cost effectiveness of actions.
5. The HMPC completed a STAPLEE evaluation of all strategies and actions in the HMP, including those that were part of the original document and were retained.
6. The HMP was modified to include tables with all strategies and actions, with related information about cost-effectiveness and prioritization (Section 8).

1.1.3 Develop Mitigation Strategies

Mitigation goals and objectives were formulated with the intent to reduce or eliminate the long-term risk to human life and property from each hazard. An action plan was developed that identifies future mitigation actions, estimates costs, defines benefits, identifies the responsible organization(s), provides an implementation schedule, relates to the mitigation objectives, establishes priorities, and identifies potential funding sources for each action.

For the 2018 HMP update, the HMPC and its consultant used a somewhat simpler process for updating the mitigation actions and strategies than was used in the 2012 version. The various actions and strategies documented in Section 8 were listed in separate documents and sent to the appropriate County POCs for evaluation and feedback, mostly regarding the current status of the actions, and to solicit input on any new actions that are being considered or implemented. County departments and offices participating in the development of mitigation strategies included: the County Executive Office, the Office of Central Services, the Office of Emergency Management, the Fire Department, the Department of Health, the Office of Information Technology, the Department of Inspections and Permits, the Office of Planning and Zoning, the Police Department, the Office of Law, the Department of Public Works, and Anne Arundel County Public Schools.

Step 4 Develop the Mitigation Plan

The process employed to develop this HMP update was based entirely on the FEMA 386-series of guides that describe hazard mitigation planning procedures. FEMA guidance and rules address local mitigation planning, and identify new mitigation planning requirements.

States and FEMA Regional Offices use the FEMA *Plan Review Tool* to evaluate HMP updates. The tool is based on the *Multi-Hazard Mitigation Planning Guidance under the Disaster Mitigation Act of 2000* (FEMA, March 2004). This Plan Review tool is consistent with the *Disaster Mitigation Act of 2000* (P.L. 106-390), enacted October 30, 2000 and *44 CFR Part 201 – Mitigation Planning, Interim Final Rule* (the Rule), published February 26, 2002. The HMP cannot be approved if it has not been formally adopted. Each requirement includes separate elements. All elements of the requirement must be rated "Satisfactory" in order for the requirement to be fulfilled and receive a score of "Satisfactory."

Step 5 Implement the Plan and Monitor Progress

The County HMP must be updated every five years in order for the County to maintain its eligibility for various FEMA grant programs and funds. During this five-year period, the County will review the HMP annually to ensure compliance with FEMA and State requirements for document maintenance (See Section 9 – Plan Monitoring and Maintenance for more details). After the updated document is approved, the County will implement specific actions to achieve the goals and objectives described in the Mitigation Strategies section.

The Anne Arundel County Council governs the County and has the final decision on what projects are implemented and how they will be funded. The Council will coordinate with the Office of Emergency Management (OEM) and project managers for the mitigation action items. The project managers will follow any current County procedures in completing the Action Items. Any progress reports and status reports (meeting minutes) will be submitted to the County Council.

The OEM is responsible for overall HMP monitoring and maintenance, and the office will review the HMP every year to consider changes in land development, population growth, or recent programs and activities that may affect mitigation initiatives. See Section 9.3 for the complete method and schedule for updating the HMP.

5.4 How the Public was Involved

Anne Arundel County OEM initiated three opportunities for the public to review and comment on the 2018 HMP update. There was one public presentation and there will be one subsequent outreach effort during the legislative process to adopt the 2018 HMP update. For the initial public meeting, notifications were prepared on the County website and OEM's Facebook page. This informed the public about the Hazard Mitigation Planning process and invited the public to participate in the process. All of the meetings were open discussions, where each person attending had the opportunity to volunteer information about the community and present ideas. Data was also collected from the respective jurisdiction representatives and used to assist with the HMP development. Drafts of the HMP were available for public review, and the public was invited to provide input on the document. In accordance with legal requirements, the County published public notices about the presentation on the County website in advance of the outreach initiative (See Appendix C, Public Notice Documents). The ads explained the purpose of the meeting, and provided the date, time, and location of the meeting place. The meeting minutes and attendee list for the public meetings are included in Appendix C of this document.

The public presentation of the draft plan was held at the Office of Emergency Management on the following date:

Outreach Initiative 1	**June 4, 2018**
Outreach Initiative 2	**Anne Arundel County Council Public Hearing (TBA) on legislation to adopt the 2018 Hazard Mitigation Plan**

The County POC placed copies of the draft and electronic web access directions in County libraries for public comment. A letter on the library display described the purpose of the HMP, and a copy of the draft and contact information were provided. The document was uploaded to the County website on DATE TO BE ADDED and provided contact information for the public to make comments and/or provide feedback. The HMPC and Stakeholders group were also provided with these directions of access to review the draft version of the update, near the end of the planning process. An email was sent to the HMPC and Stakeholders group explaining the purpose of the mailing, and provided details on the process for providing comments.

5.5 Other Local Planning Mechanisms

As required by FEMA Interim Final Rule that governs mitigation planning, the other local planning tools and mechanisms will be reviewed and updated during the routine evaluation and update cycle.

Anne Arundel County is a participant in the National Flood Insurance Program (NFIP) and has adopted a local ordinance to manage development and minimize risk from future damage and losses on properties within the 100-year floodplain from floods. The County has adopted a local Floodplain Ordinance in Article 16, Title 2 of the Anne Arundel County Code, which was last updated in 2010. The program enables properties in the floodplain district with the ability to obtain flood insurance. The Floodplain Ordinance establishes areas within the County subject to inundation of waters of a 100-year flood as the floodplain district. The floodplain district consists of the following subdistricts: Zone A, Zone AE and Zone A1-30, Zone AH and Zone AO, Zone B and Zone X (shaded), Zone C and Zone X (unshaded), and Zone VE and Zone V1-30. Floodplain identification and mapping risks are determined by the Flood Insurance Study for Anne Arundel County, Maryland and Incorporated Areas (revised February 18, 2015) and accompanying flood insurance rate and floodway maps, and all subsequent revisions, as developed by FEMA. The general provisions of Floodplain Ordinance applies to all development, construction and substantial

improvements to existing structures in the floodplain, and includes applications for subdivision development, and building and grading permits.

In addition to the County Floodplain Ordinance, the County has adopted the 2015 International Building Code and 2015 International Residential Code for One- and Two-Family Dwellings, and the administrative changes of each supplement, as the local Building and Construction Code of the County. The Building and Construction Code and the local Floodplain Ordinance are used in conjunction with the FEMA Floodplain maps to determine compliance for development, new construction, and substantial improvements to existing structures on properties located in the floodplain. The Department of Inspections and Permits is the agency responsible for administering and enforcing the Building and Construction Code and the local Floodplain Ordinance for the County, and is required to maintain all records associated with floodplain district permit actions.

The local floodplain ordinance applies to all development, construction and substantial improvements to existing structures in the floodplain, and includes applications for subdivision development, and building and grading permits. The following is a summary of the local floodplain ordinance in the review and approval of applications by the Department of Inspections and Permits within the 100-year floodplain:

A. The local floodplain ordinance limits development in the floodplain if an alternative location exists. The local floodplain ordinance also limits encroachment inside the floodplain for structures when a disturbance of the 100-year floodplain is unavoidable.

B. The local floodplain ordinance provides authority to repair or rehabilitate existing dwellings in flood hazard areas. The applications are initially reviewed to determine whether the proposed cost of work meets the definition of a substantial improvement. If the proposed cost of work equals or exceeds 50 percent of the current market value before the damage occurred, full compliance with Building and Construction Codes including raising the lowest habitable level of the structure to an elevation of one foot above the flood protection elevation level for the property is required.

C. The local floodplain ordinance provides authority to issue permits for new construction or substantial improvements to nonresidential structures when the following conditions are met:
   - a floodproofing design is submitted to ensure areas below the flood protection elevation are watertight with walls substantially impermeable to the passage of water and with structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy for flooding to the flood protection elevation; and
   - a FEMA floodproofing certificate is provided.

D. The local floodplain ordinance requires new construction, substantial improvements, and habitable space applications within the 100-year floodplain to elevate the lowest floor to one foot above the flood protection elevation level of the property unless the construction, reconstruction, and rehabilitation involves:
   - an expansion to address a violation of State or County health, safety, or sanitary codes; or
   - the construction consists of an accessory structure, attached garage, or non-substantial improvement to an existing dwelling that meets the following criteria:
     - the structure is constructed so as to minimize flood damage;
     - the structure is firmly anchored to prevent flotation;
     - the structure is used for parking, storage, or building access;

- the floor elevation of the structure is at or above existing grade and does not qualify as a basement; and
- the structure is equipped with flood equalization vents in accordance with the Building and Construction Code.

Applications for building and grading permits must include the following information to ensure the Construction and Building Code and the local Floodplain Ordinance are capable of being met:

- the elevation of the 100-year flood; high-velocity water and wave action including its relation to a stream channel, shoreline, floodplain district, and floodplain subdistrict; elevations of the existing ground contour and proposed final grade of the property; and the elevations of the lowest floor level(s) and the floor area below the lowest floor;
- the methods used to elevate a proposed structure, including details of proposed fill, pile structures, retaining walls, foundations, and erosion protection measures;
- the methods used to protect electrical, plumbing, and mechanical systems and utilities from flooding;
- the assessed value of existing structures or an "as is" appraisal of the market value of the existing structure, excluding land value; and
- a statement on the building plans for accessory structures indicating there will be no conversion of the area to habitable space unless the lowest floor is elevated to one foot above the 100-year flood elevation.

A substantial improvement is defined as any reconstruction, rehabilitation, addition, or other improvement of a building, the cost of which equals or exceeds 50 percent of the market value of the building before the start of construction of the improvement. The term includes buildings that have incurred substantial damage, regardless of the actual repair work performed.

A non-conversion agreement is required before an accessory structure, attached garage, and non-substantial improvement of an existing dwelling may be constructed within the 100-year floodplain. The non-conversion agreement prohibits conversion of the accessory structure, garage, and non-substantial improvement unless the structure is raised to the flood protection elevation. The County requires the non-conversion agreement to be recorded in land records to assure future property owners are notified of the use and occupancy limitations.

When the County undergoes an update its local Floodplain Ordinance, Building and Construction, and Development Codes, the mitigation strategies and actions identified from the 2018 HMP update and future updates will be requested to be reviewed and incorporated in the appropriate sections of the Anne Arundel County Code as well as integrated into programs, policies and other documents. Following local adoption, the 2018 HMP update will be made available to each planning committee member involved in the 2018 HMP update. The County follows the International Building Code guidelines, and maintains a General Development Plan (which is currently undergoing a major update), a Capital Improvement program, and Site Development Regulations. Like most jurisdictions, Anne Arundel County periodically reviews and updates its standards and guidelines. As part of these future reviews and updates, the County will explore opportunities on how to integrate and adopt hazard mitigation strategies and actions into existing ordinances, regulations, policies and standard practices. The County intends to use the HMP, namely the actions and projects described in Section 8, as the local process for prioritizing and recommending hazard mitigation and risk reduction projects for consideration in the County Capital Improvement program.

5.6 Review and Incorporation of Plans, Studies, Reports and other Information

Other planning documents are used as a resource for integrating hazard mitigation strategies and actions from the 2018 HMP update. The 2018 HMP update included a review of other local comprehensive plans, studies, and reports for the purpose of determining where and how to incorporate the hazard mitigation strategies and actions identified from the 2018 HMP update. A discussion on new plans, studies, and reports was also conducted to identify if the results of those plans, studies, and reports need incorporation into the 2018 HMP update.

The 2018 HMP update was made available to each HMP committee member and stakeholder.

Before the next HMP update, the Office of Emergency Management (OEM) will establish a process by which partners and stakeholders will work collaboratively to identify hazards, assess vulnerabilities, identify significant risks, and develop hazard mitigation actions to meet the needs of the community. The process will involve an annual review and assessment of existing comprehensive plans in an effort to identify how the hazard mitigation strategies and actions of the 2018 HMP update can be integrated into local comprehensive plans, policies, and programs such as the General Development Plan and Capital Improvement program. The process will involve meeting with the HMP committee members and stakeholders on an annual basis to:

- evaluate the progress of existing mitigation projects and actions listed in Table 8.4-2 of the 2018 HMP update showing the High, Medium, and Low Priority Mitigation Actions identified for the County; and.
- identify any new projects that need to be added to the HMP and Table 8.4-2 of the 2018 HMP update showing the High, Medium, and Low Priority Mitigation Actions identified for the County.

The result of this coordination effort will enable the County to maintain an up to date HMP as well as increase the level of awareness about hazard mitigation planning, projects, and actions occurring within the County. The new process will also ensure HMP committee members and stakeholders have the opportunity to provide input and have the capability to integrate hazard mitigation strategies, actions, and best practices into local comprehensive plans, programs, policies, and standard practices.

Table 5.6-1
Incorporating Plans, Studies and Reports

Planning and Zoning		
Plan Name	**Update Process**	**Incorporating Mechanism/s**
General Development Plan (GDP)	The current Plan was adopted in 2009. An update is in progress with expected adoption by late 2020.	The GDP is currently undergoing a comprehensive update. The schedule for adoption of the Plan is now anticipated in late 2020. Therefore, the County is still in the early stages of Plan development. Strategies and actions from the 2018 HMP update will be reviewed and considered by the County to address climate change, sea level rise, and resiliency planning as well as limiting or restricting the extent of future development in areas subject to coastal flooding, climate change, and sea level rise.

Article 16- Floodplain Management, Sediment & Stormwater Management	Last update occurred in 2015. Article 16 is amended to meet State criteria as needed.	OEM will assess the local Floodplain management program and ordinance with the HMPC; submit recommendations to improve local building standards, as necessary, in coastal high hazard areas, or "V" zones, subject to high velocity wind, wave action and tidal flooding; and recommend floodplain mitigation projects involving high flood risk areas into hazard mitigation planning. The purpose of any amendments will be to reduce potential damage and future losses to property, life and critical infrastructure.
Article 17- Subdivision & Development Regulations	Last comprehensive update occurred in 2005. Individual amendments occur on a regular basis as needed. Next comprehensive update will occur after2020.	OEM. will provide recommendations to improve local development regulations or implement best practices for development in Coastal high hazard areas, or "V" zones, of the County that are subject to high velocity wind, wave action and tidal flooding.
Article 18- Zoning Ordinance	Last comprehensive update occurred in 2005. Individual amendments occur on a regular basis as needed. The next comprehensive update will occur after2020.	During the comprehensive planning process for the GDP, the Office of Planning and Zoning will evaluate the Zoning Ordinance with regard to future development and land use potential in areas subject to flooding, sea level rise, and climate change.
Landscape Manual	Last updated in 2010.	OPZ will implement the Landscape manual for shoreline restoration projects that achieves a balance between restoring natural systems and habitats with protecting public and private investments and partnerships. There are not currently any elements in this manual that are directly related to hazard mitigation, and at this time the County has no specific plans to include such elements going forward. The Draft Climate Resilience Action Strategy contains strategies to incentivize the installation of living shorelines on private properties. Related guidance can be incorporated into the Landscape Manual as needed.

Office of Emergency Management		
Plan Name	**Update Process**	**Incorporating Mechanism/s**
Recovery Plan	The most recent update was completed in December 2017. The final version is pending approval by the County Office of Law.	OEM will assess and incorporate hazard mitigation strategies and actions into the Recovery Plan that reduces the potential for future damage and losses to critical infrastructure and enhances recovery operations.
Emergency Operations Plan (EOP)	A comprehensive EOP update was completed in July 2018, and as of September 2018 was under review by the County Office of Law.	The EOP describes how the County will respond to emergencies within the County. Mitigation strategies are essential in easing the burden and recovering from the effects of a disaster. Developed strategies to include in plan.
Continuity of Operations Plan (COOP)	An update was completed in July 2018.	The COOP indicates how OEM and other agencies and departments will continue to provide essential services within the County and to the public. COOP planning is a fundamental aspect of establishing resiliency within the community by identifying the systems, facilities, and resources that are needed by County government to recover from disaster events.
Department of Inspections and Permits		
Plan Name	**Update Process**	**Incorporating Mechanism/s**
Article 15– Construction and Property Maintenance Codes	The Codes were last updated in 2003. They are generally updated every three to six years.	During the annual HMP review process, the HMPC will discuss whether changes to international building codes have been or should be adopt to reduce the potential impact of natural hazards on human life, property, and critical infrastructure.
Department of Public Works		
Plan Name	**Update Process**	**Incorporating Mechanism/s**

Water Supply and Sewage Systems	The last comprehensive update occurred in 2017. The document is updated every three years, or as needed.	DPW will continue to identify best management practices and risk reduction measures that protects water supply and wastewater systems, and other critical infrastructure from potential damage and future losses.
Capital Improvement Plan/Projects Program	The Capital Projects list is continuously updated as projects are initiated, approved and completed. The list varies by year, and currently includes at least one project (the Shipley's Dam rehabilitation) with some hazard mitigation elements.	The Capital Improvement program does not currently have a review process to incorporate hazard mitigation actions. OEM intends to work with the HMPC to develop a process by using the hazard mitigation actions listed in Table 8.4-2 as the local mechanism for prioritizing and recommending projects for consideration in the County Capital Improvement program.
10-Yr Solid Waste Management Plan	The currently adopted plan is for 2013-2023, with several updates occurring since 2013 via the legislative process.	OEM will continue to support regulations imposing constraints upon the establishment of solid waste acceptance facilities to minimize the impacts on citizens and environment. (i.e. – floodplains are unacceptable areas). This Plan outlines the elements of the solid waste system in use by Anne Arundel County during the planning period, and includes existing and planned facilities -- both public and private.

Section 6
Hazard Identification, Profiling and Ranking
Contents of this Section

The original (2004) Anne Arundel County Hazard Mitigation Plan included analyses of 27 natural and man-made hazards. During the first update (2012), the HMPC determined that the HMP would shift to a focus on natural hazards and therefore man-made hazards (such as cyber crime, communication failure) were eliminated from the document. Note that eliminating these man-made hazards does not suggest that these hazards do not exist and are not of concern to the County, only that they are not natural hazards, and would not be included in the update.

During its first meeting (March 2018) the 2018 HMPC determined that the existing master list of hazards would be retained unchanged from the 2012 HMP.

6.1 Requirement for Hazard Identification and Profiling

Note that the 44 CFR reference in this section is the same as that in Section 7 (Risk Assessment) of this mitigation plan. This is the case because the hazard identification and risk assessment elements are very closely related, and are described in the same 44 CFR section.

> (i) A description of the type, 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.
> (ii) 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. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:
> (A)The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;
> (B)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;
> (C)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.
> (iii) For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

6.2 Hazard Identification

In accordance with IFR requirements, the Hazard Mitigation Planning Committee (HMPC) completed an assessment and ranking of the natural hazards that have the potential to affect the County. Ranking natural hazards allows the County to focus resources on the natural hazards of greatest concern while mapping identifies high risk areas and vulnerable populations. The coupling of these two practices enables the County to integrate hazard mitigation goals and strategies into local comprehensive plans as well as the ability to adopt local ordinances aimed at reducing potential losses to life, property, critical facilities and infrastructure, and other structures in high risk areas and with vulnerable populations. The process further identifies the areas in need and will assist the County to prioritize mitigation strategies, actions, and initiatives that will help to guide future land use, development, and comprehensive planning practices in the County. The following are the resources used to identify and rank the natural hazards which affect the County: the 2016 Maryland Hazard Mitigation Plan, the National Climatic Data Center, Flood Insurance Rate Maps, and the Anne Arundel County Flood Risk Report dated 12/31/2019. The following subsection provides a description of the type, location, and extent of all natural hazards that can affect the County. Hazard identification affecting the County was largely based on past events. Section 7 (Risk Assessment) includes detailed information about past and potential losses (risk) for the natural hazards hazards having the highest potential to affect the County.

The term “planning area” is used frequently in this section. This term refers to the geographic limits of Anne Arundel County.

6.2.1 Natural Hazards Affecting the County

According to the National Oceanic Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database, Anne Arundel County experienced 1,010 natural hazard events that affected the County from 1950 to 2017 8. The 1,010 natural hazard events resulted in 9 deaths and 98 injuries. The County divided the 1,010 natural hazard events into 12 natural hazard categories. The frequency, location, extent, and future probability of the 12 natural hazard categories are summarized in Table 6.2-1. The probability for determining future natural hazard events was made based on the historical data. The future probability is defined as follows:

- "Highly likely" is the probability that an event is likely to occur every 1-10 years.
- "Likely" is the probability that an event is likely to occur every 10-50 years.
- "Unlikely" is the probability that an event is likely to occur at intervals greater than 50 years.

More information on natural hazard categories and their potential to affect the community is provided in Section 6.3. The history of natural hazards affecting the County and data provided in Table 6.2-1 was obtained based on a February 2020 query of the NCDC database, since previous data from prior versions of the 2018 HMP update could not be duplicated. (Source: www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms).

Table 6.2-1
History of Natural Hazard Events Affecting the County 1950-2018
(NOAA National Climatic Data Center database)

Natural Hazard	Previous Occurrence	Deaths	Injuries	Location	Future Probability
Riverine Flooding	131	2		Floodplain	Highly likely
Coastal Flooding	26			Coastal Floodplain	Highly likely
Dam Failure/Release				Dam EAP	unlikely
Hurricane, Tropical Storm, and Nor'easter	3		1	County	likely
Drought	12			County	likely
Earthquakes				County	likely
Extreme Heat	48	1	61	County	likely
Severe Thunderstorm and hailstorm	513	4	29	County	Highly likely
Severe Winter Storm	196	1	1	County	Highly likely
Tornado	23			County	Highly likely
Wildfire, urban interface fire	1		2	County	unlikely

Erosion	57	1	4	County	Highly likely

Various federal agencies maintain records of property losses and damages associated with natural hazards. Unfortunately, no single source offers a definitive accounting of such losses, many of which are covered by private insurers. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The U.S. Army Corps of Engineers and the Natural Resources Conservation Service collect data on losses during the course of some of their ongoing projects and studies. Additionally, NOAA and the NCDC collect and maintain data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs.

In the absence of definitive data on some of the natural hazards that may occur in the County, illustrative examples are useful. Table 6.2-1 provides brief descriptions of particularly significant natural hazard events occurring in Anne Arundel County's recent history. This list is not meant to capture every event that has affected the area, rather lists examples of the types of events that have occurred in the County in the past.

In 1965, the federal government began to maintain records of events deemed significant enough to warrant declaration of a major disaster by the U.S. President. Presidential Disaster Declarations are made at the County level. Anne Arundel County has received eleven Presidential Disaster Declarations since 1953. Some of the more significant Presidential Disaster declarations include Tropical Storm Agnes (DR-341) in 1972, Hurricane Floyd (DR-1303) in 1999, Hurricane Isabel (DR-1492) in 2003, and Hurricane Sandy in 2012. Table 6.2-2 represents actual natural hazard events affecting the County which resulted in a declaration of a local or State of emergency. Information on the extent of the event in terms of strength or magnitude is provided in the description section of Table 6.2-2. Table 6.2-2 also includes the number of deaths and injuries associated with each historical natural hazard event.

Table 6.2-2
History of Natural Hazards and Declared Major Disasters impacting Anne Arundel County, Maryland
(FEMA, NOAA National Climatic Data Center database)

Disaster (DR) & Date	NATURAL HAZARD	Description	Deaths	Injuries
August 17, 1971 (DR-309)	Severe storms & flooding	No detailed open-source information is presently available.	0	0
June 26, 1972 (DR-341)	Tropical Storm Agnes	The entire State of Maryland was declared a disaster area. In Anne Arundel County, structures were flooded along Old Annapolis Road, in North Pumphery, and in a trailer court on Belle Grove Road. It was estimated that Agnes exceeded a 100-year flood.	0	0
October 4, 1975 (DR-489)	Heavy rains & flooding	No detailed open-source information presently available.	0	0
September 14, 1979 (DR-601)	Severe storms, tornadoes & flooding	No detailed open-source information presently available.	0	0
March 16, 1994 (DR-1016)	Severe winter storm	No detailed open-source information presently available.	0	0
January 11, 1996 (DR-1081)	Blizzard of 1996	The Blizzard of 1996 is ranked by some winter weather experts as the second-worst snowstorm ever to strike the Northeast in modern times. The Nor'easter buried portions of Maryland under three to four feet of snow. Baltimore recorded 26.6 inches over three days at BWI Marshall Airport. Snowfall totals in Anne Arundel County ranged from 15 to 18 inches.	0	0

Disaster (DR) & Date	NATURAL HAZARD	Description	Deaths	Injuries
September 24, 1999 (DR-1303)	Hurricane Floyd	Hurricane Floyd made landfall just east of Cape Fear, North Carolina in the early morning hours of the 16th and moved north-northeast across extreme southeast Virginia to near Ocean City, Maryland by evening on the 16th. The event resulted in over 1,000 homes reported flood damage and over 100 roads closed. In Anne Arundel County, between eight and 12 inches of rain were reported. Strong southerly winds ahead of the hurricane pushed tides two to three feet above normal, flooding several low lying areas in St. Mary's, Calvert, Harford, and Anne Arundel Counties. High water destroyed five homes, caused major damage to 23 others, and caused minor damage to an estimated 1,000 homes in the eastern portion of Anne Arundel County.	0	0
April 10, 2000 (DR-1324)	Severe winter storm	No detailed open-source information presently available.	0	0
March14, 2003 (DR-3179)	Severe winter storm	No detailed open-source information presently available.	0	0
September 19, 2003 (DR-1492)	Tropical Storm Isabel	On September 18, 2003, Hurricane Isabel made landfall on the North Carolina coast. By the time Isabel moved into central Virginia, it had weakened and was downgraded to a tropical storm. Isabel's eye tracked well west of the Chesapeake Bay. However, the storm's 40 to 50 mph sustained winds pushed a bulge of water northward up the Bay and its tributaries, producing a record storm surge. The Maryland western shore Counties of the Bay and along the tidal tributaries of the Potomac, Patuxent, Patapsco and other smaller rivers experienced a storm surge that reached five to nine feet above normal tides. Over 2,000 people were evacuated from their homes. In Maryland alone, 472 homes and buildings were destroyed. Of these, 3,260 had major damage and over 3,600 more were affected. In Anne Arundel County, FEMA initially estimated the storm caused approximately $500 million in damages.	0	0

Disaster (DR) & Date	NATURAL HAZARD	Description	Deaths	Injuries
December 18-20, 2009, and February 5-11, 2010 (DR-1875 and DR-1910)	Winter Storms	One winter storm in late 2009, and two severe storms in early February 2010 resulted in widespread power outages, closed roads, and caused a significant need for emergency snow removal. The two disasters were declared to provide the State and Counties reimbursement funds primarily for snow removal.	0	0
September 6, 2011 (DR-4038)	Remnants of Tropical Storm Lee	The remnants of Tropical Storm Lee brought torrential rainfall and flooding to numerous counties in Maryland. A Pasadena (Anne Arundel County) man died by drowning.	1	0
October 26 – November 4, 2012 (DR-4091)	Hurricane Sandy	Sandy created heavy rainfall and relatively high winds in Anne Arundel County, with some 57,000 Baltimore Gas and Electric customers losing power in the County. A falling tree killed a Pasadena man. Overall, damages in Anne Arundel County were relatively minor compared to other jurisdictions and States on the eastern seaboard.	1	0
January 22-23, 2016 (DR-4261)	Winter Storm	Heavy snow caused widespread disruptions and resulted in a long clean-up period after the event.		
		TOTAL	2	0

6.2.2 Weather-Related Deaths and Injuries

Note that in the interim between when this information was collected and the final draft of the HMP, NOAA has significantly modified its hazard database, with the result that many of the historical events being eliminated from the public-access data set. The numbers of deaths and injuries indicated here were compiled from the more robust data set, but cannot presently be assigned to individual events or years.

6.3 Overview of the Natural Hazards that can affect Anne Arundel County

The HMPC met in early March 2018 and determined that the following overall list of natural hazards is still valid for the 2018 update.

1. Riverine flooding
2. Coastal flooding
3. Dam failure and release
4. Hurricane, tropical storm and nor'easter
5. Drought
6. Earthquake
7. Extreme heat
8. Severe thunderstorm and hailstorm
9. Severe winter storm
10. Tornado
11. Wildfire, urban interface fire
12. Erosion

The following section profiles the 12 hazards listed above, and includes a description of the hazard, location and extent of the hazard, severity of the hazard, impact on life and property, and past occurrences. A scoring system is then used in Section 6.4 to broadly characterize the level of risk each hazard poses to the County. A scoring classification of low (1), medium (2), and high (3) was given to each hazard, based on five criteria. The resulting numerical rankings were used to determine which hazards would be given priority in developing detailed risk assessments later in the process. The hazard ranking determined that the **Flood, Hurricane Wind, Tornado and Winter Storm** hazards would be included in the more detailed risk assessment in Section 7. See Section 6.4 for additional details about the criteria used to rank each hazard and the complete results of the hazard ranking.

• 6.3.1 Riverine Flooding

6.3.1.1 Description of the Flood Hazard

Flooding is defined as the accumulation of water within a water body and the overflow of excess water onto adjacent floodplain lands. The floodplain is the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that is susceptible to flooding.

Hundreds of floods occur each year in the United States, including overbank flooding of rivers and streams and shoreline inundation along lakes and coasts. Flooding typically results from large-scale weather systems generating prolonged rainfall. Flooding in Anne Arundel County can be the result of the following weather events: hurricanes, thunderstorms (convectional and frontal), storm surge and winter storms. Flooding from hurricanes is covered in Section 6.3.2 and flooding from storm surge is covered in Section 6.3.3.

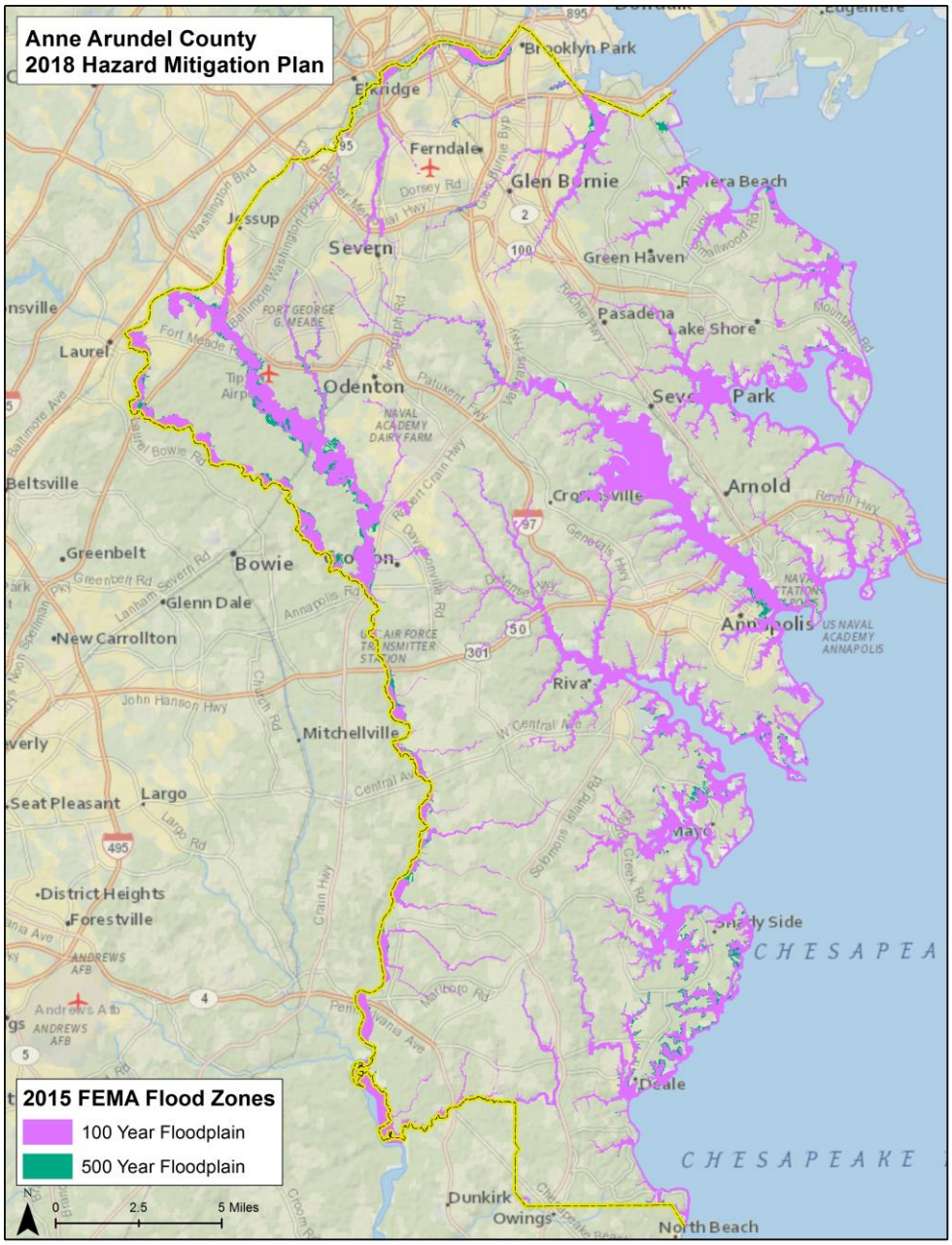
6.3.1.2 Location and Extent of the Flood Hazard

Anne Arundel County is located on the western shore of the Chesapeake Bay. The County's 533 miles of shoreline constitute more coastline than any other part of Maryland. According to the U.S. Census Bureau, the County has a total area of 588 square miles. Of that, 416 square miles is land and 172 square miles is water. An updated Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for Anne Arundel County were published by FEMA and adopted by Anne Arundel County in 2015. This study characterizes flooding in Anne Arundel County and the surrounding area, describes its causes, and identifies flood protection measures. The FIS indicates that the principal cause of flooding within the County is from severe thunderstorms, hurricanes and tropical storms that follow a northern route along the Atlantic coastline (Source: Anne Arundel County FIS, final 2015).

Topography in the County ranges from level to very steep. Nearly level and gently sloping soils are located in large areas north of the Severn River and Magothy River on the Deale-Shadyside flats and in the southwestern portion of the County adjoining the Patuxent River. The steepest slopes are found in a north-south section that runs through the central part of the County, where many small streams have cut deep V-shaped valleys into the soft unconsolidated materials of the coastal plain. Broad alluvial terraces border many of the large streams and rivers that flow into the Chesapeake Bay to more than 300 feet in the northwestern part of the County (Source: Anne Arundel County 2015 Flood Insurance Study). The average annual precipitation varies from 40 to 44 inches and is fairly evenly distributed throughout the year. Most precipitation in the colder half of the year is the result of low-pressure systems moving northeast along the coast. In the summer, precipitation occurs in the form of showers and thunderstorms. Thunderstorms occur on an average of 31 days per year, with almost 70 occurring from May through August.

The specific causes and effects of flooding within the planning area are discussed in more detail in Section 7 (Risk Assessment). The FIS produced for the County also includes Flood Insurance Rate Maps (FIRMs) depicting the 100-year floodplain. The FIRMs covering Anne Arundel County were last revised in 2015. FIRMs identify the 100- and 500-year floodplain boundaries, shaded in gray on the map (and shown in green and purple shading in the graphic below). This area, also known as the Special Flood Hazard Area (SFHA), includes numbered contours to identify the 100-year flood elevations. Review of the FIRM shows that the approximately five percent of the County is within the 100-year floodplain. Figure 6.3-1 shows the 100- and 500-year floodplains for Anne Arundel County.

Figure 6.3-1
Anne Arundel County 100- and 500-year Floodplains
(Source: FEMA RAMPP)



6.3.1.3 Severity of the Flood Hazard

Flood severity is measured in several ways, including depth, velocity, duration and presence of contamination, among others. Since 1902, the National Weather Service (NWS) has compiled annual estimates of the number of lives lost and flood damage, excluding losses to agriculture. Despite known problems with the NWS data, they provide the most complete and consistent information over the longest period of record. For the period 1916 to 1989, there has been a definite increase in flood damage in the United States. With adjustment for population and inflation, the average annual damage was $902 million for the 1916 to 1950 period, and $2.15 billion for the 1951 to 1985 period. These figures will certainly increase with the eventual inclusion of several major floods since then, including Katrina (and the numerous other events of that same year and the next), Isabel, Sandy, Harvey, Florence and various other hurricanes.

Floods have been and continue to be the most common natural hazard affecting Anne Arundel County. This is supported by a review of the Statewide Risk Assessment for the Maryland Hazard Mitigation Plan. Section 5.4 (Flood) of the State Plan includes a table of the highest average annual flood losses determined from reviewing National Flood Insurance Program (NFIP) records. As of April of 2005, Anne Arundel County was ranked third in the State with an average of slightly less than $5 million in annual NFIP claims. Note that the current (2016) version of the State Hazard Mitigation Plan does not include this data, so this County HMP update reiterates the existing information from the previous HMP.

6.3.1.4 Impact on Life and Property

The National Climatic Data Center (NCDC) database indicates that there have been 32 inland floods in Anne Arundel County in the period from 1950 to 2009. Hurricanes and all the associated damages, such as flooding, are tracked as a separate hazard category in the NCDC database. Figures maintained by NCDC indicate that Anne Arundel County has experienced no deaths and two injuries due to floods. (Source: NOAA/NCDC database). Note that as of March 2018, the NOAA NCDC database has not been updated since it was last queried for this information. The impacts of floods on life and property in Anne Arundel County are discussed in more detail in the subsection related to National Flood Insurance Program information.

6.3.1.5 Occurrences of the Flood Hazard

Past versions of this HMP included more detailed summaries of past flood events, based on data provided in NOAA's National Climatic Data Center (NCDC) on-line resource. Since the 2012 version of the HMP, the NCDC website has changed, and now provides only limited summaries of past events. This is not particularly significant, since the previous data set was largely incomplete as well. The 2012 County HMP indicated that the NCDC database listed 46 flood events between 1993 and 2009, with 15 resulting in property damage. The most recent query, shown in Table 6.3-1 summarizes the flood events that have caused property damage within Anne Arundel County between 2003 and 2017. This should be considered a significant underestimate of damages, presumably because of the reporting processes used by NOAA. The NFIP claims data discussed elsewhere in the HMP offer a better overall picture of the magnitude and locations of flood losses.

Table 6.3-1
Inland Flood Events Resulting in Property Damage,
Anne Arundel County, 2003 – 2017

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								1	0	106.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/22/2003	08:00	EST	Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	12/11/2003	05:00	EST	Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	07/07/2005	18:00	EST	Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/08/2005	13:00	EST	Flood		0	0	0.00K	0.00K
SEVERN	ANNE ARUNDEL CO.	MD	11/16/2006	14:30	EST-5	Flood		0	0	0.00K	0.00K
GLEN BURNIE	ANNE ARUNDEL CO.	MD	03/16/2007	14:00	EST-5	Flood		0	0	0.00K	0.00K
FT MEADE	ANNE ARUNDEL CO.	MD	04/15/2007	08:00	EST-5	Flood		0	0	0.00K	0.00K
ANNAPOLIS	ANNE ARUNDEL CO.	MD	05/12/2008	01:00	EST-5	Flood		0	0	100.00K	0.00K
REVELL	ANNE ARUNDEL CO.	MD	08/18/2010	07:05	EST-5	Flood		0	0	0.00K	0.00K
SEVERNA PARK	ANNE ARUNDEL CO.	MD	08/18/2010	08:47	EST-5	Flood		0	0	0.00K	0.00K
ARNOLD	ANNE ARUNDEL CO.	MD	09/30/2010	09:30	EST-5	Flood		0	0	0.00K	0.00K
RUTLAND	ANNE ARUNDEL CO.	MD	04/17/2011	13:30	EST-5	Flood		0	0	0.00K	0.00K
JACOBSVILLE	ANNE ARUNDEL CO.	MD	07/08/2011	15:50	EST-5	Flood		0	0	0.00K	0.00K
GREEN HAVEN	ANNE ARUNDEL CO.	MD	07/08/2011	16:32	EST-5	Flood		0	0	0.00K	0.00K
LYONS CREEK	ANNE ARUNDEL CO.	MD	08/28/2011	06:00	EST-5	Flood		0	0	0.00K	0.00K
RIVA	ANNE ARUNDEL CO.	MD	09/06/2011	00:45	EST-5	Flood		0	0	0.00K	0.00K
EARLEIGH HGTS	ANNE ARUNDEL CO.	MD	09/07/2011	20:15	EST-5	Flood		1	0	0.00K	0.00K
GLEN BURNIE	ANNE ARUNDEL CO.	MD	09/08/2011	03:15	EST-5	Flood		0	0	0.00K	0.00K
LYONS CREEK	ANNE ARUNDEL CO.	MD	09/08/2011	03:45	EST-5	Flood		0	0	0.00K	0.00K
ANNAPOLIS	ANNE ARUNDEL CO.	MD	09/08/2011	23:35	EST-5	Flood		0	0	0.00K	0.00K
TIPTON AAF ARPT	ANNE ARUNDEL CO.	MD	10/02/2012	12:30	EST-5	Flood		0	0	1.00K	0.00K
ORDNANCE	ANNE ARUNDEL CO.	MD	10/29/2012	10:29	EST-5	Flood		0	0	0.00K	0.00K
NORTH LINTHICUM	ANNE ARUNDEL CO.	MD	04/30/2014	09:30	EST-5	Flood		0	0	0.00K	0.00K
GLEN BURNIE	ANNE ARUNDEL CO.	MD	04/30/2014	09:34	EST-5	Flood		0	0	0.00K	0.00K
GLEN BURNIE	ANNE ARUNDEL CO.	MD	05/16/2014	06:58	EST-5	Flood		0	0	0.00K	0.00K
CROFTON	ANNE ARUNDEL CO.	MD	05/19/2015	03:58	EST-5	Flood		0	0	0.00K	0.00K
FT MEADE JCT	ANNE ARUNDEL CO.	MD	05/19/2015	04:08	EST-5	Flood		0	0	5.00K	0.00K
RUTLAND	ANNE ARUNDEL CO.	MD	06/21/2016	17:15	EST-5	Flood		0	0	0.00K	0.00K
CROFTON	ANNE ARUNDEL CO.	MD	09/29/2016	07:03	EST-5	Flood		0	0	0.00K	0.00K
LAUREL SURBURBAN ARP	ANNE ARUNDEL CO.	MD	05/05/2017	09:40	EST-5	Flood		0	0	0.00K	0.00K
RAYNOR HGTS	ANNE ARUNDEL CO.	MD	07/29/2017	01:45	EST-5	Flood		0	0	0.00K	0.00K
CROFTON	ANNE ARUNDEL CO.	MD	07/29/2017	06:44	EST-5	Flood		0	0	0.00K	0.00K
Totals:								1	0	106.00K	0.00K

A review of past Presidential Disaster Declarations and historical records such as the Anne Arundel County FIS, showed that there have been several other flood events in Anne Arundel County that are not listed in the database. Highlights of the declared events and other significant past floods are provided in Table 6.3-2 below. The inclusion of a Disaster (DR) Number indicates a Presidentially-declared event. Note that flooding associated with Hurricane Isabel in September 2003 can be found under Section 6.3.2, Coastal Flooding.

Table 6.3-2
Description of Significant Flood Events in
Anne Arundel County from 1950 – 2018
(Sources: Anne Arundel County Flood Insurance Study, NCDC database)

Event & Date	Flood Description
June 26, 1972 (DR-341)	**Tropical Storm Agnes.** The entire State of Maryland was declared a disaster area. In Anne Arundel County, structures were flooded along Old Annapolis Road, in North Pumphery, and in a trailer court on Belle Grove Road. It was estimated that Agnes exceeded a 100-year flood.
June 19, 1996	Heavy rains from severe thunderstorms, combined with runoff from earlier events upstream, pushed the Patapsco River out of its banks along the Howard/Baltimore County line shortly after noon. For the second time in three days, portions of Baltimore City were flooded. In Anne Arundel County, Defense Highway (near Annapolis) was closed due to high standing water. Numerous basements were flooded, as were low-lying neighborhoods especially in Arnold near the Magothy River. Five other County roads were closed as well. The event caused an estimated $25,000 in damages in Anne Arundel County.
December 13, 1996	A north-south band of moderate to heavy rain dumped between two and three inches onto fairly saturated soil across northern and central Maryland, producing several areas of flooding and flash flooding. In Anne Arundel County, six thoroughfares were closed prior to and during the evening commute, including the intersection of State routes 32 and 198 near Laurel, Route 450 at St. Stephens Church Road near Annapolis, and route 648 at Dorsey Road. Several motorists were stranded in the high water.
February 4, 1998	A powerful Nor'easter, carrying copious moisture from the Gulf of Mexico and Caribbean region, dumped between two and four inches of rain across much of Maryland between the foothills and the Chesapeake Bay. The highest totals, ranging from three to five inches, fell in lower southern Maryland, causing widespread flooding of low-lying areas and small streams and creeks. The Nor'easter caused tides of three to four feet above normal from the Calvert/Anne Arundel County line south to Point Lookout in extreme southeastern St Mary's County. The flooding closed seven roads in Anne Arundel County. The event caused approximately $650,000 in damages in Anne Arundel County.
August 26, 1999	Significant flooding of low-lying areas and streams resulted in many roads submerged. A line of intense thunderstorms moved across much of Maryland during the afternoon, producing damaging winds and frequent lightning. Anne Arundel County reported significant flooding after two to seven inches of rain fell in less than four hours. In Anne Arundel County, Brock Bridge, Mill Creek, Race, River, Rideout, and Severn Side Roads were closed by high water.
September 16, 1999 (DR-1303)	**Hurricane Floyd.** Hurricane Floyd made landfall just east of Cape Fear, North Carolina in the early morning hours September 16, 1999, and moved north-northeast across extreme southeast Virginia to near Ocean City, Maryland by evening. The event resulted in over 1,000 homes with flood damage, and over 100 roads closed. In Anne Arundel County, between eight and 12 inches of rain were reported. Strong southerly winds ahead of the hurricane pushed tides two to three feet above normal, flooding several low lying areas in St. Mary's, Calvert, Harford, and Anne Arundel Counties. High water destroyed five homes and caused major damage to 23 homes, and minor damage to an estimated 1,000 homes in the eastern portion of Anne Arundel County. The NDCD database estimated damages totaled approximately $2 million.

Event & Date	Flood Description
October 8, 2005	**Tropical Storm Tammy.** The remnants of Tropical Storm Tammy caused widespread heavy rainfall between three and seven inches across the region. Many roads flooded due to the prolonged rains. Localized areas received close to 12 inches of storm total rainfall. Several roads were flooded and closed across Anne Arundel County due to high water.
June 27, 2006	The NDCD database indicates that a weak cold front settled over area from June 23 until June 27. Waves of low pressure rode northeast along the front. As a result, double-digit rainfall totals affected parts of the region through the five day period. Scattered areas of flash flooding began on June 23 and continued into June 24. In Anne Arundel County, secondary roads near Annapolis were flooded. A foot of water flooded a basement in Annapolis. Route 450 east of Crofton was closed due to high water.
May 12, 2008	On May 12, 2008, widespread showers and thunderstorms produced heavy rain. Anne Arundel Emergency Management as well as newspapers reported widespread flooding that closed roads across Anne Arundel County.
October 5, 2011	Remnants of Tropical Storm Lee. Some flooding in Anne Arundel County.
October 29, 2012	Hurricane/Tropical Storm Sandy. This event is discussed in detail in the Hurricane hazard section of the County mitigation plan update, and is noted here for clarity.

Based on past and recent history, certain parts of the County of Anne Arundel County clearly have a high probability of flooding repeatedly in the future. Based on open source records, the County experiences a flood event on average slightly less than once every year. Section 7 of this HMP includes detailed probability-based estimates of potential future losses for various areas of the County.

National Flood Insurance Program Participation

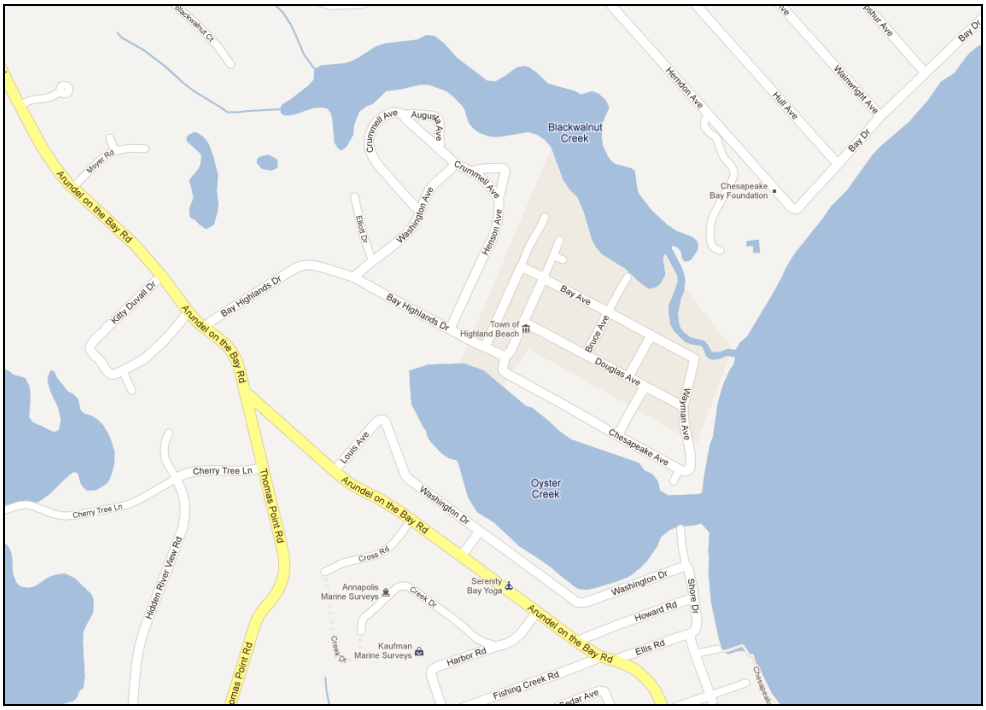
Anne Arundel County has been a participant in the National Flood Insurance Program since May 1983. The County is Community Number 240008B. The initial Flood Hazard Boundary map was adopted in November 1974, and the initial Flood Insurance Rate Map was adopted in May 1983. The current effective FIRM is dated February 18, 2015. The Town of Highland Beach also participates in the NFIP (Community Number 240161B). The Town joined the program in November 1981. Its current effective FIRM is dated February 18, 2015.

Appendix A includes a detailed discussion of National Flood Insurance Claims history, including Repetitive Loss Properties, as required by FEMA mitigation planning guidance. The information has been moved to the appendix for the 2018 HMP update in order to maintain the structure of the present section.

Flood Hazards in Highland Beach

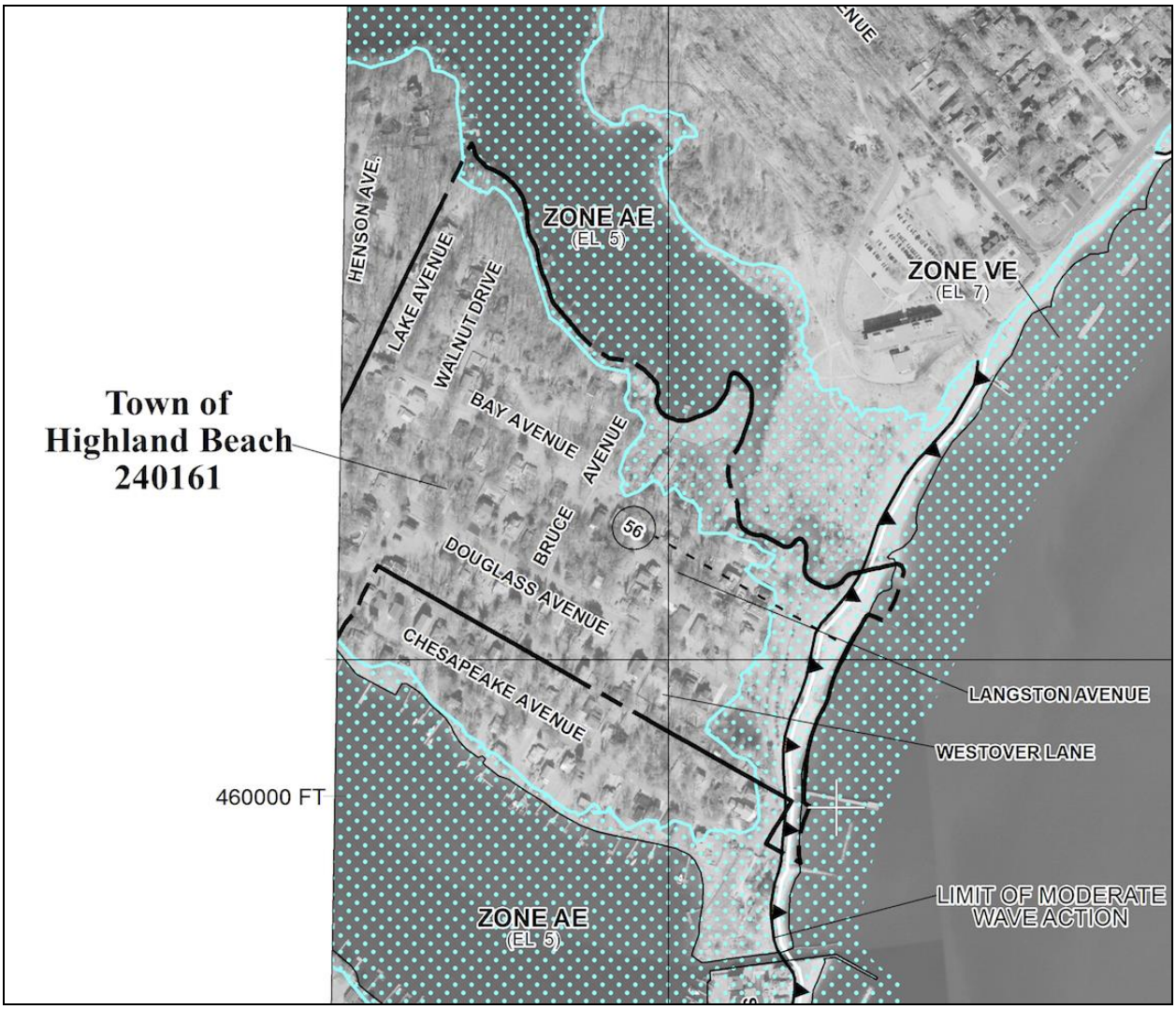
As its name indicates, the Town of Highland Beach is an incorporated jurisdiction within Anne Arundel Count. It was founded in 1893, and presently comprises about one-tenth of a square mile of land area, and is home to a population of 96 (2010 U.S. Census). There are 74 housing units in the area, and according to the census, 46 are presently occupied and used for residences. Figure 6.3-2 shows the location of the Town on the eastern side of the County, south of the City of Annapolis. The town is surrounded on three sides by water – the Chesapeake Bay on the east, and Blackwalnut Creek and Oyster Creek on the north and south sides, respectively.

Figure 6.3-2
Town of Highland Beach Location Map
(Source: Google)



Because of its location on the western side of the Chesapeake Bay, the Town is potentially subject to the effects of flooding and storm surge. The current effective Flood Insurance Rate Map (FIRM) is dated February 18, 2015, and shows that part of the Town is in the floodplain, either in designated *A* zones, or in *V* zones, as shown in the figure below. It appears from the FIRM and a review of Google Earth aerials that there are a few structures in the 100-year floodplain in the northeast quadrant of the Town, north of Bay Street and east of Walnut Street.

Figure 6.3-3
Town of Highland Beach Flood Insurance Rate Map (2015)
(Source: FEMA Map Service Center)



Over time, the small amount of development that has occurred in Highland Beach has moved inland from the Chesapeake Bay, with the result that there is only a very small residual exposure to flooding for structures in the jurisdiction. A review of NFIP flood insurance records supports this conclusion – while the County overall has 81 designated Repetitive Loss properties, none are listed in Highland Beach. Part of the reason for this may be that residents have not chosen to buy flood insurance (or to make claims if they had policies and were flooded), but it is notable that in an area with such exposure to potential flooding, there is little evidence to suggest that there is significant risk, and potential impacts should be considered small except in extreme events.

6.3.2 Coastal Flooding

6.3.2.1 Description of the Coastal Flooding Hazard

Coastal flooding refers to the inundation of land areas caused by water levels exceeding above normal tidal action. Winds generated from tropical storms and hurricanes or intense offshore low-pressure systems can drive water inland and cause significant flooding. This is known as storm surge.

Storm surges occur when the water level of a tidally-influenced body of water increases above the normal high tide. Storm surges occur with coastal storms caused by massive low-pressure systems with cyclonic flows that are typical of hurricanes. Storm surges are particularly damaging when they occur at the time of a high tide, combining the effects of the surge and the tide. This increases the difficulty of predicting the magnitude of a storm surge because it requires weather forecasts to be accurate to within a few hours. Coastal flooding occurs in seasonal patterns. Tropical storms tend to come together from June until October. See Appendix A for a more detailed description of the coastal flooding hazard.

6.3.2.2 Location and Extent of the Coastal Flooding Hazard

The storm surge hazard associated with hurricanes and other severe storms are responsible for coastal flooding and erosion along the Maryland Gulf Coast. In the Anne Arundel County the coastal flooding hazard is greatest along areas adjacent to the Chesapeake Bay. The effects of coastal flooding can be felt in the County from hurricanes that make landfall as far away as New Jersey, Virginia and the Carolinas.

6.3.2.3 Severity of the Coastal Flooding Hazard

Storm surges inundate coastal floodplains by tidal elevation rise in inland bays and ports, and backwater flooding through coastal river mouths. Severe winds associated with low-pressure systems cause increase in tide levels and water surface elevations. Storm systems also generate large waves that run up and flood coastal areas. The combined effects create storm surges that affect the beach, marsh, and low-lying floodplains. Shallow offshore depths can cause storm driven waves and tides to pile up against the shoreline and inside bays. See Table 6.3-3 for factors that can influence the severity of coastal storms.

The morphology of the continental shelf also influences the level of surge in a particular area. A shallow slope off the coast, like what is found off the coast of Maryland, will allow a greater surge to inundate coastal communities.

Table 6.3-3
Factors that Influence the Severity of Coastal Storms

Factor	Effect
Wind Velocity	The higher the wind velocity the greater the damage.
Storm Surge Height	The higher the storm surge the greater the damage.
Coastal Shape	Concave shoreline sections sustain more damage because the water is driven into a confined area by the advancing storm, thus increasing storm surge height and storm surge flooding.
Storm Center Velocity	Then slower the storm moves, the greater damage. The worst possible situation is a storm that stalls along a coast, through several high tides.
Nature of Coast	Damage is most severe on low-lying island barrier shorelines because they are easily over washed by wave action.
Previous Storm Damage	A coast weakened by even a minor previous storm will be subject to greater damage in a subsequent storm.
Human Activity	With increased development, property damage increases and more floating debris becomes available to knock down other structures.

6.3.2.4 Impact on Life and Property

Persons and property located near the coast of the Chesapeake Bay are most vulnerable to coastal flooding in the County. Loss of life and property, reduced recreation opportunities, loss of environmental quality, and alteration of traditional coastal uses are just a few of the detrimental impacts of shoreline erosion and coastal flooding. Major flooding can cause multiple deaths, completely shut down critical facilities and businesses.

Coastal flooding usually occurs with some warning. The greatest impact would be in those areas of the County that are adjacent to the Chesapeake Bay. Since many of the County's residents live near the shore, there is the potential for considerable loss of human life, and the economic effects may be widespread. According to the NCDC there have been no injuries or deaths death from coastal flooding in Anne Arundel County. For Anne Arundel County, approximately $2.1 million has been reported in property damages related to this hazard, although the figure is likely much greater because the NCDC database is based on open sources of information that are not always reliable. Appendix A of this document discusses National Flood Insurance Program claims data, much of which is along the County coastline.

6.3.2.5 Occurrences of the Coastal Flooding Hazard

The NCDC indicates there have been 30 events to impact Anne Arundel County between 1998 and 2018. Table 6.3-4 summarizes the major coastal flooding events that have impacted Maryland and Anne Arundel County since 1950.

Table 6.3-4
Coastal Flooding Events, Anne Arundel County 1998– 2018
(Source: NOAA/NCDC)

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	50.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/04/1998	08:00	EST	Coastal Flood		0	0	50.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	06/28/2006	03:00	EST	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/28/2006	08:00	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/25/2010	12:23	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	09/30/2010	13:00	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/01/2010	00:00	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	03/10/2011	17:39	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	04/16/2011	14:30	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	05/18/2011	04:54	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	06/17/2011	04:24	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/13/2011	16:09	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	06/02/2012	01:07	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	06/06/2012	04:42	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	09/18/2012	17:54	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/30/2012	03:00	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	04/30/2014	05:12	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/03/2014	21:40	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/04/2014	10:10	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/04/2015	20:54	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/05/2015	22:00	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/10/2016	17:38	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/09/2016	04:42	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/09/2016	16:55	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/24/2016	20:15	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/01/2016	16:48	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	10/24/2017	04:36	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	03/06/2018	19:12	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	03/07/2018	06:03	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	04/16/2018	06:11	EST-5	Coastal Flood		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	04/16/2018	15:12	EST-5	Coastal Flood		0	0	0.00K	0.00K
Totals:								0	0	50.00K	0.00K

Although not listed under the Coastal Flooding events for Anne Arundel County, perhaps the most significant coastal flooding event in the past ten years occurred on September 19, 2003 as a result of Hurricane Isabel. On September 18, 2003, Isabel made landfall on the North Carolina coast. Its huge wind field was already piling water up into the southern Chesapeake Bay. By the time Isabel moved into central Virginia, it had weakened and was downgraded to a tropical storm. Isabel's eye tracked well west of the Bay, but the storm's 40 to 50 mph sustained winds pushed a bulge of water northward up the Bay and its tributaries, producing a record storm surge. The western shore Counties of the Chesapeake Bay and along the tidal tributaries of the Potomac, Patuxent, Patapsco and other smaller rivers experience a storm surge reached five to nine feet above normal tides. In many locations, Isabel's surge was higher than the previous record storm known as the Chesapeake-Potomac Hurricane of 1933. Over 2,000 people were evacuated from their homes. In Maryland alone, 472 homes and buildings were destroyed, and 3,260 had major damage. Extensive damage occurred to Maryland's shoreline, which rarely sees storms of this intensity (Source: NOAA/NCDC database). See Section 6.3.4, Hurricane, Tropical Storm, Nor'easter, for a description of the wind damages in Anne Arundel County associated with Hurricane Isabel. On September 19, 2003 a Presidential-Disaster Declaration was declared for the entire State of Maryland. In Anne Arundel County, FEMA initially estimated damages from the storm totaled approximately $500 million.

Probabilities for the most significant coastal flooding are closely related to occurrences of tropical storms and hurricanes that produce storm surge in the Chesapeake Bay. As discussed below in subsection 6.3.4, the average return period for all hurricanes (Categories 1 through 5) is slightly less than 50 years, and for major hurricanes (Categories 3-5) it is greater than 97 years. Because they are less severe (i.e. below a category 1 hurricane), tropical storms are by general definition more likely to occur and impact the County.

Coastal Flood Hazards in Highland Beach

See discussion at the end of Section 6.3.1 above.

6.3.3 Dam Failure and Release

6.3.3.1 Description of the Dam Failure Hazard

A dam is defined as any artificial dike, levee or other barrier that is constructed for the purpose of impounding water on a permanent or temporary basis, that raises the water level five feet or more above the usual, mean, low water height when measured from the downstream toe-of-dam to the emergency spillway crest or, in the absence of an emergency spillway, the top-of-dam. Most dams in Maryland consist of an earthen embankment to store water and a combination of spillways designed to pass water safely around or through the facility.

Dam failures can result from a variety of causes including lack of maintenance, seismic activity, improper design or construction, or the effects of large storms. Significant rainfall can quickly inundate an area and cause floodwaters to overwhelm a reservoir. If the spillway of the dam cannot safely pass the resulting flows, water will begin flowing in areas not designed for such flows and failure may occur.

Dams are typically ranked by hazard classification that is determined by the potential for infrastructure and property damages downstream if a dam failure were to occur. The three hazard classifications include high hazard (H), significant (S), and low (L) and are defined as follows:

- **High Hazard Dams.** Probable loss of life; major increases in existing flood levels at houses, buildings, major interstates and state roads with more than six lives in jeopardy.
- **Significant Hazard Dams.** Possible loss of life, significant increased flood risks to roads and buildings with no more than two houses or six lives in jeopardy.
- **Low Hazard Dams.** Loss of life is unlikely; minor increases to existing flood levels at road and buildings.

6.3.3.2 Location and Extent of the Dam Failure Hazard

There are just over 400 dams in Maryland, ranging in height from six to 296 feet in height. The majority of Maryland's dams are earth fill or earth and rock fill embankment structures. There are also several large concrete and "slab and buttress" dams such as Liberty, Prettyboy and Brighton that provide storage for drinking water. The Maryland Department of the Environment (MDE) website[5] indicates that as of March, 2017 across Maryland there are:

[5] (http://mde.maryland.gov/programs/Water/DamSafety/Documents/FactSheet-DamInventory.pdf)

- 85 high hazard dams
- 125 significant hazard dams
- 330 low hazard dams
- 66 breached dams

According to the online sites "Topozone" and "US-places" there is a total of six dams in Anne Arundel County. The following table is a listing of all Anne Arundel County dams including the municipality name, the elevation, and the name of the dam. Table 6.3-5 provides an inventory of County dams, including the name, location, owner, elevation, and the current status of any Emergency Action Plan (EAP) for the dam.

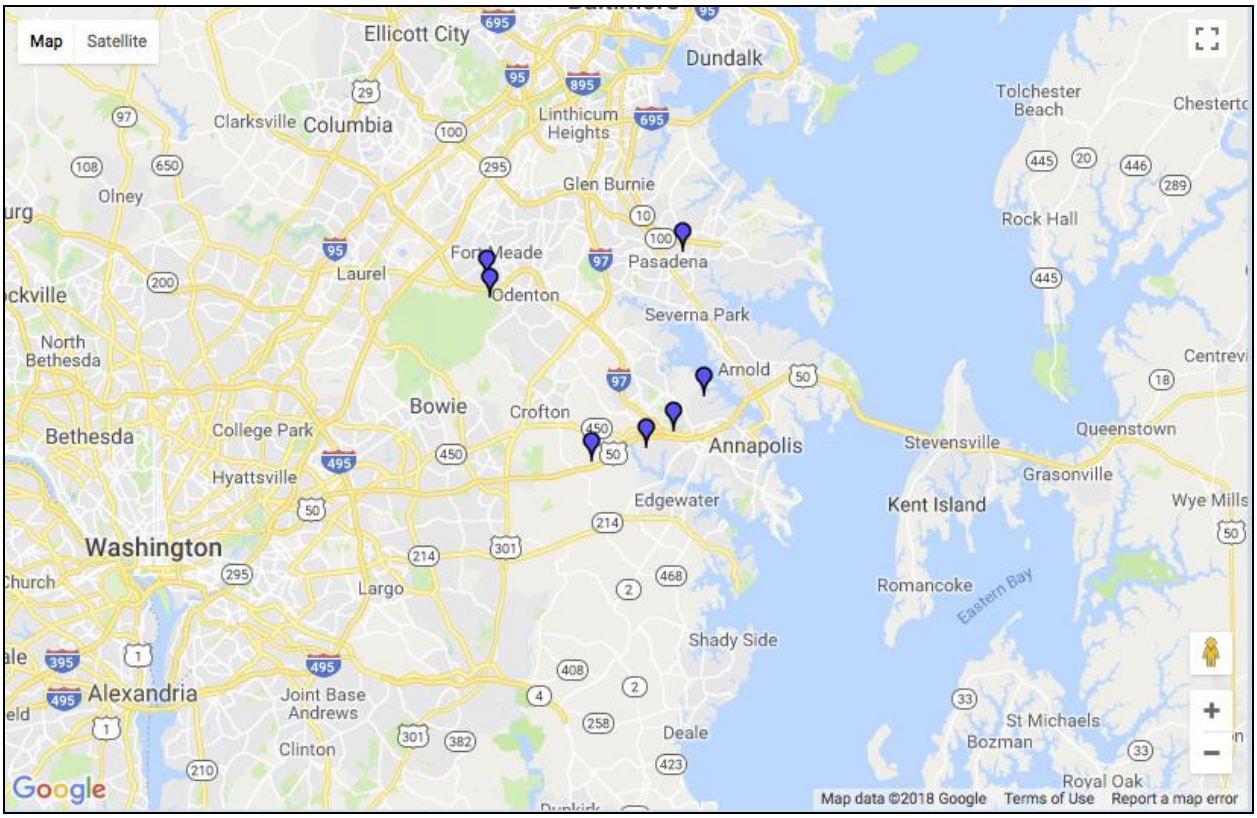
Table 6.3-5
Inventory of Anne Arundel County Dams (Ownership and Status of Required Emergency Action Plans)

Dam Name	Municipality Name	Hazard Classification	Elevation
Burba Lake Dam	Odenton; Ft. Meade (DoD) (no EAP)	Significant	138 feet
Heritage Harbour Site One Dam	South River; homeowner association (no EAP)	Low	105 feet
Lake of the Pines Dam	Millersville; County (EAP updated April 2018)	Significant	102 feet
Lake Waterford Dam	Pasadena; County (EAP updated May 2018)	Significant	23 feet
Saefern Recreation Lake Dam	Round Bay; no records (unknown)	Low	26 feet
Soldier Lake Dam	Odenton; no records (unknown)	Low	118 feet

Note that the USACE National Inventory of Dams (NID) provides basic information about more than 91,000 dams in the U.S. As of 2019, the NID database included three of the six dams listed above, and provided Hazard Potential Information for three of them, as noted in Table 6.3-5.

In addition to these dams, Anne Arundel County OEM also has recent records of several other dams in the County, including: River Trace dam (not County owned, EAP updated August 2016); Shipley's Choice dam (owned by County, EAP updated April 2018, scheduled to be removed by mid-2020); Shipley's Crossing North waste management pond #1 (owned by Homeowner Association (HOA) EAP updated January 2016); Shipley's Crossing North waste management pond #2 (owned by HOA; EAP updated January 2016); Windgate stormwater management pond #3 (HOA, EAP updated May 2016).

Figure 6.3-4
Locations of Dams in Anne Arundel County
(us-places.com)



6.3.3.3 Severity of Dam Failure

The severity of a dam failure event depends on various aspects related to the size of the dam, the extent of the failure, the velocity of the floodwaters released, and the intensity of the downstream development. There is the potential for total collapse of a dam, but less significant failures are more likely as a result of a overtopping (inadequate spillway design, debris blockage), foundation defects, or seepage. Overtopping of a dam during a flood event due to clogged debris has the potential to be catastrophic. As mentioned above, dams are typically categorized into three hazard classifications consisting of high, significant, and low hazard.

6.3.3.4 Impact on Life and Property

According to the U.S. Army Corps of Engineers (USACE) National Inventory of Dams Program, as of 2016 there were 90,580 dams in the United States. Approximately one third of these pose a "high" or "significant" hazard to life and property if failure occurs. Dam failure has the potential for catastrophic impact on life and property. This risk can be reduced by proper design, construction and routine maintenance and inspection.

In Anne Arundel County, people and property located in the watershed of the Patuxent River most vulnerable to a dam failure at one of two high hazard dams located upstream in Howard County. The two high hazard dams are Brighton and T. Howard Duckett. Figure 6.3.3-1 depicts the 100-year floodplain for the Patuxent River in Anne Arundel County. The Census Blocks that intersect the floodplain contain 30,886 people who would potentially be affected by this hazard. An estimated $1.95 billion in building and contents are exposed to this hazard. No Anne Arundel County critical facilities are exposed.

To prevent or reduce the probability of a failure, professional engineers periodically inspect existing dams. The State of Maryland has been assuring the safety of dams since 1934 through a permit and inspection program. Maryland Department of the Environment's (MDE) Dam Safety Program ensures all dams in Maryland are designed, constructed, operated and maintained safely to prevent dam failures and the consequences of failure. MDE's responsibilities include conducting inspections of dams based on their hazard classification issuing permits for construction, repairs or for modifying dam structures; conducting construction inspections and working with dam owners and emergency management professionals to develop and exercise Emergency Action Plans to be used in the event of dam failure (Source: MDE – Dam Safety Program).

Periodic safety inspections are performed through MDE's Dam Safety Program. High hazard dams are inspected every year. Significant hazard dams are inspected every three years. Low hazard dams are inspected every five to seven years.

6.3.3.5 Occurrences of Dam Failure

The 2004 and 2012 County HMPs indicated there had been no failures of high hazard dams over the past 25 years (according to the Maryland Department of the Environment). A thorough search of open sources for the 2018 HMP showed this is still the case, that there have been no recent dam failures in Anne Arundel County. Based on no past dam failures in the County, the probability of future failures is considered low.

Dam Failure Hazards in Highland Beach

There are no dams in or near Highland Beach, and thus no dam failure hazards. Potential impacts are negligible.

6.3.4 Hurricane, Tropical Storm and Nor'easter

6.3.4.1 Description of the Hurricane, Tropical Storm, and Nor'easter Hazard

-
- Hurricanes, tropical storms, and typhoons, collectively known as tropical cyclones, are among the most devastating naturally occurring hazards in the United States. They present flooding, storm surge, and high wind hazards to the communities that they impact. A hurricane is defined as a low-pressure area of closed-circulation winds that originates over tropical waters. A hurricane begins as a tropical depression with wind speeds below 39 mph. As it intensifies, it may develop into a tropical storm, with further development producing a hurricane.
-

Nor'easters are extra-tropical storms that derive their strength from horizontal gradients in temperature. These storms form as a result of a drastic drop in temperature as cold, arctic air flows south where it collides with warmer air moving northward. This tends to cause the storm to begin to revolve. Winds around the storm center carry warm, moist air from over the Gulf Stream, up and over the colder inland air. The air rises, cools, and snow begins to fall.

Winds around the Nor'easter's center can become intense, with wind gusts that exceed hurricane force in intensity. The wind builds large waves that batter the coastline and sometimes pile water inland causing major coastal flooding and severe beach erosion. Unlike a hurricane, which usually comes and goes within one tide cycle, the Nor'easter can linger through several tides, each one piling more and more water on shore and into bays and dragging more and more sand away from beaches.

6.3.4.2 Location and Extent of the Hurricane, Tropical Storm, and Nor'easter Hazard

Hurricane risk in the United States extends along the entire east coast from Main to Florida, the Gulf Coast (including Florida, Alabama, Louisiana, and Texas), and Hawaii. The southeastern U.S. and Gulf Coast are at greatest risk based on historical storm tracks and the warmer waters of the Gulf of Mexico and Atlantic Ocean. Risks associated with hurricanes include wind and flooding from storm surges. The multi-component nature of the hazard means that all areas of Anne Arundel County are subject to the effects of hurricanes, including high winds, flooding and storm surge. In the middle Atlantic region, Maryland and Anne Arundel County are at moderate risk from Hurricanes, Tropical Storms, and Nor'easters. See the Occurrence of the Hurricane, Tropical Storm, and Nor'easter subsection for a map showing the historical hurricane tracks for nine previous tropical storms that have impacted the region.

6.3.4.3 Severity of the Hurricane, Tropical Storm, and Nor'easter Hazard

The severity of hurricanes and tropical storms is measured primarily by wind velocity, flooding, and storm surge. Hurricane severity is expressed in numbered categories. Hurricanes are classified as Categories 1 through 5 based on central pressure, wind speed, storm surge height, and damage potential. As shown in Table 6.3-6 the Saffir/Simpson Hurricane Scale is used to classify storms by numbered categories.

Table 6.3-6
Saffir/Simpson Hurricane Scale
(Source: NOAA)

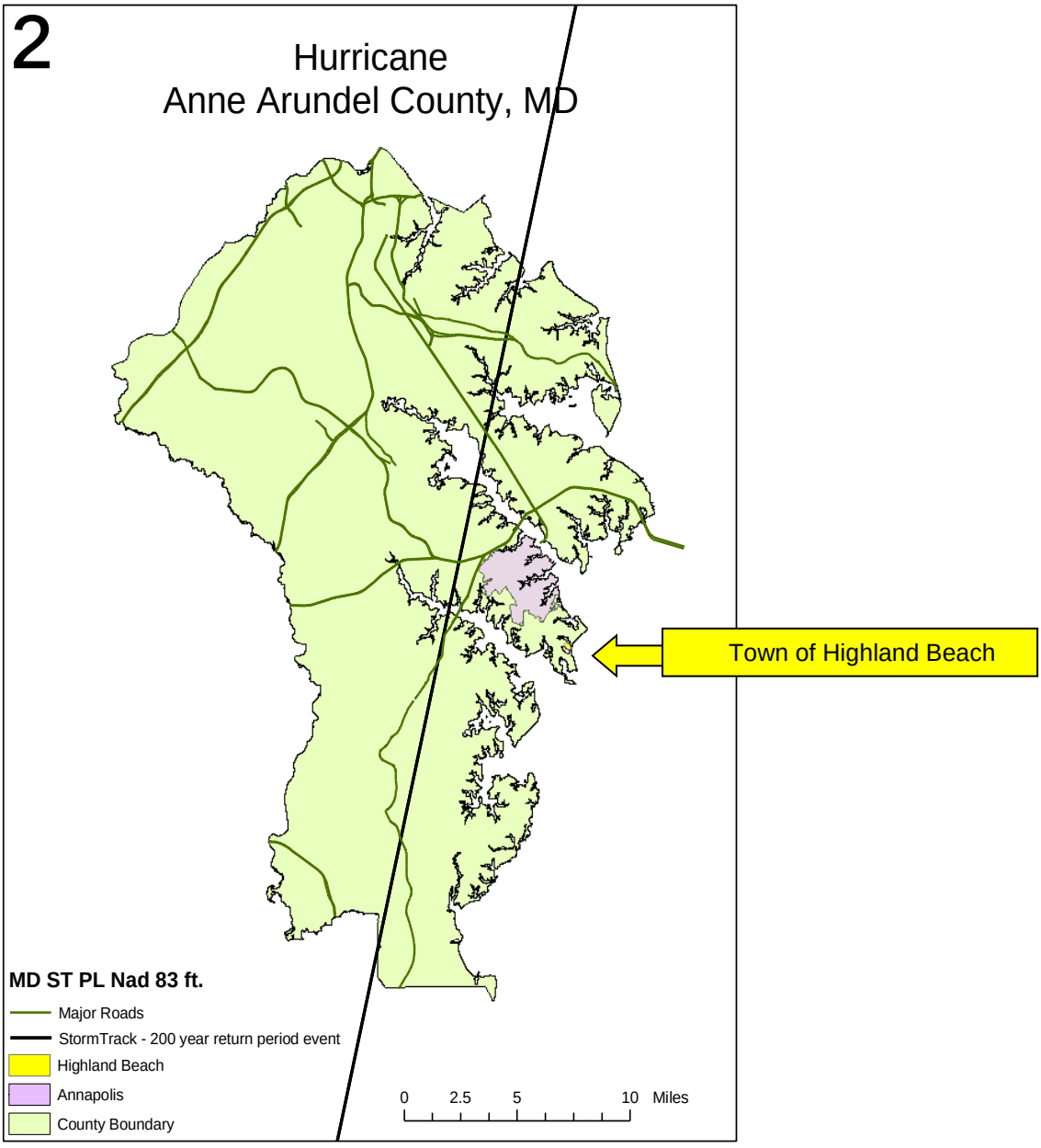
Storm Category	Central Pressure	Sustained Winds	Storm Surge	Potential Damage
1	> 980 mbar	74 - 95 mph	4 – 5 ft	Minimal
2	965 – 979 mbar	96 - 110 mph	6 – 8 ft	Moderate
3	945 – 964 mbar	111 – 130 mph	9 – 12 ft	Extensive
4	920 – 944 mbar	131 – 155 mph	13 – 18 ft	Extreme
5	< 920 mbar	> 155 mph	> 18 ft	Catastrophic

6.3.4.4 Impact on Life and Property

For Anne Arundel County from 1950 to 2009, there was one death and 200 injuries reported in the NCDC database for hurricanes and tropical storms. Property damage was estimated at $531.3 million (Source: NOAA/NCDC). Nor'easters have effects on the County that are similar to those of a Tropical Cyclone event. These storms can have a tremendous impact on the County, with a high potential for loss of life and property and the capacity to greatly impact the economy. The intensity of a tropical storm is directly related to its impacts.

The original County HMP used a HAZUS-based process to model a 200-year probabilistic storm passing just west of Annapolis (as illustrated in Figure 6.3-5). Wind damage from a storm of this magnitude would potentially create a loss of $633,320,000 to building and contents. Such a storm could potentially put the entire population of the County at risk. All 47 critical infrastructure facilities have the potential to be impacted by this hazard. Note that the potential loss value from the 2004 version of the HMP was inflated to the indicated figure using the U.S. Bureau of Labor Statistics on-line inflation calculator.

Figure 6.3-5
Anne Arundel County: HAZUS Hurricane Potential Track Scenario
With a 200-year Return Period
(Source: Anne Arundel County Office of Emergency Management)



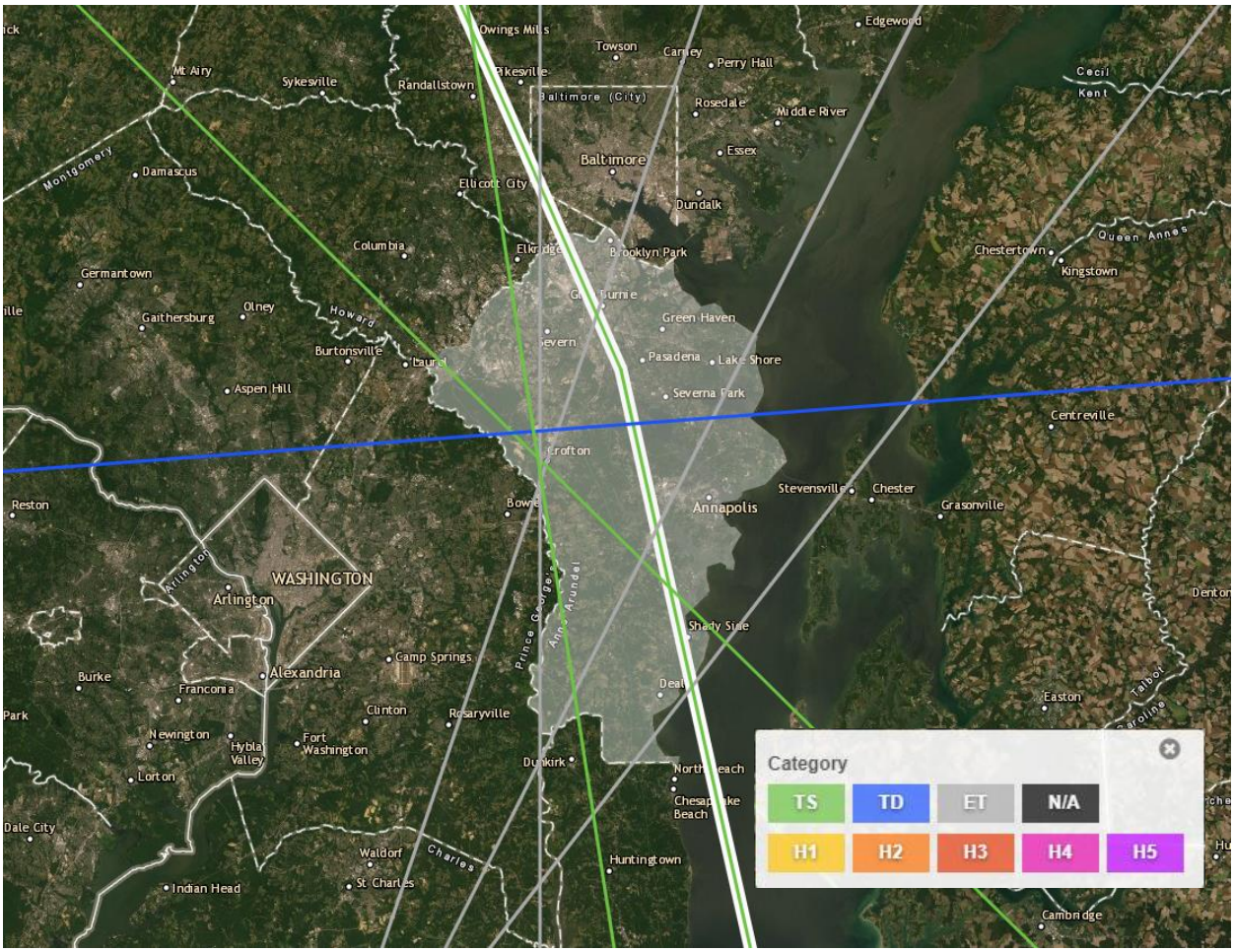
6.3.4.5 Occurrences of the Hurricane, Tropical Storm and Nor'easter Hazard

The original 2004 County HMP indicated that, according to the National Weather Service, over the last 104 years Anne Arundel County has experienced twelve hurricanes, tropical storms, or Nor'easters.

As part of the 2018 HMP update, several data sources were researched to identify historical hurricanes and tropical storms that have impacted the mid-Atlantic region and Anne Arundel County. The NCDC database indicated there were two tropical storms impacting Anne Arundel County between 1950 and 2009. The first event, Hurricane Floyd, occurred in September 1999 and the second event, Hurricane Isabel, occurred in September 2003 – both events were downgraded to tropical storm status by the time they impacted the County. Late in 2012, Hurricane Sandy impacted nearly the entire east coast of the U.S., including Anne Arundel County. The NCDC database appears to omit numerous tropical storm events that have impacted the area, many of which occurred prior to 1999. Some of the events missing include Tropical Storms Bertha, Dean, and Diane. Note that recent changes to the NCDC database appear to eliminate much of the historical data, particularly before the 1990s.

Figure 6.3-6 shows historic hurricane tracks through or near the State of Maryland. Note that in the legend the TS designation is Tropical Storm, TD is Tropical Depression, ET is Extra Tropical event, and the H-series is hurricanes.

Figure 6.3-6
Historic Maryland Hurricane Tracks
(Source: https://coast.noaa.gov/hurricanes/; query July 2019)



The NHC query did not include the two tropical storms identified in the NCDC database (Floyd and Isabel). Counting the nine tropical storms reported by the NHC and the three from the NCDC database, Anne Arundel County has experienced a total of 12 tropical storms since 1950. Based on approximately 60 years of historical data from the NHC, the probability of future tropical storms impacting Maryland and Anne Arundel County is moderate, averaging approximately one event every five to six years (Source: National Hurricane Center – Historic Hurricane Tracks).

As noted elsewhere in this section of the 2018 HMP, Hurricane Isabel made landfall along the North Carolina Coast. The storm was downgraded to a tropical storm by the time it reached Maryland. Isabel's eye tracked well west of the Chesapeake Bay, with sustained winds of 40 to 50 mph. Although most of the damage was related to storm surge, high winds from Isabel still resulted in moderate wind damage. The NCDC database indicated that Patuxent Naval Air Base recorded wind gusts to 69 mph and Quantico Marine Base recorded a wind gust of 78 mph. Unofficial wind gust readings of up to 110 mph were reported, but not confirmed. Wind damage to trees in the area was extensive and widespread to the region. Soil moisture was high from previous rains making it easier for trees to uproot. Also, the trees were still in full canopy, which acted like a sail to catch the wind. High winds caused trees to fall on electrical and utility wires taking out power and phone service. Trees also fell on roads, cars, and homes. In Anne Arundel County, 196,000 out of a possible 211,000 customers lost power (Source: NOAA/NCDC database). See Section 6.3.2, Coastal Flooding, for a description of the flood damages in Anne Arundel County associated with Hurricane Isabel.

In 2012, Hurricane Sandy tracked up the east coast of the U.S., and had devastating consequences for New York City in particular. Anne Arundel County experienced fairly high winds and some coastal flooding, but effects and damages were limited, particularly compared to other locations on the east coast.

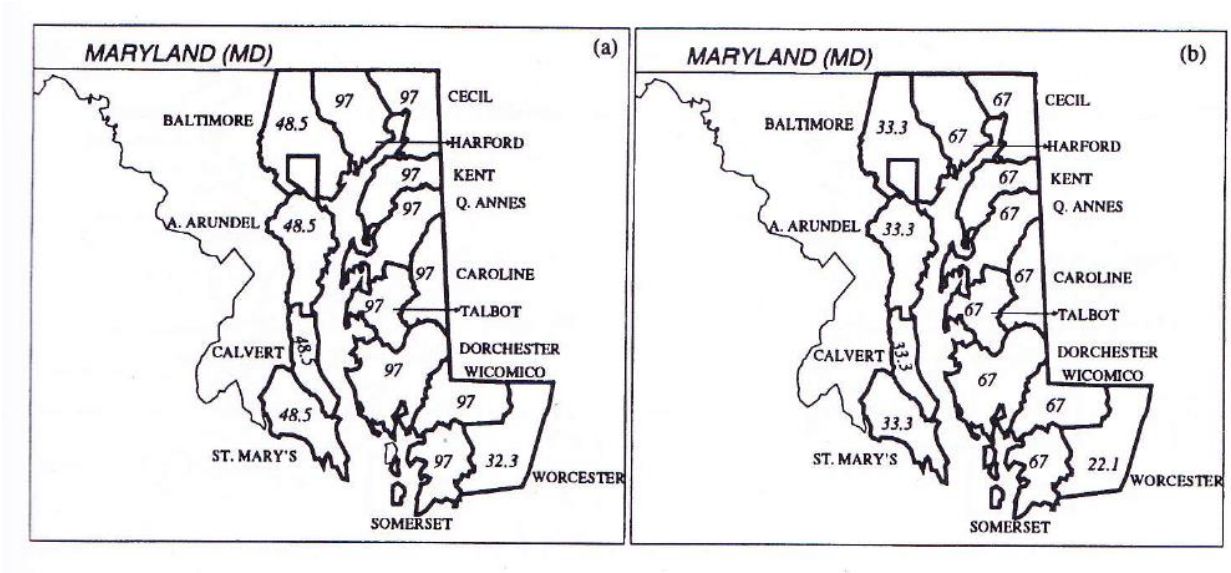
The NCDC database was used to identify past Nor'easter events in Anne Arundel County. Although the NCDC database does specifically track Nor'easters, the *Tropical Storm* category was reviewed to identify previous such events that have impacted Anne Arundel County. There is no specific way to know if this category description is analogous to Nor'easters, so the data should be reviewed in that context. These tropical storm events occurred in 1999, 2003 and 2011, years that correspond to flood, wind and surge events discussed elsewhere in this section of the HMP. Table 6.3-7 summarizes the tropical storm events that have impacted Maryland and Anne Arundel County since 1950. As discussed in various other sections, it is unclear why NCDC data is truncated before 1999.

Table 6.3-7
Tropical Storm Events, Anne Arundel County 1950 – 2018
(Source: NOAA/NCDC)

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	4.420M	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	09/16/1999	08:00	EST	Tropical Storm		0	0	100.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	09/18/2003	15:00	EST	Tropical Storm		0	0	4.020M	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	08/27/2011	13:00	EST-5	Tropical Storm		0	0	300.00K	0.00K
Totals:								0	0	4.420M	0.00K

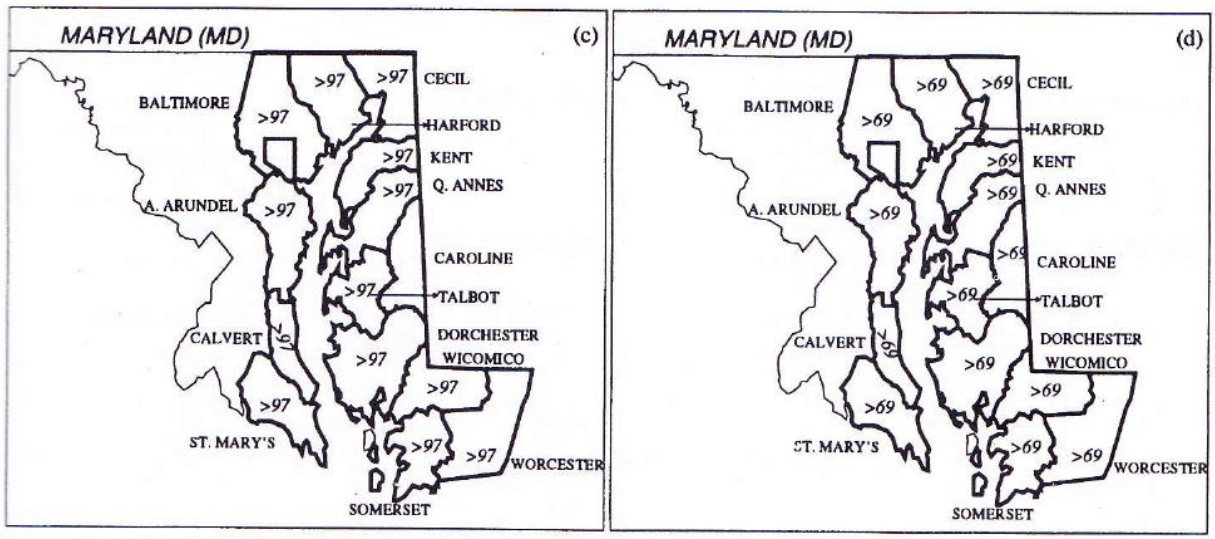
Figures 6.3-7 and 6.3-8 (below) show the expected return frequencies and wait times for all hurricanes and major hurricanes, respectively. Return frequency is analogous to probability, and the figures indicate that Anne Arundel County may be impacted by a hurricane of some magnitude about every 50 years, and a major hurricane (categories 3-5) less than once every 100 years (the graphic indicates >97 years). Tropical storms will presumably occur more frequently because they are less severe. In fact, storm history shows fairly clearly that many hurricanes decay to tropical storms before they reach Maryland.

Figure 6.3-7
All Hurricane Event (Categories 1-5) Return Frequencies and Wait Times



(Source: Hurricanes of the North Atlantic, Elsner, James, and Kara, A. Birol, Oxford University Press, 1999)

Figure 6.3-8
Major Hurricane Event (Categories 1-5) Return Frequencies and Wait Times
(Source: Hurricanes of the North Atlantic, Elsner, James, and Kara, A. Birol, Oxford University Press, 1999)



Hurricane and Tropical Storm Hazards in Highland Beach

Highland Beach is subject to effects from both surge and high winds related to hurricanes and tropical storms. However, as discussed above in the flood subsection, there are few structures in the FEMA-identified V-zone SFHA. As shown on the effective FIRM (see Subsection 6.3.1), about a third of the land area in Highland Beach appears to be in the SFHA, much of it in V-zone. However, most of the small amount of development in the Town is outside this zone, and thus the hazard should be considered relatively minor.

As noted elsewhere, Highland Beach has no properties on the NFIP Repetitive Loss (RL) list. Many of the properties that are on the list had claims from Tropical Storm Isabel (2003), but Highland Beach is not among them, which provides some evidence that there is minimal surge risk here, except in the most severe potential events. However, this should not be considered definitive, because it is possible that there was flooding during Isabel, but that there were no claims submitted to the NFIP, or that policy holders may have submitted too few (or such low dollar amounts) of claims over time that they did not appear on the RL list. The HMPC reviewed NFIP claims as part of the 2018 HMP update and found no RL claims for Highland Beach. Because of its position on the coast of the Bay, Highland Beach is more exposed to the effects of high winds than are the inland parts of the County. There are no open source records that can be consulted to identify past wind damages (private insurance covers losses, and the information is proprietary). It is reasonable to assume that structures in Highland Beach have about the same level of exposure as other coastal areas of the County, and that the housing stock is likely somewhat older than much of the remainder of the County. This suggests that the vulnerability of these structures is comparatively high, although without detailed engineering study it is difficult to quantify the risk.

There are no open-source records that indicate Highland Beach had any significant damage (wind or surge) from Hurricane Sandy.

6.3.5 Drought

6.3.5.1 Description of the Drought Hazard

A drought is an extended dry climate condition when there is not enough water to support urban, agricultural, human, or environmental water needs. 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.

The State of Maryland uses the U.S. Army Corps of Engineers definition of drought. It states, "droughts are periods of time when natural or managed water systems do not provide enough water to meet established human and environmental uses because of natural shortfalls in precipitation or stream flow." Droughts unfold at an almost imperceptible pace with beginning and ending times that are difficult to determine, and with effects that often are spread over vast regions. While maintaining water supplies for human use is an important aspect of drought management, drought can also have many other dramatic and detrimental effects on the environment and wildlife.

In order to monitor potential drought conditions in a uniform manner, the State uses four indicators of water sufficiency. The indicators are based on the amount of precipitation and the effect of the precipitation (or lack of precipitation) on the hydrologic system. These indicators include:

- Precipitation levels
- Stream flows

- Ground water levels
- Reservoir storage

The indicators are used in conjunction with historic data to determine if a current deficit is within a commonly experienced range, or whether it is unusually large. Ground water levels in confined aquifers are responsive to pumping stresses at distances far removed from pumping centers. No baseline exists for measuring changes in water levels for confined systems. Therefore percentile frequencies are not available for wells in these systems. Evaluation of drought impacts in these systems will be analyzed as a departure from the long-term downward trend in water levels.

Reservoirs are designed to provide adequate storage when demand exceeds reservoir inflow. As stream flows are lowest during the summer period and demand is also greatest, the most critical time begins at the onset of summer. Adequate storage is presumed to be enough to last for a four-month period or 120 days.

6.3.5.2 Location and Extent of the Drought Hazard

Droughts may occur anywhere in the United States. Effects seen in different regions vary depending on normal meteorological conditions such as precipitation and temperature, as well as geological conditions such as soil type and subsurface water levels. Drought is possible throughout the planning area, but the data has revealed no significant drought history since 1950. The entire County is at some risk from drought events.

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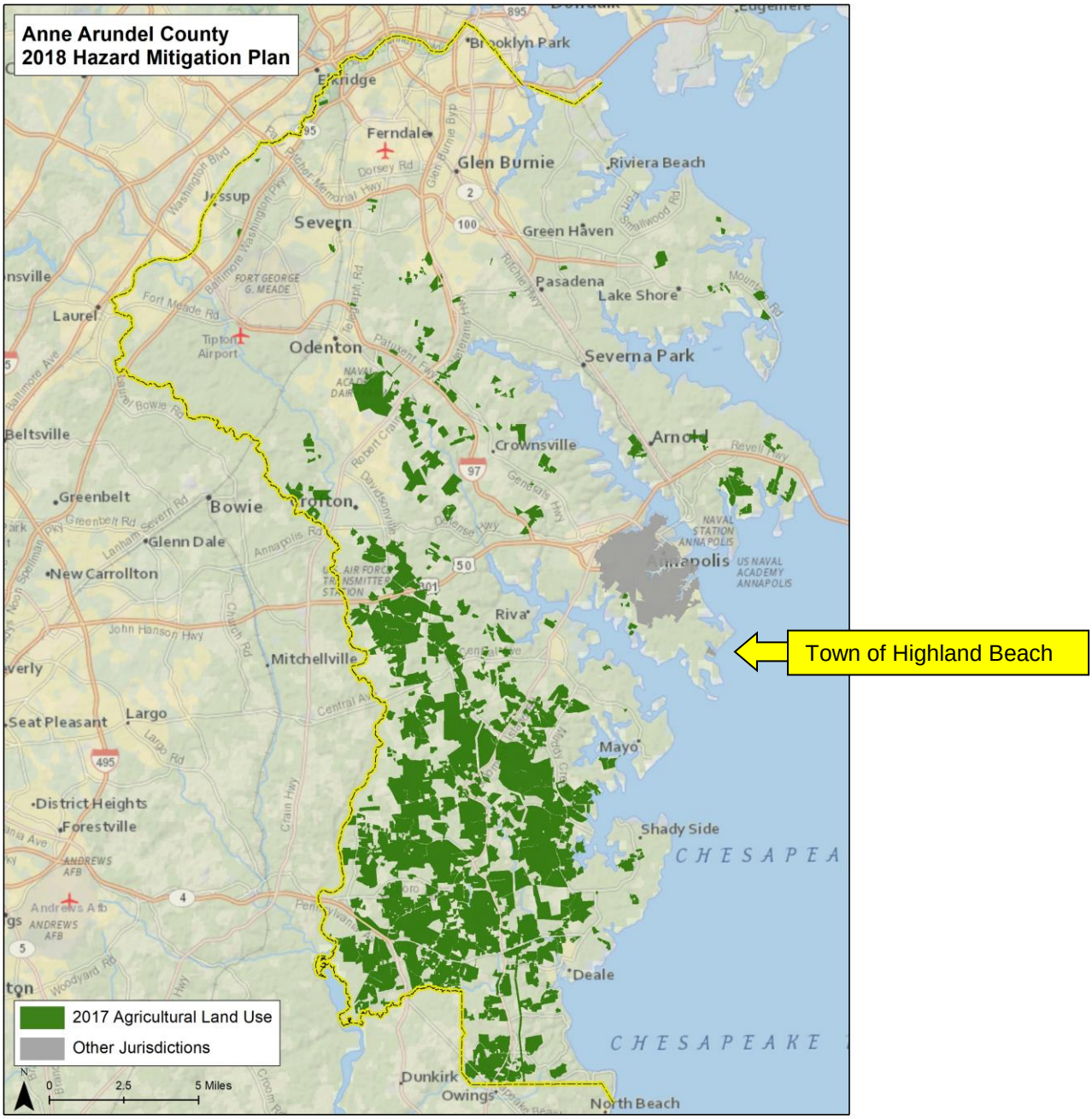
Drought does not have particular impacts in any one geographical section of the County. However, this hazard would have the greatest impact on the agricultural community. Figure 6.3-9 depicts the areas of the County that are devoted to agricultural pursuits. These areas contain 74,857 people who will potentially be affected by this hazard. The economic impacts of this hazard cannot be evaluated geographically. Critical County infrastructure is unlikely to be affected by this hazard.

Figure 6.3-9
Agricultural Areas of Anne Arundel County
(Source: Anne Arundel County Office of Emergency Management)



6.3.5.3 Severity 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 climatic factors, such as prolonged high winds and low relative humidity (FEMA, 1997). Due to its multi-dimensional nature, drought is difficult to define in exact terms and also poses difficulties in terms of comprehensive risk assessments. Drought can cause extensive damage to commercial and residential structures foundations, framing and walls, agricultural crops, roads, bridges, pipelines, utilities and railroads.

Precipitation amounts are evaluated based on the water year (beginning October 1). Water years are a natural dividing point for water supply as precipitation that falls in the first six months of a water year is analogous to putting money in the bank. A higher percentage of this rainfall or snowfall ends up recharging the ground water system, which sustains the stream flows and ground water levels during dry periods. Deficits during this time are more critical for later water levels than deficits during the growing season. If a precipitation deficit outside of the normal range exists at the end of a water year, the precipitation records will carry forward until a normal condition is reached. Because the significance of a precipitation deficit changes as the water year progresses, drought stages will trigger at different percentages of normal depending upon the date of evaluation. See Table 6.3.5-9 for the precipitation drought triggers.

Stream flow gages are used to measure stream flow. Using seven-day average flows, the median flow for an evaluation period is compared with low flows representing historical occurrence frequencies of 25%, 10% and 5% for the same date for the period of record. A 25% frequency equates to a one in four year occurrence, 10% frequency a one in 10 year occurrence and 5% frequency a one in 20-year occurrence.

Representative wells are used for monitoring ground water levels. Ground water conditions are evaluated on a monthly basis. The monthly levels are compared with values equivalent to the 25th, 10th, and 5th percentiles of historical records.

The State of Maryland uses a staged process for defining drought conditions. Drought indicators are monitored on an ongoing, year-round basis, and drought status is determined on a variable timeframe according to drought stage (See Tables 6.3-8 and 6.3-9 below).

The frequency of evaluation increases if the drought intensifies:

- *Stage 1,* Monthly
- *Stage 2,* Bi-weekly
- *Stage 3,* Weekly
- *Stage 4,* Weekly or as needed

Table 6.3-8
Drought Indicators
(Source: Maryland Department of the Environment)

	Precipitation As Percent of Normal for Evaluation Period [1]	Stream flow As Percentile of Normal[2]	Ground Water Levels As Percentile of Normal[2]	Reservoir Storage in days
Stage 1 Normal	See Table 8-14	>25	>25	>120
Stage 2 Watch		25	25	120
Stage 3 Warning		10	10	90
Stage 4 Emergency		5	5	60

[1] These values vary depending of length of review period. For more detail see Table 7-10.
[2] At the 25th percentile, it means that historical stream flows or ground water levels are lower than this value only 25% of the time for the evaluation period. 10th and 5th percentiles represent increasingly lower stream flows or ground water levels and more severe drought events.

Source: Maryland Department of the Environment, http://www.mde.state.md.us/Water/Drought/assessing/index.asp

Table 6.3-9
Precipitation Triggers
(Source: Maryland Department of the Environment)

Number of Months Analyzed	Normal (% of Normal Precipitation)	Watch (% of Normal Precipitation)	Warning (% of Normal Precipitation)	Emergency (% of Normal Precipitation)
3	>75.0	75.0	65.0	55.0
4	>80.0	80.0	70.0	60.0
5	>80.0	80.0	70.0	60.0
6	>80.0	80.0	70.0	60.0
7	>81.5	81.5	71.5	61.5
8	>82.5	82.5	72.5	62.5
9	>83.5	83.5	73.5	63.5
10	>85.0	85.0	75.0	65.0
11	>85.0	85.0	75.0	65.0
12	>85.0	85.0	75.0	65.0

Source: Maryland Department of the Environment, http://www.mde.state.md.us/Water/Drought/assessing/index.asp

6.3.5.4 Impact on Life and Property

Drought usually occurs slowly with some warning. Human lives may not be lost, but life styles could be dramatically altered and the economic effects felt Countywide. The NCDC database indicates there are no known deaths or injuries from droughts in the planning area.

6.3.5.5 Occurrences of the Drought Hazard

The NCDC data was queried again for the 2018 HMP update. As of March 2018, the database indicated 12 droughts in Anne Arundel County from 1997 to 2007. The site reported three events that caused agricultural damage totaling $1.67 million (which was all from one event, in 1998). It is unclear from the data set if NCDC has stopped recording droughts as of 2007, or if there have simply been no droughts to report.

Based on the 12 events between 1997 and 2007, on average, a drought event occurs in Anne Arundel County approximately every 1.7 years. From these previous occurrences, it is reasonable to assume that droughts will continue in Anne Arundel County, but with no previous injuries, deaths, or property damage the impacts will probably be minimal.

Drought Hazards in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to droughts as the rest of the County. However, as noted in text, the County generally has little risk from this hazard. Potential impacts are negligible.

6.3.6 Earthquakes

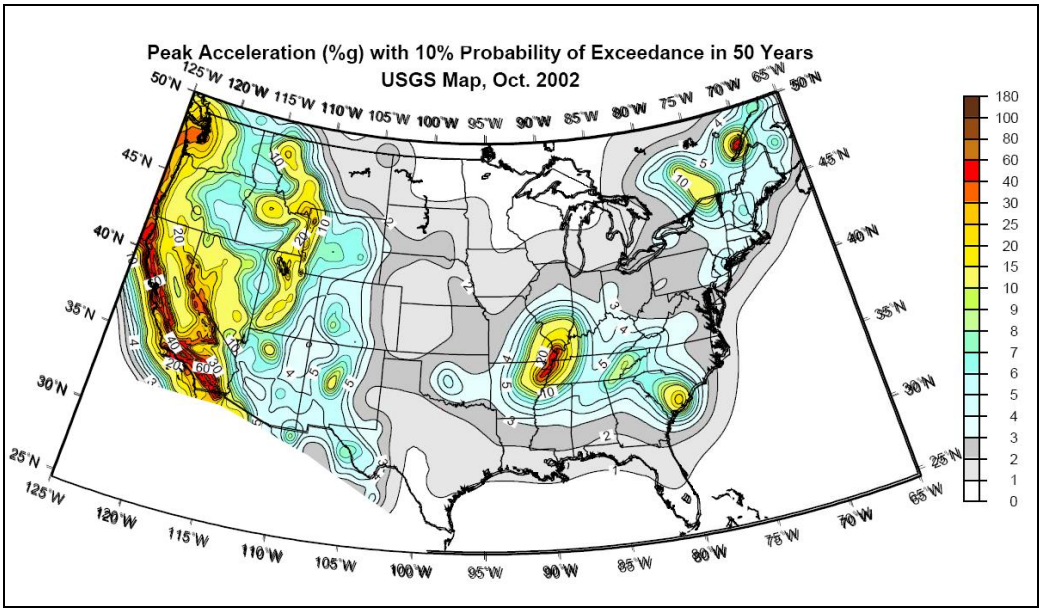
6.3.6.1 Description of the Earthquake Hazard

An earthquake is a sudden release of energy from the earth's crust that creates seismic waves. Tectonic plates become stuck, putting a strain on the ground. When the strain becomes so great that rocks give way, fault lines occur. At the Earth's surface, earthquakes may manifest themselves by a shaking or displacement of the ground, which may lead to loss of life and destruction of property. The "size" of an earthquake is expressed quantitatively as magnitude, and local strength of shaking as intensity.

6.3.6.2 Location and Extent of the Earthquake Hazard

The entire planning area is equally susceptible to the effects of earthquakes. Figure 6.3-10 displays the United States Geological Survey (USGS) earthquake hazard map produced in October of 2002. The map shows peak ground acceleration (pga) with a 10% chance of being exceeded over 50 years. In Maryland, the majority of the State falls in the low seismic risk range. The *FEMA How-To guidance, Understanding Your Risks*, suggests the earthquake hazard should be profiled if the pga is greater than 3%g (source: *FEMA How-To guidance, Understanding Your Risks).* The map shows that Maryland, including Anne Arundel County, is located in the 2%g range, a low risk area. The earthquake hazard affects the entire planning area.

Figure 6.3-10
United States Seismic Hazard Map, Showing Peak Ground Acceleration in Percent of G, With 10% Exceedance In 50 Years.
(Source: USGS, October 2002)



6.3.6.3 Severity of the Earthquake Hazard

The mid-Atlantic and central Appalachian region, including Maryland, is characterized by a moderate amount of low-level earthquake activity, but their causes are largely a matter of speculation. In Maryland, for example, there are numerous faults, but none is known or suspected to be active. As shown in the figure above, the probability of any severe earthquake in the area is minimal. The severity of earthquakes is influenced by several factors, including the depth of the quake, the geology in the area, and the soils.

Measurement of the severity of an earthquake can be expressed in several ways, the two most common being intensity and magnitude. The intensity, reported on the Modified Mercalli Intensity (MMI) Scale, is a subjective measure in terms of eyewitness accounts (See Table 6.3-10. Intensities are ranked on a 12-level scale and range from barely perceptible (I) to total destruction (XII)). The lower intensities are described in terms of people's reactions and sensations, whereas the higher intensities relate chiefly to observable structural damage. Magnitude is an objective measure of earthquake severity and is closely related to the amount of seismic energy released at the focus of an earthquake. It is based on the amplitude of seismic waves as recorded on standardized seismographs. The standard for magnitude measures is the Richter Scale, an open-ended scale expressed in whole numbers and decimal fractions. The Richter Scale is logarithmic, meaning that an earthquake of magnitude 5.0 has 10 times the wave amplitude of a magnitude 4.0 and 100 times the ground vibration amplitude of a magnitude 3.0 event (See Table 6.3-10).

Table 6.3-10
The Modified Mercalli Intensity Scale of 1931 (abridged)

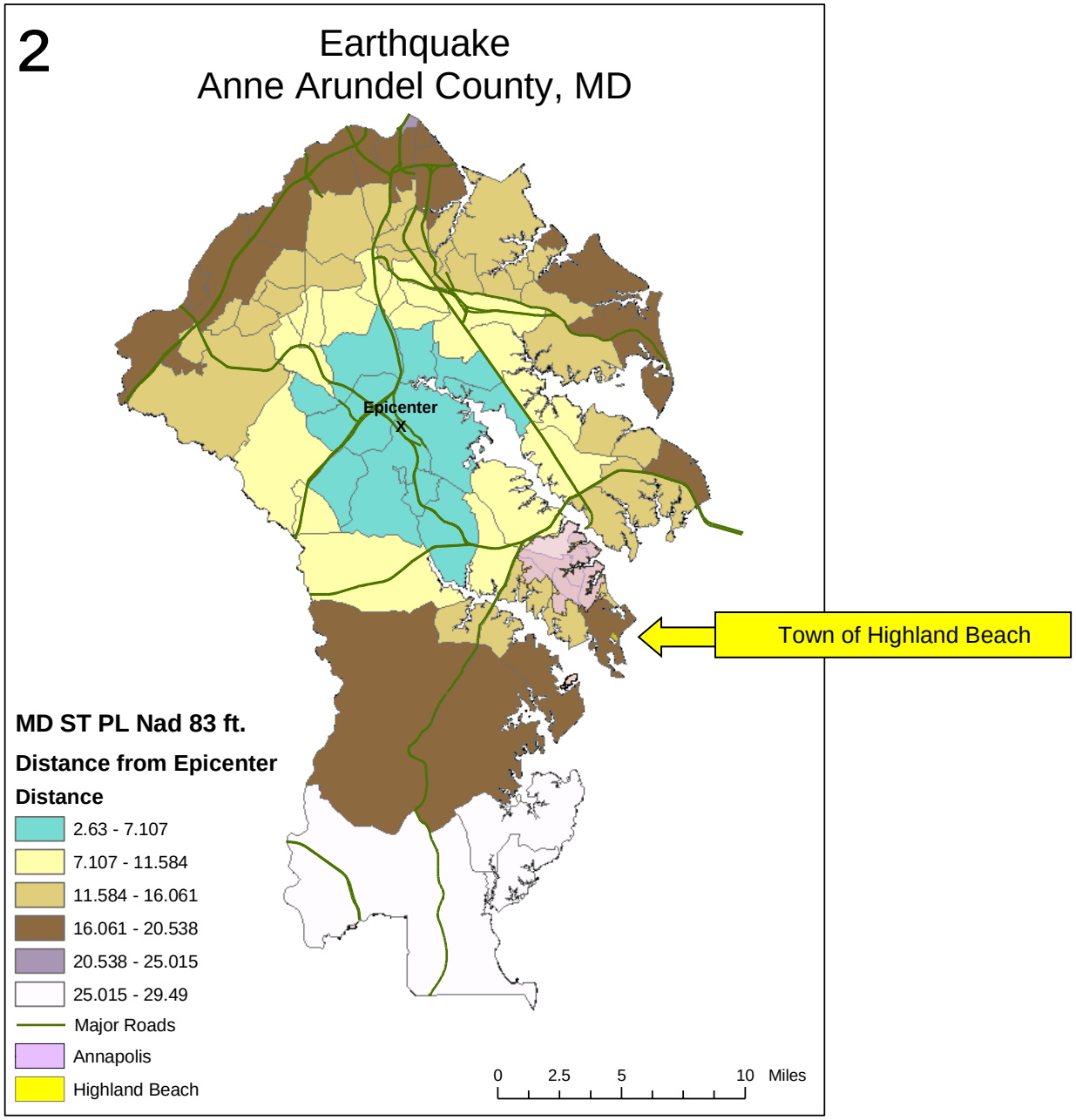
Intensity	Effect
I	Not felt except by very few people under especially favorable conditions.
II	Felt by a few people, especially those on upper floors of buildings. Suspended objects may swing.
III	Felt quite noticeably indoors. Many do not recognize it as an earthquake. Standing motorcars may rock slightly.
IV	Felt by many who are indoors; felt by a few outdoors. At night, some awakened. Dishes, windows and doors rattle.
V	Felt by nearly everyone; many awakened. Some dishes and windows broken; some cracked plaster; unstable objects overturned.
VI	Felt by everyone; many frightened and run outdoors. Some heavy furniture moved; some fallen plaster or damaged chimneys.
VII	Most people alarmed and run outside. Damage negligible in well constructed buildings; considerable damage in poorly constructed buildings.
VIII	Damage slight in specially designed structures; considerable in ordinary buildings; great in poorly built structures. Heavy furniture overturned. Chimneys, monuments, etc. may topple.
IX	Damage considerable in specially designed structures. Buildings shift from foundations and collapse. Ground cracked. Underground pipes broken.
X	Some well-built wooden structures destroyed. Most masonry structures destroyed. Ground badly cracked. Landslides on steep slopes.
XI	Few, if any, masonry structures remain standing. Railroad rails bent; bridges destroyed. Broad fissure in ground.
XII	Virtually total destruction. Waves seen on ground; objects thrown into the air.

Table 6.3-11
Relationships Between Intensity & Magnitude
(Source: USGS 1981, 1989)

General Description	Richter Magnitude	Modified Mercalli Intensity	Expected Annual Incidence (Worldwide)	Distance Felt (miles)
Microearthquake	below 2.0	--	600,000	--
Perceptible	2.0-2.9	I--II	300,000	--
Felt generally	3.0-3.9	II-III	49,000	15
Minor	4.0-4.9	IV-V	6,000	30
Moderate	5.0-5.9	VI-VII	1,000	70
Large (Strong)	6.0-6.9	VII-VIII	120	125
Major (Severe)	7.0-7.9	IX-X	18	250
Great	8.0-8.9	XI-XII	1.1	450
Approximate relationships among earthquake magnitude, intensity, worldwide occurrence, and area affected (after U.S. Geological Survey, 1981, 1989).				

However, an earthquake of magnitude 5.0 located in the center of the County, as illustrated in Figure 6.3-11, could have substantial effects on the County. An earthquake of this magnitude would potentially create a loss of $8,393,000,000 to buildings and their contents. Note that the HAZUS database that was originally used to estimate total building and contents values is no longer available, so these figures are extrapolated from the 2012 hazard mitigation plan using the U.S. Bureau of Labor Statistics on-line inflation calculator. A significant earthquake could potentially put the entire population of the County at risk, although potential losses would vary greatly depending on specific conditions at the time, and by site.

Figure 6.3-11
Earthquake Scenario - Anne Arundel County
(Source: Anne Arundel County Office of Emergency Management)



6.3.6.4 Impact on Life and Property

There are no known deaths, injuries, or property damage from earthquakes in Anne Arundel County. The very low probability of an event suggests that potential for these impacts is minimal. The HMPC and its consultant reviewed various open sources of earthquake probability data for this region of the country. As shown in Figure 6.3-10, seismicity in Maryland is negligible, with a predicted percent ground acceleration (PGA) of about 3% with a 10% exceedance probability in 50 years. This means that even in low-probability (higher severity) events, the potential risk to the built environment is minimal because of the low predicted levels of shaking.

6.3.6.5 Occurrences of the Earthquake Hazard

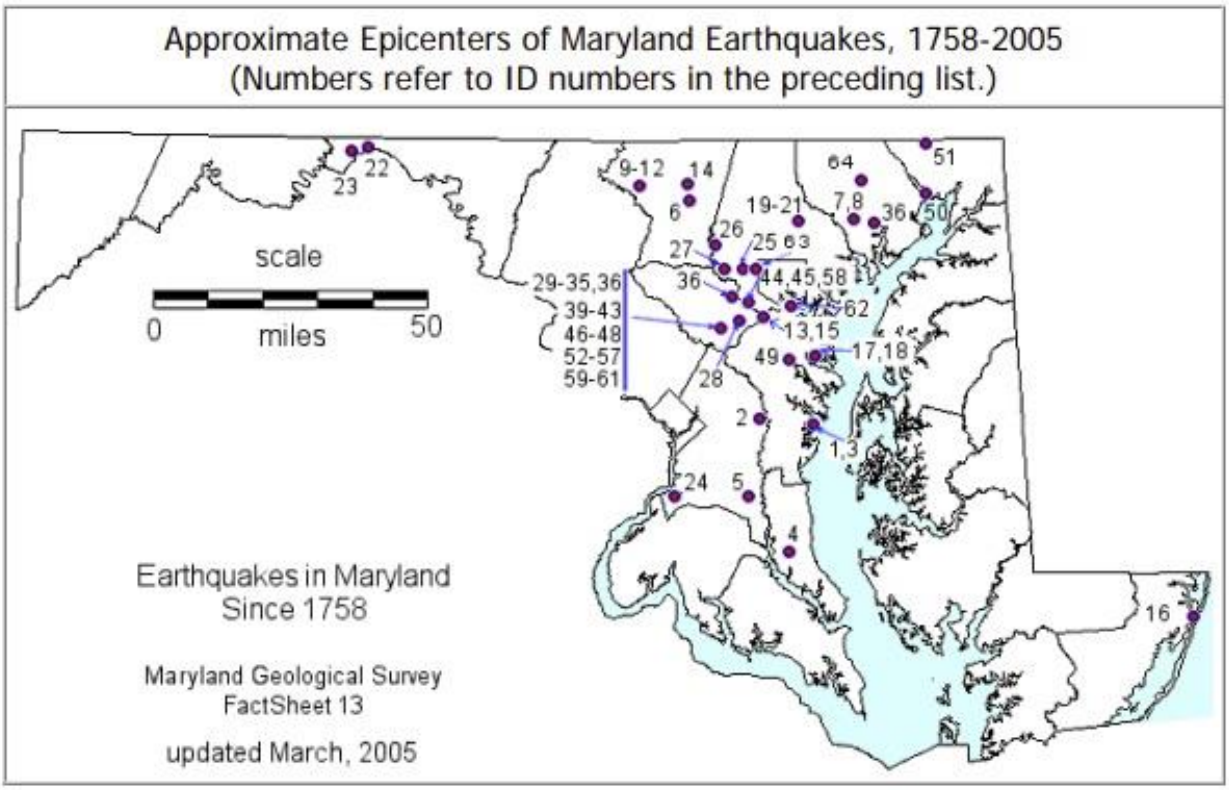
For 2018 HMP update, the USGS historical earthquake data by State was used to identify past earthquakes in Anne Arundel County. The earliest recorded earthquake in Maryland occurred in Annapolis, on April 24, 1758. The shock lasted 30 seconds and was preceded by subterranean noises. In recent years moderate-sized earthquakes in nearby states have been felt in Maryland with only negligible effects. Anne Arundel County has experienced few and minor earthquakes of low magnitude and intensity over the past 40-plus years. The U.S. Geologic Survey (USGS) earthquake history for Maryland indicates there have been three earthquakes statewide between 1969 and 2009, with no detailed records of any since. There have been at least two other earthquakes since then in which shaking was felt in Maryland – these had epicenters in Virginia (7/10) and Delaware (11/17). The Virginia event initiated the activation of the Anne Arundel County Emergency Operations Center, and some damages were reported in the County. Three other events reported by the USGS are listed below:

> November 19, 1969, earthquake (magnitude 4.3) occurred near Elgood, West Virginia. The event was felt as far away as West Hyattsville.
>
> The February 10, 1972, tremor at Wilmington, Delaware, was felt at Elkton, Maryland.
>
> On February 28, 1973, residents throughout a broad area of the middle-Atlantic region of the United States were jolted out of their sleep by shock waves from a minor earthquake near the Delaware - New Jersey - Pennsylvania border. Numerous points in northeastern Maryland reported this earthquake.

In addition to these USGS events, the County OEM reports that there have been several earthquakes since 1973, including an event in July 2010, the epicenter of which was in Virginia. It resulted in the activation of the County Emergency Operations Center. There have also been a few other minor earthquakes since that time that have been felt in Anne Arundel County, including a Richter 4.1 event in 2017 that originated in Dover, Delaware.

Figure 6.3-12 shows the epicenters of earthquakes originating in Maryland 1758 to 2005. All of these have been minor events with minimal reported damage. Most of the more significant earthquake in the State have originated elsewhere.

Figure 6.3-12
Historic Earthquake Epicenters in the State of Maryland
(Source: Maryland Geological Survey)



Based on historical records over the past 75 years the probability of significant future earthquakes occurring in Anne Arundel County and the planning area is minimal.

Earthquake Hazards in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to earthquakes as the rest of the County, although it is possible that local soils may differ from other parts of the County due to the coastal location. However, as noted in text, the County generally has little risk from this hazard because of the very low seismicity in the region. Potential impacts are negligible.

- 6.3.7 Extreme Heat

6.3.7.1 Description of the Extreme Heat Hazard

Extreme heat kills by pushing the human body beyond its limits. Under normal conditions, the body's internal thermostat produces perspiration that evaporates and cools the body. However, in extreme heat and high humidity, evaporation is slowed and the body must work extra hard to maintain a normal temperature.

Temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks are defined as extreme heat. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. Excessively dry and hot conditions can provoke dust storms.

There are seasonal patterns to excessive heat waves, with an event most likely to occur in the summer months. Excessive heat can also cause utility outages due to an increased demand for electricity. Utility outages could severely hamper the County's ability to provide services as facilities become inoperable and must be closed due to a lack of power or water.

6.3.7.2 Location and Extent of the Extreme Heat Hazard

Most areas of the U.S. are at some risk of extreme heat events, but these are much more common in the west and southwest. Nevertheless, the mid-Atlantic in general, and Anne Arundel County in particular are at some risk from extreme heat, particularly during the June through September months, when temperatures exceeding 100 degrees Fahrenheit are always a possibility. High temperatures may be exacerbated by humidity and poor air quality, presenting additional risks to vulnerable populations. The potential for extreme heat events is uniform for all of Anne Arundel County. All people and assets are considered to have the same degree of exposure.

6.3.7.3 Severity of Extreme Heat

Heat kills by pushing the body beyond its limits. Under normal conditions an internal thermostat produces perspiration that evaporates and cools the body. The human body dissipates heat by varying the rate and depth of blood circulation, by losing water through the skin and sweat glands, and as a last resort, by panting, when blood is heated above 98.6°F. Sweating cools the body through evaporation. However, high relative humidity retards evaporation, robbing the body of its ability to cool itself. When heat gain exceeds the level the body can remove, body temperature begins to rise, and heat related illnesses and disorders may develop.

Most heat disorders occur because the victim has been overexposed to heat or has over-exercised for his or her age and physical condition. The **Heat Index** (HI) is the temperature the body feels when heat and humidity are combined. Tables 6.3-12 and 6.3-13 illustrate the heat index and its potential effects on the human body.

Table 6.3-12
Temperature Versus Relative Humidity
(Source: National Weather Service)

Temperature (F)	Relative Humidity (%)					
	90%	80%	70%	60%	50%	40%
80	85°	84°	82°	81°	80°	79°
85	101°	96°	92°	90°	86°	84°
90	121°	113°	105°	99°	94	90°
95		133°	122°	113°	105°	98°
100			142°	129°	118°	109°
105				148°	133°	121°
110						135°
*This chart is based upon shady, light wind conditions; exposure to direct sunlight can increase the HI by up to 15°F. ** Due to the nature of the heat index calculation, the values in the table has an error +/- 1.3F.						
Source: National Weather Service: http://www.crh.noaa.gov/pub/heat.htm						

Table 6.3-13
Heat Index Versus Possible Effects
(Source: National Weather Service)

Hi Temperature	Possible Heat Disorder
80°F - 90°F	Fatigue possible with prolonged exposure and physical activity.
90°F - 105°F	Heat stroke, heat cramps and heat exhaustion possible.
105°F - 130°F	Heat stroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
130°F or greater	Heat stroke highly likely with continued exposure.
Source: National Weather Service: http://www.crh.noaa.gov/pub/heat.htm	

6.3.7.4 Impact on Life and Property

Excessive heat can have a major impact, causing multiple deaths, but sparing property. With extreme heat, there is little physical destruction, although roads can buckle, trains derail, and livestock die. Extreme heat conditions can pose problems for those not accustomed to the climate or who are outside for prolonged periods of time. Extreme heat can create a threat even to individuals and communities that are accustomed to high temperatures. Excessive heat can also cause utility outages due to an increased demand for electricity.

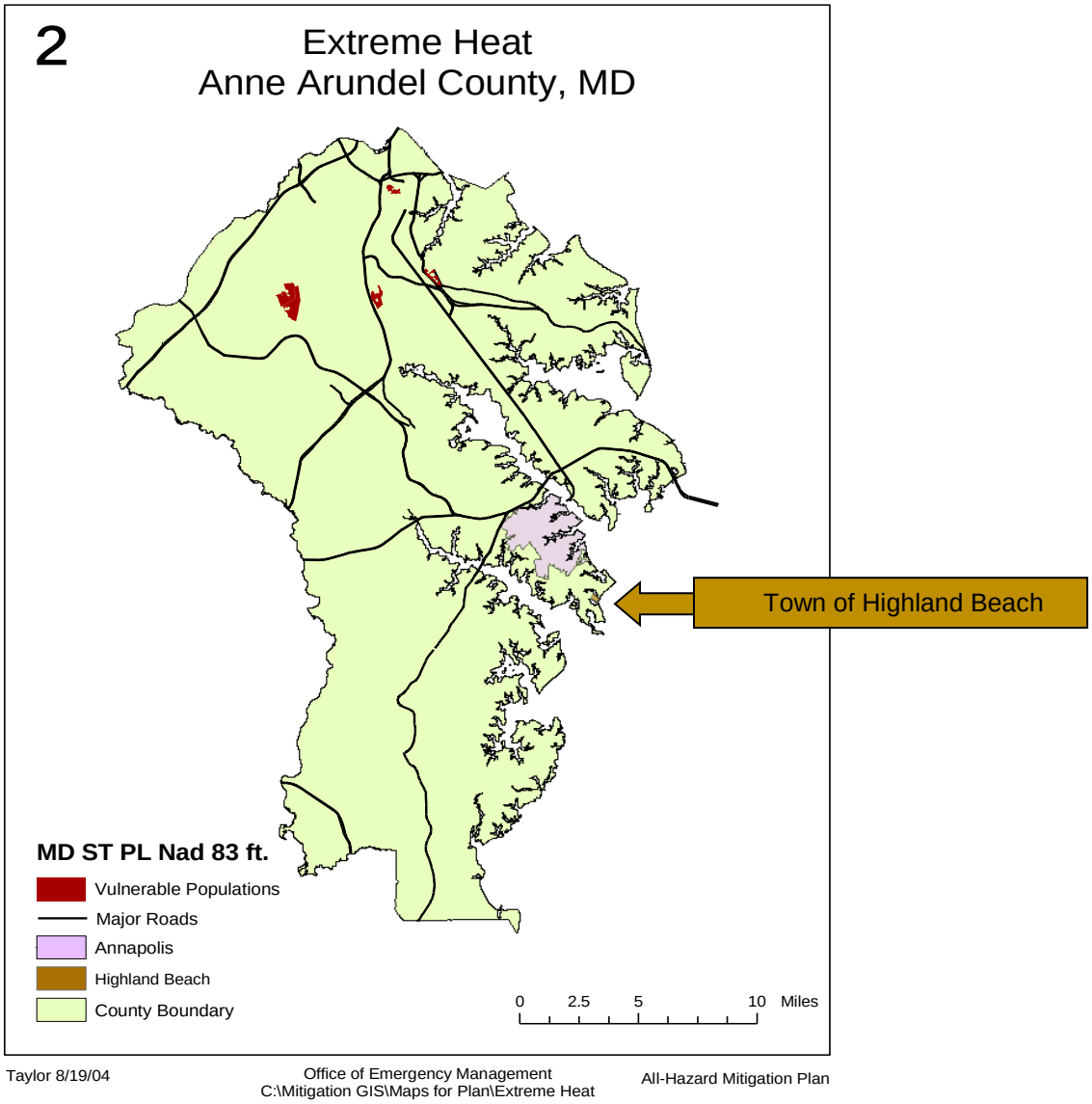
Older adult residents, young children, those who are overweight, individuals who live alone, residents who lack access to transportation and air-conditioning, and people suffering from serious illnesses are especially prone to heat-related problems. According to the Federal Emergency Management Agency, between 1936 and 1975, nearly 20,000 people succumbed to the effects of heat and solar radiation. Extreme heat disorders include sunburn, heat cramps, heat exhaustion, and heat stroke.

People living in urban areas may be at greater risk from the effects of a prolonged heat wave than people living in rural regions. An increased health problem can occur when stagnant atmospheric conditions trap pollutants in urban

areas, thus adding contaminants to excessively hot temperatures. Moreover, high temperatures in urban areas are often magnified by the presence of large areas of pavement rooftops, which can create heat island effects, increasing temperatures and holding heat even when the sun has gone down.

Excessive heat does not have particular impacts in any one geographical section of the County. The most vulnerable individuals to this hazard are the older adults and the young, as well as those individuals whose socio-economic status prevents them from having access to artificial cooling methods. Figure 6.3-13 presents the Census Blocks in the County where the highest concentrations of vulnerable populations reside. These areas contain 2,985 people who will potentially be affected by this hazard. The economic impacts of this hazard cannot be evaluated geographically. Critical County infrastructure is unlikely to be affected by this hazard.

Figure 6.3-13
Census Blocks in Anne Arundel County with the Highest Concentration of Vulnerable Residents
(Source: Anne Arundel County Office of Emergency Management)



6.3.7.5 Occurrences of the Extreme Heat Hazard

The 2012 version of the HMP indicated that the NCDC database showed 34 deaths and 432 injuries from extreme heat events in the planning area between 1950 and 2009 (with $30,000 in property damage). A query of the database for the 2018 update shows only five events between 2000 and 2016. This change is likely a result of modifications in how NCDC manages and reports data. Presumably, the longer-term figures offer a more accurate characterization of heat risks. In addition to the NCDC database, the State of Maryland Department of Health, Office of Preparedness and Response, provides weekly reports during the warm months of the year (May through September) with data on the numbers of heat-related illnesses and deaths by jurisdiction and age group. These reports indicated heat-related deaths in Anne Arundel County in 2016 and 2017, but none in 2014 or 2015. The data does not extend further back in time.[6]

Based on the reported previous occurrences listed above, it is reasonable to assume that extreme heat events will continue in the County, but the impacts to the planning area will most likely be minimal.

-

Extreme Heat Hazard in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to extreme heat as the rest of the County, However, as noted in text, the County generally has little risk from this hazard because the climate of the area does not suggest extreme heat events are particularly common. Potential impacts are negligible.

6.3.8 Severe Thunderstorm and Hailstorm

6.3.8.1 Description of the Severe Thunderstorm and Hailstorm Hazard

Thunderstorms are the by-products of atmospheric instability, which promotes vigorous rising of air particles. A typical thunderstorm may cover an area three miles wide. The National Weather Service considers a thunderstorm "severe" if it produces tornadoes, hail of 0.75 inches or more in diameter, or winds of 58 miles per hour or more. Structural wind damage may imply the occurrence of a severe thunderstorm. Hail is a form of precipitation comprised of spherical lumps of ice. Known as hailstones, these ice balls typically range from five mm to 50 mm in diameter on average, with much larger hailstones forming in severe thunderstorms. The size of hailstones is a direct function of the severity and size of the storm.

6.3.8.2 Location and Extent of the Severe Thunderstorm and Hail Hazard

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10 percent are classified as severe.

Hailstorms occur more frequently during the late spring and early summer, when the jet stream migrates northward across the Great Plains. This period has extreme temperature changes from the ground surface upward into the jet stream, which produces the strong updraft winds needed for hail formation.

[6] https://preparedness.health.maryland.gov/Pages/Reports.aspx

Peak periods for hailstorms, late spring and early summer coincided with the Midwest's peak agricultural seasons for crops such as wheat, corn, barley, oats, rye, tobacco, and fruit trees. Long-stemmed vegetation is particularly vulnerable to damage by hail impacts and winds. The land area affected by individual hail events is not much smaller than that of a parent thunderstorm, an average of 15 miles in diameter around the center of a storm.

6.3.8.3 Severity of the Severe Thunderstorm and Hail Hazard

The severity of hailstorms is measured by duration, size of the hail itself, and by geographic extent. All of these factors are directly related to the weather phenomena that create the hail, thunderstorms. There is wide potential variation in these severity components.

Data on the probability and frequency of occurrence of hailstorms is limited, with little recent research. What data that is available shows that only a localized area along the border of northern Colorado and southern Wyoming experiences hailstorms eight or more days each year. Outside of the coastal regions, most of the United States experiences hailstorms at least two days each year.

The entire County is at risk from hailstorms. Hailstorms affect Anne Arundel County equally and uniformly. Hailstorms have affected the entire County at one time or another.

6.3.8.4 Impact on Life and Property

Severe thunderstorms or hailstorms do not have particular impacts in any one geographical section of the County. However, hail and heavy rain typically have the greatest impact on the agricultural community. Such areas contain 74,857 people in the County who will potentially be affected by this hazard (this value is from the 2012 version of the HMP; no more recent data is available for the 2018 HMP update). The economic impacts of this hazard cannot be evaluated geographically. Critical County infrastructure is unlikely to be affected by this hazard.

There are no known instances of injuries or death from hail events in Anne Arundel County. Although typically not life threatening, severe hailstorms have the potential to cause significant property damage, particularly to automobiles and some building types. The development of hailstorms from thunderstorm events causes nearly $1 billion in property and crop damage each year. The NCDC database indicates there were no deaths and 16 injuries from thunderstorm events in the planning area between 1950 and 2009. During this same time period the NCDC reported a total of approximately $8.7 million in property damage.

6.3.8.5 Occurrences of the Severe Thunderstorm and Hailstorm Hazard

The NCDC database indicates that there have been 54 hailstorm events in Anne Arundel County between 1950 and 2009. A re-query of the database for the 2018 HMP update shows 14 more events (for a total of 68). These events produced hail ranging in size between 0.75 and 2.0 inches in diameter. Of the 68 hail events, five resulted in property damage (there was no additional property damage reported in the 2018 re-query).

- Based on historical records from the NCDC database the future probability of hailstorms in Anne Arundel County is reasonably high. However, property damage and impact to on life in the County is minimal compared to the potential damage from other hazards.

The NCDC database indicates that between 1950 and 2009, Anne Arundel County experienced 130 severe thunderstorms (16 of which had greater than 60 knot winds). The 2018 re-query of the NCDC database showed an additional 102 events through 2017, with no additional reported damages or deaths. It should be noted that the database cannot accurately report damages from thunderstorms, since presumably the large majority of such damages are either not reported, addressed via private insurance (the data for which is highly proprietary), or simply repaired by utilities or public entities without any specific reporting requirements.

Based on historical records from the NCDC database, the future probability of thunderstorms in Anne Arundel County is very high – thunderstorms occur very often in the County, particularly during the spring and summer months. However, generally speaking, property damage and impact on life in the County are minor compared to the potential damage from other hazards.

Thunderstorm Hazard in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to thunderstorms as the rest of the County. The County has a moderate exposure to this hazard, but the impacts are generally insignificant.

• 6.3.9 Severe Winter Storm

6.3.9.1 Description of the Severe Winter Storm Hazard

Winter storms typically form along a front generally following the meandering path of the jet stream. These storms, called mid-latitude cyclones or extra-tropical cyclones, differ from hurricanes in that they move from west to east as opposed to east to west. These weather patterns carry cold air from Canada and the Rockies into the southern U.S. A severe winter storm event includes a storm with heavy snow, ice, or freezing rain – all of which can cause significant problems for residents.

Heavy snowfall and extreme cold can immobilize an entire region. Even areas that normally experience mild winters can be hit with a major snowstorm or extreme cold. Winter storms can result in flooding, storm surge, closed highways, blocked roads, downed power lines and hypothermia.

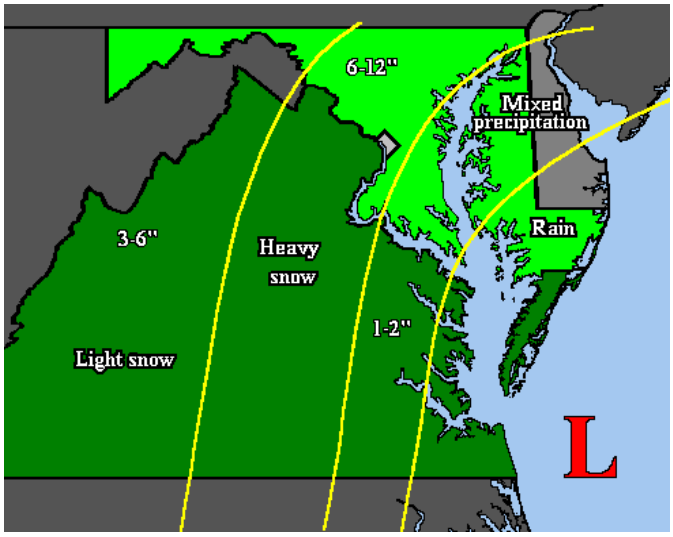
Figure 6.3-14
Annapolis Street during the February 2016 Snowstorm

The County's greatest winter storms are "Nor'easters." It takes a specific combination of conditions to get heavy snow and wind from a Nor'easter. First, an arctic air mass should be in place. As high pressure builds over New England, cold, arctic air flows south. This dense cold air is unable to move west over the Appalachian Mountains and thus is funneled south down the valleys and along the Coastal Plain. This is called "cold air damming." To the east of the cold air is the warm water of the Gulf Stream. The contrast of the cold air sliding south into the Carolinas and the warm air sitting over the Gulf Stream creates a breeding ground for storms. With the correct position of the jet stream, storm development off the Carolinas may become "explosive" (sudden, rapid intensification with a dramatic drop in the central pressure of the storm). Nor'easters can produce blizzard conditions. The National Weather Service (NWS) definition of a blizzard is a winter storm that produces the following conditions for three hours or longer: sustained winds or frequent gusts 35 mph or greater and falling and/or blowing snow reducing visibility frequently to less than one-quarter mile on a widespread or local basis.

The ideal position of the jet stream has it crossing the West Coast of the United States and then splitting. The northern branch crosses the northern Rockies and Canada and the southern branch dips down to the Gulf Coast states. The latter branch then turns northeast across Virginia and rejoins the northern branch near Newfoundland. The northern branch of the jet supports the southward sinking cold air. The southern branch carries a disturbance from the Gulf Coast northeast to the Carolina coast where it intensifies into a Nor'easter. Winds around the storm center carry warm, moist air from over the Gulf Stream up and over the cold inland air. As the air rises, it cools and causes snow to begin falling.

During winter storm events, it is quite common for a rain-snow line to develop over the Richmond-Washington-Baltimore-Philadelphia metropolitan areas. The heaviest snow band generally occurs in a 50-mile wide swath about 150 miles northwest of the low-pressure center (represented as an "L" on Figure 6.3-15). Closer to the low, the warm ocean air changes the precipitation over to sleet, freezing rain, and eventually rain. The track of the storm can mean the difference between heavy rain, freezing rain, or sleet (marked as mixed precipitation in the diagram), and a foot or more of snow.

Figure 6.3-15
Typical Nor'easter Snowfall Map
(Source: NOAA)

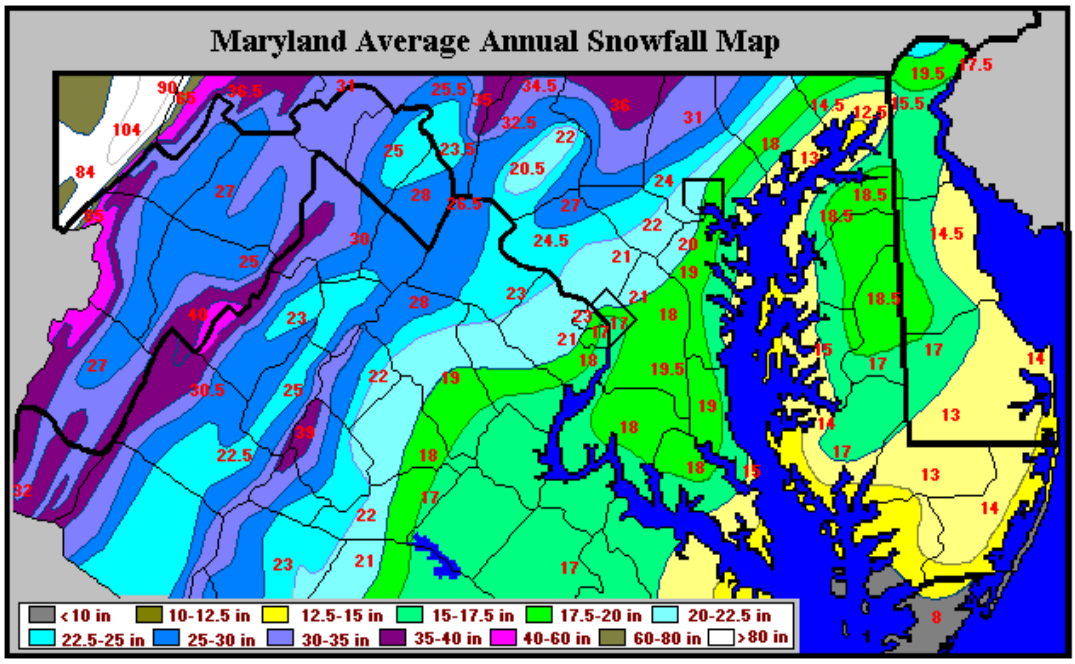


6.3.9.2 Location and Extent of the Severe Winter Storm Hazard

Nearly the entire United States is considered at risk for severe winter storms. Heavily populated areas are particularly impacted when severe winter storms disrupt communication and power due to downed lines from high winds and icing. Debris associated with heavy icing may impact utility systems and transportation routes. The potential for winter storms is uniform for all of Anne Arundel County. All people and assets are considered to have the same degree of exposure.

Seasonal snowfall in Maryland varies from an average of about 12 to 14 inches on the eastern shore to about 80 to 100 inches in Garret County. There is, however, significant variation from year to year. February is the month when maximum accumulations on the ground are usually reached. Figure 6.3-16 shows the average annual snowfall for Maryland. The map shows the average yearly snowfall in Anne Arundel County ranges from 12 to 18 inches.

Figure 6.3-16
Average Annual Snowfall Map - Maryland
(Source: NOAA)



6.3.9.3 Severity of Severe Winter Storm

Blizzards are the most severe type of winter storms characterized by low temperatures, strong winds, and heavy blowing snow. Many winter depressions give rise to exceptionally heavy rain and widespread flooding. Conditions worsen as the temperature drops, rain turns to ice, and accumulation of ice begins to occur. Winter storms are known to spawn other natural hazards, such as coastal flooding and erosion, severe thunderstorms, tornadoes, high winds, and severe ice.

Ice storms can often be as disruptive as blizzards. Trees, cars, roads, and other surfaces develop a coating or glaze of ice making even small accumulations of ice an extreme hazard to motorists and pedestrians. The most prevalent impacts of heavy accumulations of ice are slippery roads and walkways, collapsed roofs from fallen trees, telephone poles and lines, electrical wires, and communication towers. As a result of severe winter storms, telecommunications and power can be disrupted for days.

6.3.9.4 Impact on Life and Property

Severe winter storms do not have particular impacts in any one geographical section of the County. The most vulnerable individuals to this hazard are the very old and the young, as well as those individuals whose socio-economic status prevents them from having access to adequate shelter and heat. The economic impacts of this hazard cannot be evaluated geographically. Critical County infrastructure is unlikely to be affected by this hazard.

The NCDC database shows one death, one injury, and 31 winter storms between 1999 and 2018 in Anne Arundel County. In December 2009 and February 2012, the State of Maryland (and other areas in the mid-Atlantic) experienced a series of very significant winter storms that in many areas dropped more than 60 inches of snow (total). As noted elsewhere, the President declared disasters for both events, primarily in FEMA Public Assistance Category B (Emergency Protective Measures). Similar events occurred in 2015 and 2016, though the NCDC database does not specify any damages, deaths or injuries.

The potential power outage hazard (which may be caused by winter storms) was not specifically considered in the HMP development process. Although power outages occur periodically in the County, sometimes as effects from natural hazards, there is little to suggest that power outages themselves present significant risks. Most Anne Arundel critical facilities have generators, which are maintained and tested regularly, and these can support essential functions during most power outages.

Section 7.3.4 of the HMP update includes a risk assessment for the Severe Winter Storm hazard. This section includes detailed risk projections for the 100-year time horizon.

6.3.9.5 Occurrences of the Severe Winter Storm Hazard

The NCDC database indicates that between 1999 and 2018, Anne Arundel County experienced 31 winter storm events. Of these, two events resulted in property damage totaling $2.005M. Table 6.3-13 summarizes the winter storm events that resulted in property damage. Note that the NCDC data extends back only to 1999, so not all historic winter storms are included in the data set. Note that Section 7 of the HMP incorporates a slightly different set of data as the basis of the risk calculation, because of inconsistencies in the NCDC data periods.

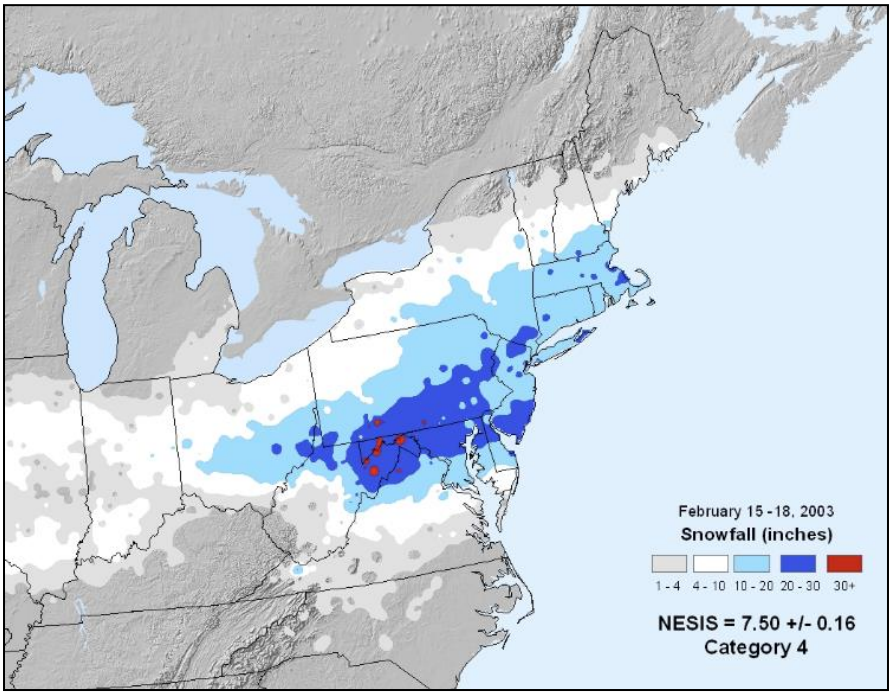
Table 6.3-13
Winter Storm Events Resulting in Property Damage,
Anne Arundel County 1999 – 2018
(Source: NOAA/NCDC)

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								1	1	2.005M	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	03/09/1999	02:00	EST	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/20/2000	00:00	EST	Winter Storm		0	1	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/25/2000	03:00	EST	Winter Storm		1	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/30/2000	03:00	EST	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/22/2001	09:00	EST	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	12/05/2002	00:00	EST	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/06/2003	19:00	EST	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/14/2003	08:00	EST	Winter Storm		0	0	2.000M	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/25/2004	12:00	EST	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/22/2005	07:00	EST	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/24/2005	11:00	EST	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/28/2005	21:00	EST	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/12/2007	22:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/27/2009	05:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	03/01/2009	18:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	12/18/2009	19:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/30/2010	10:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/02/2010	17:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/05/2010	11:00	EST-5	Winter Storm		0	0	5.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/09/2010	17:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/17/2011	20:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/26/2011	16:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/02/2014	16:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/21/2014	09:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/12/2014	19:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	03/03/2014	02:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	03/16/2014	18:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/16/2015	16:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	02/21/2015	10:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	03/05/2015	08:00	EST-5	Winter Storm		0	0	0.00K	0.00K
ANNE ARUNDEL (ZONE)	ANNE ARUNDEL (ZONE)	MD	01/22/2016	14:00	EST-5	Winter Storm		0	0	0.00K	0.00K
Totals:								1	1	2.005M	0.00K

Several of the events listed in the table above caused millions of dollars in damage. The first event occurred in 1999 when a strong arctic cold front moved slowly southeast across the Mid-Atlantic region. This front brought a thick layer of sub freezing air to the lowest levels of the atmosphere, but just off the surface warmer air moved in. The ice storm resulted in accumulations from one-quarter to nearly one inch occurred across all of Western and Central Maryland. Winds gusted over 40 mph after the precipitation ended and trees weighed down by the heavy ice accumulations fell on homes, across roads, and onto power lines across the area. An estimated 2,000 power lines were reported down in PEPCO's Maryland power service area leading to a loss of power for 230,000 of the utility companies 680,000 customers.

The second event occurred on February 14, 2003 when record-breaking snow and sleet accumulations were reported. Across Western and North Central Maryland, and the Baltimore metropolitan area, snow accumulations of mainly ranged from 20 to 32 inches. In Anne Arundel County, two middle schools suffered partial roof collapses. Other buildings that suffered structural damage included a church, warehouse, athletic club, shopping center, mall, grain silo, awning on a house and a restaurant, garage, boat storage structure, and a grocery store. The storm also resulted in four deaths in Anne Arundel County due to heart attacks after shoveling snow.

Figure 6.3-17
Snowfall Totals, Blizzard of February 2003



In addition to the events listed in the table above, Anne Arundel County was also impacted by the Blizzard of 1996. Winter weather experts have ranked this storm as the second-worst snowstorm to strike the Northeast in modern times. The Nor'easter buried portions of Maryland under as much as four feet of snow. Baltimore recorded 26.6 inches over three days at BWI Marshall Airport. Snowfall totals in Anne Arundel County ranged from 15 to 18 inches.

More recently, the Mid-Atlantic was impacted with blizzard conditions and record-breaking snow on February 6-7, 2010. The event occurred just a few weeks prior to the NCDC database query for the HMP update, so loss data did not appear there. On February 5th, 2010 a strong storm moved across the Gulf of Mexico and up the East Coast of the United States. This storm produced heavy snowfall from Virginia to New Jersey. Many sites in Pennsylvania, Virginia, Maryland, Delaware, and New Jersey received record snowfall. Snowfall totals at some sites exceeded 30 inches in Maryland and Pennsylvania. Reports of snowfall in excess of 20 inches were common in the Pittsburgh, Harrisburg, Philadelphia, Washington, and Baltimore metropolitan areas.[7] The National Weather Service (NWS) indicated that blizzard conditions were recorded at Baltimore/Washington International Thurgood Marshall Airport on February 7th from approximately 12 midnight to 5 a.m. Saturday. During this time period wind gusts were reported at 37 mph, with visibility at or below one-quarter mile with heavy snow.

The storm caused major disruption to the area and left hundreds of thousands without power from Virginia to Pennsylvania. The storm caused massive power outages in the Washington and Baltimore areas, where temperatures were close to freezing at the height of the storm. Across Maryland, approximately 100,000 residents were without power. Heavy snow and blowing snow closed roads, rails, and major airports throughout the Mid-Atlantic region Friday into Saturday.

Anne Arundel County and Maryland have experienced several additional winter storms of varying magnitudes since the 2012 HMP update. The most significant of these occurred in 2016. Dubbed “snowzilla”, the storm dumped nearly 30” of snow on BWI Marshall Airport, and resulted in widespread traffic interruptions and downed trees. There is no reliable way to estimate damages from the event. The Obama administration declared a major disaster (DR-4261) for Maryland to assist with the recovery.

As with all climate- and weather-based hazards, there is no completely reliable way to estimate probabilities of future occurrences, except over a fairly long period of time. However, given the long history of winter storms on the Atlantic seaboard, it is reasonable to expect an average of one or more significant events every year. These can include ice storms and snowstorms, and the definition can also include extreme cold.

[7] National Weather Service Office – State College PA. The Historic Mid-Atlantic Snow Storm of February 5-6 2010 (Draft).

Severe Winter Storm Hazard in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to severe winter storms as the rest of the County. The County has a moderate risk from this hazard overall, however, the Anne Arundel and Highland Beach experience winter weather often enough that the jurisdictions are well prepared for it. While potential impacts are serious, there is nothing to suggest that these would be catastrophic or long-lasting.

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- 6.3.10 Tornadoes

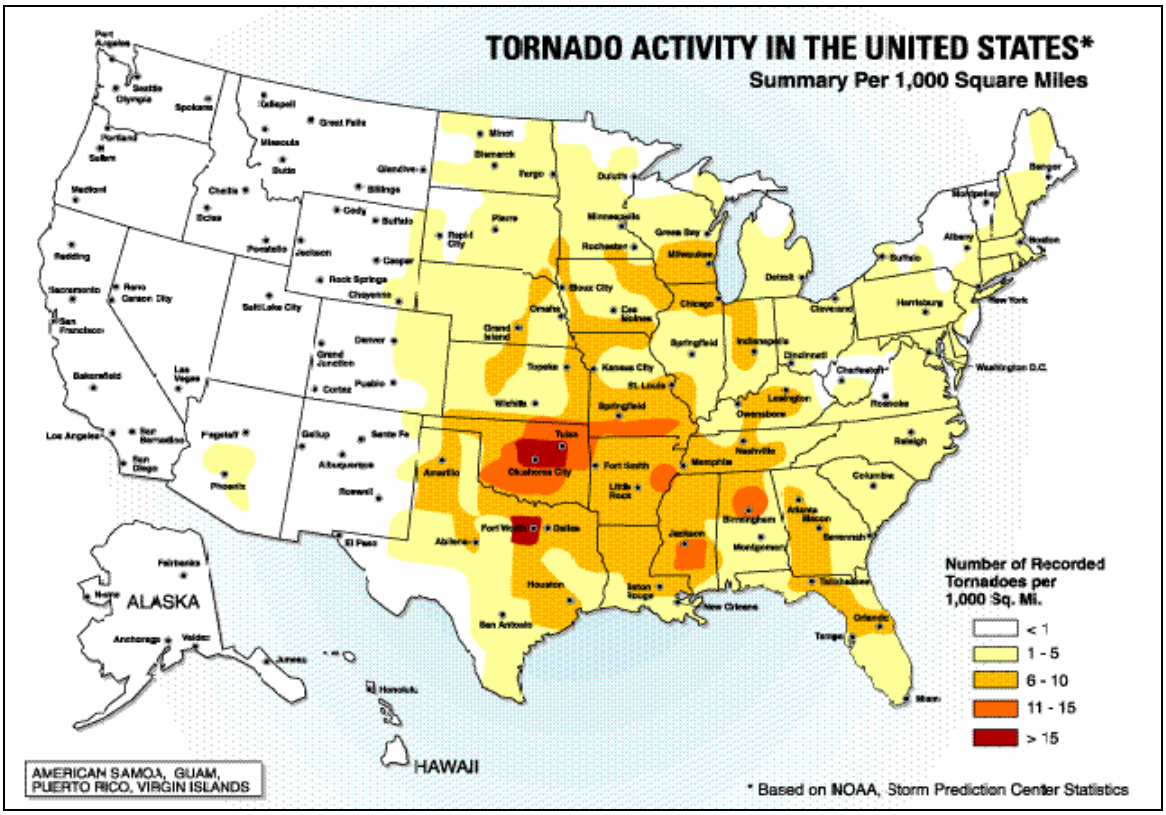
6.3.10.1 Description of the Tornado Hazard

A tornado is a rapidly rotating vortex or funnel of air extending to the ground from a cumulonimbus cloud. Most of the time, vortices remain suspended in the atmosphere. When the lower tip of a vortex touches earth, the tornado becomes a force of destruction. Approximately 1,000 known tornadoes are spawned by severe thunderstorms each year.

6.3.10.2 Location and Extent of the Tornado Hazard

From 1953 to 1993, Texas experienced the highest average annual number of tornadoes with 128, followed by Oklahoma (52), Kansas (47), Florida (46), and Nebraska (38). Maryland has more than 25. In Maryland, peak tornado occurrence is in March through May, and in November.

Figure 6.3-18
Tornado Activity in the United States



An area covering portions of Texas, Oklahoma, Arkansas, Missouri, and Kansas is known as Tornado Alley, where the average annual number of tornadoes is the highest in the United States. Cold air from the north collides with warm air from the Gulf of Mexico, creating a temperature differential on the order of 20 – 30 degrees C. Most tornadoes in this area occur in the spring. People living in manufactured or mobile homes are most exposed to damage from tornadoes. Even if anchored, mobile homes do not withstand high wind speeds as well as permanent, site-built structures.

6.3.10.3 Severity of the Tornado Hazard

Tornado damage severity is measured by the Fujita Tornado Scale. The Fujita Scale assigns numerical values based on wind speeds and categorizes tornadoes from 0 to 5. The letter "F" often precedes the numerical value. Tornadoes are related to larger vortex formations, and therefore often form in convective cells such as thunderstorms or in the right forward quadrant of a hurricane, far from the hurricane eye. See Table 6.3-14 for a description of the Fujita Tornado Measurement Scale.

Table 6.3-14
Fujita Tornado Measurement Scale
(Source: National Weather Service)

Category	Wind Speed	Examples of Possible Damage	Number in Maryland	% of Total
F0	Gale (40-72 mph)	Light damage. Some damage to chimneys; break branches of trees; push over shallow rooted trees; damage to sign boards.	321	22%
F1	Moderate (73-112 mph)	Moderate damage. Peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads.	698	48%
F2	Significant (113-157 mph)	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.	292	20%
F3	Severe (158-206 mph)	Severe damage. Roofs and some walls torn off well constructed houses; trains overturned; most trees in forest uprooted; cars lifted off ground and thrown.	132	9%
F4	Devastating (207-260 mph)	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.	18	1%
F5	Incredible (261-318 mph)	Incredible damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile sized missiles fly through air in excess of 100 yards; trees debarked; incredible phenomena will occur.	2	0%

In February of 2007 the F-Scale was replaced with a more accurate Enhanced Fujita Scale (Enhanced F-scale). It was the Jarrell, Texas tornado of May 27, 1997 and the Oklahoma City/Moore tornado of May 3, 1999 that brought to the forefront the problem that perhaps the wind estimates were too high in the F-Scale. The changes to the original scale were proposed by a committee of meteorologist and engineers searching for a more accurate method of assessing the magnitude of tornadoes. The modifications made to the F-scale were limited to ensure that the new Enhanced F-scale could continue to support the original tornado database found within the NDCD.

The Enhanced F-scale is a set of wind estimates (not measurements) based on observed damages after a tornado. Its uses three-second gusts estimated at the point of damage based on a judgment of eight levels of damage to 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 EF-0 to EF-5 (NOAA – Enhanced Fujita Scale). The wind speeds from the Fujita Scale were used as the basis for development of the Enhanced F-scale. The following table displays the wind speed ranges for the original Fujita Scale, the derived wind speeds (Enhanced F-scale), and the new Enhanced F-scale (in use since February 2007).

Table 6.3-15
Wind Speed Comparison of the Fujita Scale and Enhanced Fujita Scale
(Source: NOAA – National Weather Service)

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	**EF Number**	**3 Second Gust (mph)**
0	40-72	45-78	0	65-85	**0**	**65-85**
1	73-112	79-117	1	86-109	**1**	**86-110**
2	113-157	118-161	2	110-137	**2**	**111-135**
3	158-207	162-209	3	138-167	**3**	**136-165**
4	208-260	210-261	4	168-199	**4**	**166-200**
5	261-318	262-317	5	200-234	**5**	**Over 200**

Between 1975 and 1995, 106 major Federal disaster declarations included impacts caused by tornadoes. The States with the greatest number of tornado-related disasters were: Mississippi (14); Alabama and Illinois (9 each); Oklahoma (8); Wisconsin (7); Ohio (6); and Missouri, Minnesota, Maryland, Georgia, and Arkansas (5 each).

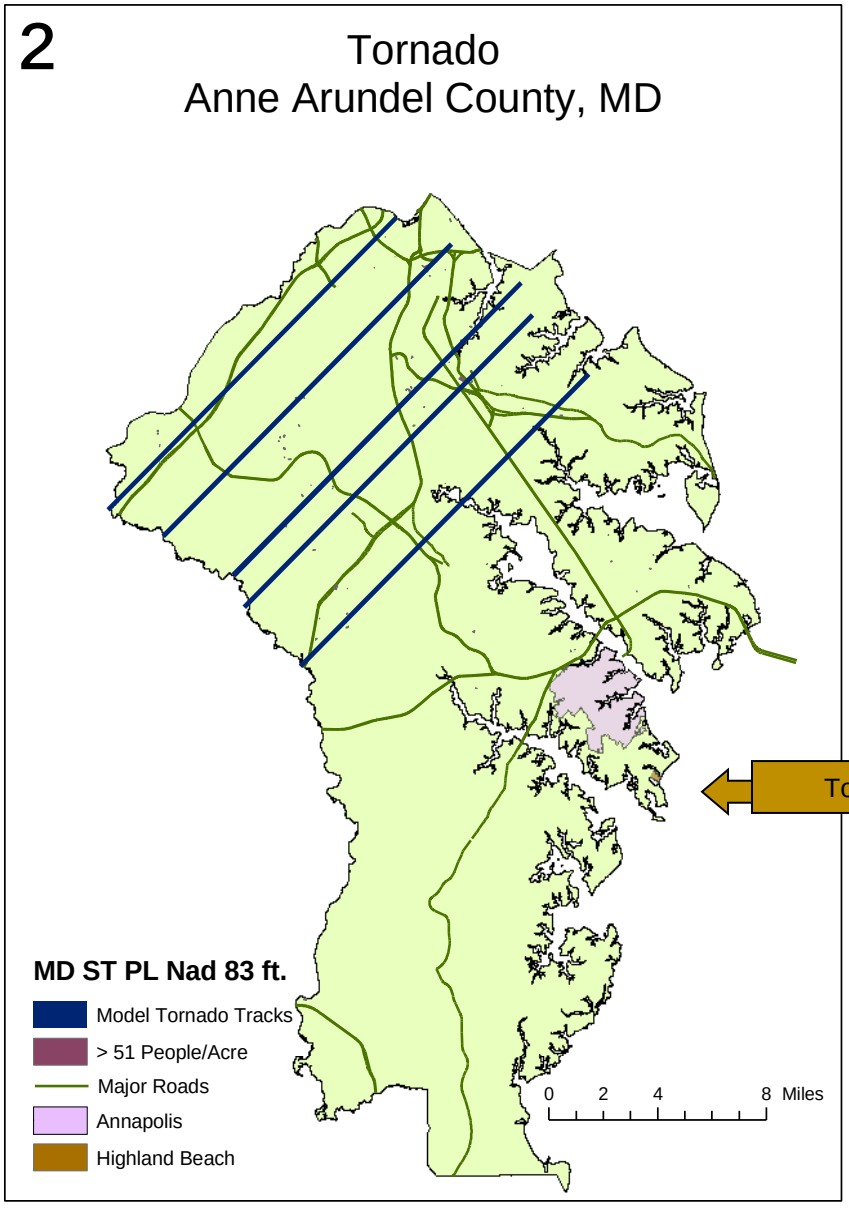
The tornadoes identified in the NCDC database for Anne Arundel County ranged in severity from an F0 to an F3.

6.3.10.4 Impact on Life and Property

Although technology and warning system capabilities have improved significantly in recent years, tornadoes can still occur with little or no warning, bringing a great deal of destruction and loss of life. The National Climatic Data Center reports that 21 tornadoes have occurred in Anne Arundel County between 1950 and 2018. The tornadoes caused an estimated $7.121 million in property damage. There were no deaths and one injury in these events. (Source: NOAA/NCDC database).

Within the planning area, tornadoes have an impact on Anne Arundel County equally and uniformly. However, a typical storm track (300 yards wide, 15 miles long, tracking from the southwest to the northeast) that passed through the five most densely populated areas of the County, as illustrated in Figure 6.3-19, could have major effects on the County. Persons and property located in Census Blocks through which these storms pass are most vulnerable to this hazard. These Census Blocks contain 15,375 people who will potentially be affected by this hazard. $3,861,000 in buildings and contents are exposed to this hazard. Note that Section 7 of this HMP update includes a general risk assessment using the FEMA Tornado Benefit-Cost Analysis tool. Note also that the value for exposed buildings and contents is extrapolated from the value in the 2012 version of the HMP, because the HAZUS database from which the original figure was derived is no longer available.

Figure 6.3-19
Anne Arundel County: Model Tornado Tracks
(Source: Anne Arundel County Office of Emergency Management)



6.3.10.5 Occurrences of the Tornado Hazard

As mentioned above, a total of 21 tornadoes were identified in the NCDC database for Anne Arundel County between 1950 and 2018. Of the 21 tornadoes, eight were F/EF 0, 12 were F/EF 1, and one was F/EF 3. The tornado events for Anne Arundel County are summarized below in Table 6.3-16.

Table 6.3-16
Tornado Events, Anne Arundel County 1950 – 2018
(Source: NOAA/NCDC)

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	1	7.121M	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	07/02/1953	20:00	CST	Tornado	F1	0	0	0.25K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	04/26/1960	15:30	CST	Tornado	F1	0	0	2.50K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	06/09/1961	15:30	CST	Tornado	F3	0	0	250.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	07/13/1961	15:00	CST	Tornado	F1	0	0	25.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	05/12/1974	14:15	CST	Tornado	F1	0	0	2.50K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	07/14/1975	05:15	CST	Tornado	F1	0	0	25.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	08/14/1976	16:20	CST	Tornado	F1	0	0	250.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	09/05/1979	12:55	CST	Tornado	F1	0	1	25.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	08/28/1992	15:15	CST	Tornado	F0	0	0	0.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	08/28/1992	15:32	CST	Tornado	F0	0	0	0.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	05/12/1993	17:55	EST	Tornado	F0	0	0	5.00K	0.00K
Crownsville, Arnold,1	ANNE ARUNDEL CO.	MD	10/05/1995	16:57	EST	Tornado	F1	0	0	60.00K	0.00K
Odenton to	ANNE ARUNDEL CO.	MD	10/05/1995	20:31	EST	Tornado	F1	0	0	250.00K	0.00K
Arnold	ANNE ARUNDEL CO.	MD	10/05/1995	20:32	EST	Tornado	F0	0	0	1.00K	0.00K
UPPER MARLBORO	ANNE ARUNDEL CO.	MD	06/24/1996	16:39	EST	Tornado	F1	0	0	100.00K	0.00K
MARYLAND CITY	ANNE ARUNDEL CO.	MD	07/10/2000	16:32	EST	Tornado	F1	0	0	5.00K	0.00K
SEVERNA PARK	ANNE ARUNDEL CO.	MD	09/28/2006	17:34	EST	Tornado	F1	0	0	6.000M	0.00K
LAKE SHR	ANNE ARUNDEL CO.	MD	09/30/2010	08:46	EST-5	Tornado	EF0	0	0	15.00K	0.00K
CONAWAYS	ANNE ARUNDEL CO.	MD	04/05/2011	03:56	EST-5	Tornado	EF0	0	0	2.00K	0.00K
(FME)TIPTON AAF FT M	ANNE ARUNDEL CO.	MD	06/01/2012	16:46	EST-5	Tornado	EF0	0	0	3.00K	0.00K
TIPTON AAF ARPT	ANNE ARUNDEL CO.	MD	06/01/2012	18:06	EST-5	Tornado	EF0	0	0	100.00K	0.00K
Totals:								0	1	7.121M	0.00K

The event causing the most damage occurred on September 28, 2006 when an F1 tornado touched down in the area of Severna Park. At its maximum the storm was 250 yards wide with winds of 90 mph. 34 homes were severely damaged by falling trees with 13 of those homes rendered uninhabitable. The tornado then reached its most intense and widest extent as it passed through the community of Lower Magothy Beach. Many of these trees knocked down in this area were large two-foot diameter hardwood trees that were 60 to 80 feet tall. The tornado caused an estimated $6 million in property damage.

Based on previous occurrences listed in the NCDC database, the probability of future tornado events in Anne Arundel County is one event approximately every three to four years, and this estimate is valid for the 2018 version of the HMP. The overall impact to the planning area from tornadoes will most likely be low to moderate considering the frequency and magnitude of the past occurrences.

Tornado Hazard in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to tornadoes as the rest of the County. The County has very low risk from this hazard overall. The housing stock in the area is fairly vulnerable to the hazard; however, the very low probability of a tornado strike in such a small, specific area is so low that potential impacts must be considered negligible.

6.3.11 Wildfire, Urban Interface Fire

6.3.11.1 Description of the Wildfire Hazard

Wildfires are uncontrolled fires often occurring in wildland areas, which can consume houses or agricultural resources if not contained. Wildfires/urban interface is defined as the area where structures and other human development blend with undeveloped wildland.

Forest and grassland fires can occur any day throughout the year. Most of the fires occur during the spring season. The length and severity of burning periods largely depend on the weather conditions. Low humidity, high winds, below-normal precipitation, and high temperatures that are frequently present during the spring result in extremely high fire danger. Drought conditions can also hamper efforts to suppress wildfires as decreased water supplies may not prove adequate to quickly contain the fire. The second most critical period of the year is fall. Depending on the weather conditions, a sizeable number of fires may occur between mid-October and late November.

As more people choose to build homes, operate businesses, and engage in recreational activities in areas where wild-lands border more urban areas, the threat to private property from wildland fire increases. Creating "defensible" or "survivable" space around structures can make the difference between returning to an intact home or a smoldering pile of ashes if a wildfire moves through the area.

6.3.11.2 Location and Extent of the Wildfire Hazard

The potential for wildfires exists over the entire planning area. However, wildfires have the greatest potential to affect those parts of the County that are forested or at the interface between forest and other land cover.

6.3.11.3 Severity of Wildfire Hazard

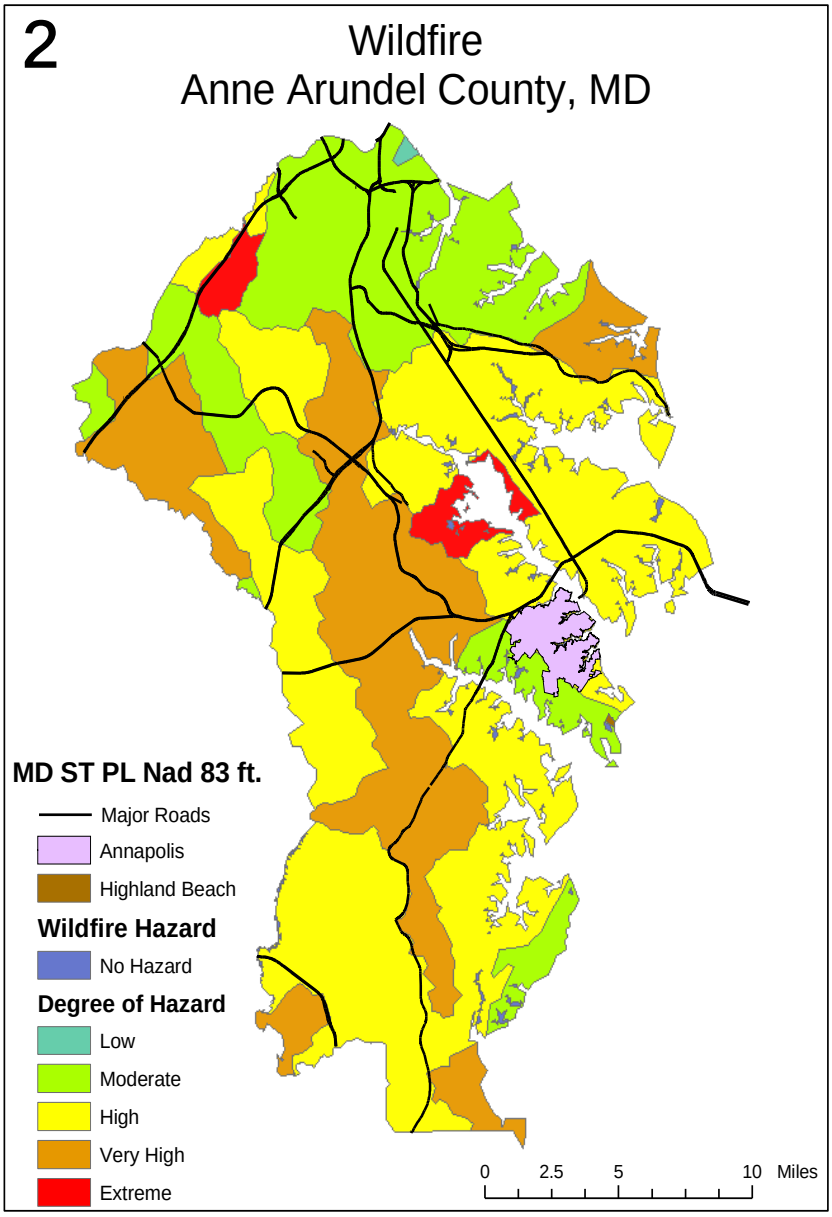
The frequency and severity of wildfires is dependent on weather and on human activity. In the planning area, severity has historically been very low, and duration a matter of hours to a day. Very few acres have burned in the last ten years, and this trend will likely continue.

6.3.11.4 Impact on Life and Property

Figure 6.3-20 depicts the wildfire hazard for Anne Arundel County, according to Maryland Department of Natural Resources (MDNR) Forest Service data. As part of the Wildfire analysis, the impact on the County was be restricted to Census Blocks in the area classified as being at extreme risk from wildfire. These Blocks contained 12,594 people

who will potentially be affected by this hazard. A total of $764,707,900 in buildings and contents is exposed to this hazard. No critical County infrastructure buildings are exposed within the extreme wildfire risk category (shown in red on the map). Note that the HAZUS database on which the value of buildings and contents were based in the 2012 mitigation plan is no longer available, so the 2012 values were inflated to present day via the U.S. Bureau of Labor Statistics on-line inflation calculator.

Figure 6.3-20
Anne Arundel County: Wildfire Risk Map
(Source: Anne Arundel County Office of Emergency Management)



There are no records of deaths or injuries and no recorded loss of property from wildfires in the planning area.

6.3.11.5 Occurrences of the Wildfire Hazard

Forest fire incident data shows that fires in Maryland are a frequent and annual occurrence. Between 2003 and 2015, records from the MDNR Forest Service indicate an average of 379 wildfires that burned 3,652 acres of

forestland each year.[8] Table 6.3-17 summarizes the number of fires and acres burned in Maryland in this period. For years 2012 to 2105 the MDNR published Wildland Fire Reports that include information about numbers of fires and acres burned by County. Anne Arundel County experienced two wildfires in this period, in 2013 and 2014. A total of 7.5 acres burned in 2013, and 10.41 in 2014.

Table 6.3-17
Number of Forest Fires and Acres Burned in Maryland
(Source: Maryland Department of Natural Resources)

Year	Total Number of Fires	Total Acres Burned
2003	753	6,074
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	125	8,310
2012	159	837
2013	122	161
2014	158	1,078
Total	**4,547**	**43,824**

Based on historical records from the NCDC database and the MDNR, the future probability of wildfires in Anne Arundel County is fairly high. However, property damage and impact on life in the County is considered minimal compared to the potential damage from other hazards.

Wildfire Hazard in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to wildfire as the rest of the County, although open areas near water are clearly less likely to burn than areas that have more potential fuel. The Town has a minor risk from this hazard overall. Impacts can be considered negligible.

6.3.12 Erosion

6.3.12.1 Description of the Erosion Hazard

[8] Maryland Department of Natural Resources (MDNR)- Forest Service

Erosion is defined as the group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface. One type of erosion is coastal erosion, which is a dynamic process that is constantly occurring at varying rates along the coasts and shorelines of the U.S. Numerous factors can influence the severity and rate of coastal erosion including human activities, tides, the possibility of rising sea levels, and the frequency and intensity of hurricanes. Strong storms and hurricanes can erode large sections of coastline with a single event. The process of coastal erosion results in permanent changes to the shape and structure of the coastline. Human activities such as poor land use practices and boating activities can also accelerate the process of coastal erosion.

6.3.12.2 Location and Extent of the Erosion Hazard

The potential for erosion exists over the entire planning area. Although possible to occur anywhere in the County, erosion is most likely to occur during Nor'easters' or downgraded hurricanes that can significantly impact shoreline areas of the County. Anne Arundel County has hundreds of miles of shoreline, most of which is within close proximity to major metropolitan centers such as Baltimore, Annapolis and Washington D.C.

Protecting the Chesapeake Bay and its tributaries is considered one of the highest priorities for Anne Arundel County. To reduce water pollution and prevent erosion, the County places material such as topsoil, jute mats, grass seed, rip rap, etc. by hand or by machine on County-maintained property.[9]

Figure 6.3-21
Rip-Rap Placed by Hand to Reduce Erosion
(Source: Anne Arundel County website)

[9] Anne Arundel County.org

6.3.12.3 Severity of Erosion Hazard

Episodic storms generate the most significant erosion along the Anne Arundel shoreline. Typically these storms can impact the coast over periods of hours (tropical cyclones) to several days (Nor'easters). Although the storm events are short-lived, the resulting erosion can be equivalent to decades of long-term coastal change. The actual quantity of sediment eroded from the shore is a function of storm tide elevation relative to land elevation, the duration of the storm and the characteristics of the storm waves. During severe coastal storms, it is not uncommon for the entire berm and part of the dune to be removed from the beach. The amount of erosion is also dependent on the pre-storm width and elevation of the shoreline or beach. If the beach has been left vulnerable to erosion due to the effects of recent storms, increased erosion is likely. The time necessary for the beach to naturally recover from significant erosion can be years to decades.

6.3.12.4 Impact on Life and Property

Erosion from coastal storms has the potential to cause significant property damage particularly to properties located along the shoreline areas of Anne Arundel County. Potentially millions of dollars of shoreline development may be damaged or destroyed by the effects of erosion. Additionally, the loss of beach shoreline can also have a negative impact on a community due to the potential loss of tourism.

6.3.12.5 Occurrences of the Erosion Hazard

Table 6.3-18 highlights some of the major events that have caused coastal erosion in Anne Arundel County.

Table 6.3-18
Major Coastal Erosion Events impacting Anne Arundel County (1990 – 2018)
(Sources: FEMA, NOAA/NCDC)

Event date & Disaster (DR)	Erosion Event
February 4, 1998	A powerful Nor'easter, carrying copious moisture from the Gulf of Mexico and Caribbean region, dumped between two and four inches of rain across much of Maryland between the foothills and the Chesapeake Bay. Highest totals, ranging from three to five inches, fell in lower southern Maryland, causing widespread flooding of low-lying areas and small streams and creeks. The degree of erosion was greater than that associated with the remnants of hurricane Fran in 1996.
September 24, 1999 (DR-1303)	Hurricane Floyd made landfall just east of Cape Fear, North Carolina in the early morning hours of the 16th and moved north-northeast across extreme southeast Virginia to near Ocean City, Maryland by evening on the 16th. The event resulted in over 1,000 homes reported flood damage, over 100 roads closed. In Anne Arundel County between 8 and 12 inches of rain were reported. Strong southerly winds ahead of the hurricane pushed tides two to three feet above normal, flooding several low lying areas in St. Mary's, Calvert, Harford, and Anne Arundel Counties. The NCDC database indicated that erosion was reported on the South River and Broad Creek.

Event date & Disaster (DR)	Erosion Event
September 18, 2003 (DR-1492)	On September 18, 2003, Hurricane Isabel made landfall on the North Carolina Coast. By the time Isabel moved into central Virginia, it had weakened and was downgraded to a tropical storm. Isabel's eye tracked well west of the Bay, but the storm's 40 to 50 mph sustained winds pushed a bulge of water northward up the bay and its tributaries producing a record storm surge. The Maryland western shore counties of the Chesapeake Bay and along the tidal tributaries of the Potomac, Patuxent, Patapsco and other smaller rivers experienced a storm surge of five to nine feet above normal tides. The NDCD database indicated that in Baltimore County alone, $3 million in damage was estimated to have occurred from erosion of the shoreline. The NDCD did not indicate the severity of erosion in Anne Arundel County, but based on the degree of flooding, it mostly like was comparable to Baltimore County.
October 27, 2012 (DR-4091)	There is no readily available evidence that Hurricane Sandy created significant erosion problems in Anne Arundel County. The event is listed in this table to recognize that it was reviewed and considered in the HMP update.

Erosion is an ongoing problem along many areas of the Anne Arundel County shoreline. It is difficult, if not impossible, to assign a probability to the near constant small, ongoing erosion that may occur over a continuous period of time. However, a probability can be assigned to larger storm events such as Nor'easters, hurricanes and coastal storms that can result in significant storm induced coastal erosion.

As described earlier in this section, there were three major Nor'easters or downgraded hurricanes that caused erosion in Anne Arundel County between 1990 and 2007, and none since the last version of this HMP (2012). This translates to about one event approximately every nine years. In addition to the larger events noted above, smaller Nor'easters and other coastal storms cause erosion along the County coastline on average one to two times per year. The period of time over which this data is provided suggests the probability of erosion will be about the same in the future, with year-to-year variations.

Erosion Hazard in Highland Beach

Highland Beach has a higher exposure to the erosion hazard than many other parts of the County, because of its coastal location. There are no reliable open-source records indicating the degree of damage to Highland Beach from past erosion events, which are usually related to storm surge. The potential impacts to Highland Beach may be considered moderate, but absent further study it is impossible to characterize them more precisely.

6.4 Methodology for Identifying Natural Hazards for Additional Analysis

In accordance with the requirements of the Interim Final Rule, all hazards with potential to affect Anne Arundel County are profiled in the present section of the HMP. However, because this is a County-level hazard mitigation plan, it is useful to identify the hazards that are of the most concern Countywide, so these can be the focus of more detailed assessment. It is important to note, however, that many hazards and risks are very site-specific, so as local municipalities perform more detailed risk assessments and identify mitigation actions they should recognize that this process and the resulting table should be used only as a guide.

Various national, regional and local sources were used to identify and classify different hazards for Anne Arundel County. The criteria used were:

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 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 Anne Arundel 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 Anne Arundel County has received numerous disaster declarations for the particular hazard.

The table on the following pages lists the hazards, describes the rationale for identifying (or not identifying) hazards as significant, shows sources of information that were consulted for the determination, and the disposition of the hazard with regard to hazard identification and risk assessment in this HMP. The initial hazards in the shaded portion of the table are those that were identified by the Anne Arundel County HMPC as significant enough to warrant a full risk assessment.

Table 6.4-1
Anne Arundel County Qualitative Hazard Ranking

Hazard	Rationale	Sources	Disposition
Riverine Flooding	Widespread impacts, history of occurrences in the County, potentially significant annual damages.	FEMA Flood Insurance Studies, FEMA Flood Insurance Rate Maps, FEMA Public Assistance records, FEMA National Flood Insurance Program claims data, US Army Corps of Engineers (USACE), and National Oceanographic and Atmospheric Administration (NOAA), studies and records	Profile and risk assessment
Hurricane, Tropical Storm, Nor'easter	Hurricanes: Relatively low historic probability; potential for widespread impacts. Tropical Storms: Low to moderate probability; potential for widespread impacts Nor'easters: Moderate probability of more extreme events, potential for moderately widespread impacts.	NOAA and National Climatic Data Center (NCDC) records, National Hurricane Center, NOAA Coastal Service Center – Historic Hurricane Tracks database	Profile and risk assessment
Severe Winter Storm	High annual probability, widespread impacts, but losses generally limited except in most extreme events.	NOAA, NCDC, National Weather Service (NWS)	Profile and risk assessment
Tornadoes	High annual probability, localized impacts, but losses generally limited except in most extreme events.	NOAA -NCDC	Profile and risk assessment
Coastal Flooding	Widespread impacts, history of occurrences in the County, potentially significant annual damages.	FEMA Flood Insurance Studies, FEMA Flood Insurance Rate Maps, FEMA Public Assistance records, FEMA National Flood Insurance Program claims data, USACE, and NOAA studies and records	Profile and risk assessment (combined with flood hazard in risk calculations)
Earthquake / Geological	Low annual probability.	United States Geologic Survey (USGS)	Profiled, but not part of detailed risk assessment
Dam Failure and Releases	Low annual probability based on historical data, but impacts potentially significant in specific areas.	Maryland Department of the Environment - Dam Safety Program	Profiled, but not part of detailed risk assessment
Drought	High annual probability, but impacts are generally limited.	NOAA – NCDC; New Jersey State Department of Agriculture NJDEP	Profiled, but not part of detailed risk assessment

Hazard	Rationale	Sources	Disposition
Erosion	Relatively high annual probability, but impacts are minimal relative to other hazards and mainly limited to coastal areas.	NOAA, Maryland Department of Natural Resources (MDNR) – Shore Erosion Control	Profiled, but not part of detailed risk assessment
Extreme Heat	Relatively high annual probability, but impacts are limited.	NOAA – NCDC, National Weather Service	Profiled, but not part of detailed risk assessment
Severe Thunderstorm and hailstorm	High annual probability but impacts are limited in severity and area.	NOAA – NCDC, National Weather Service	Profiled, but not part of detailed risk assessment
Wildfire, Urban Interface fire	High annual probability of site-specific events, but impacts generally limited.	NOAA, MDNR - Forest Service	Profiled, but not part of detailed risk assessment

Summary

Based on qualitative ranking above, the HMPC recommended including four natural hazards in the more detailed risk assessments in Section 7:

- **Riverine Flood (including coastal storms)**
- **Hurricane, Tropical Storm, and Nor'easter**
- **Severe Winter Storm**
- **Tornado**

Summary Description of the County's Vulnerability to Hazards

The DMA 2000 legislation and related FEMA planning guidance require hazard mitigation plans to include discussion of community vulnerability to natural hazards. Vulnerability is generally defined as the damage (including direct damages and loss of function) that would occur when various levels of hazards impact a structure, operation or population. For example vulnerability can be expressed as the percent damage to a building when it is flooded, or the number of days that a government office will be shut down after a wind storm, etc., assuming there is sufficient detailed data available to support the calculations.

Because this HMP update is at the scale of an entire County, it is not practical to complete vulnerability assessments on the many individual assets, operations and populations in the planning area. It is possible, however, to make some general observations based on the hazard identifications and risk assessments that are the subjects of Sections 6 and 7 of this update.

As illustrated in Section 6 (Hazard Identification), Anne Arundel County is subject to numerous natural and man-made hazards, although in some cases the hazards have rarely impacted the area, or their effects have been relatively minor. As is the case with many parts of the mid-Atlantic, although relatively localized, flooding is the most frequent and most damaging natural hazard in Anne Arundel County. However, it is important to recognize that several other hazards present significant risks (i.e. potential for future losses) to the County, even though they have occurred infrequently in the past, or have not caused much damage. For example, the occurrence of tornadoes in

Anne Arundel County may have been relatively infrequent in the past, but still presents a significant enough risk to warrant a more detailed assessment.

Section 7 (Risk Assessment) of this HMP update demonstrates that there is some vulnerability to wind in the County, mainly from hurricanes and tropical storms. While hurricanes are rare events in the mid-Atlantic, tropical storms and Nor'easters are fairly common, and many structures in the communities are vulnerable to extreme winds. However, as discussed in Section 7, the vulnerability is widespread, hence the relatively large risk figure. In addition to the flood, high wind (hurricane, tropical storm, Nor'easter) and tornado hazards, Section 7 also analyzes the severe winter storm and coastal flooding hazards (the latter as part of the general/riverine flood section). Most of the other hazards are either localized or improbable, and therefore, while various elements in the communities may be vulnerable to such hazards, the likelihood of them occurring in any specific location is very small or the impact considered relatively minimal.

Section 7
Risk Assessment

Contents of this Section

7.1 Interim Final Rule Requirement for Risk Assessments

44 CFR § 201.6 Local Mitigation Plans **(2)** 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. The risk assessment shall include:

(i) A description of the type, 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.

(ii) 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. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:

(A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;

(B) 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;

(C) 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.

7.2 Overview and Analysis of Anne Arundel County's Vulnerability to Hazards

As discussed in Section 6 of this HMP (Hazard Identification), Anne Arundel County identified twelve natural hazards that can affect the community. The likelihood of a future natural hazard event affecting the County was made based on an assessment of historical data and a prediction if a future event is likely to occur. Many of the natural hazards, outside of the 4 natural hazards listed below, have a low probability of affecting the County that would result in a Presidential Disaster Declaration. Section 6.4 describes how the County narrowed the focus from twelve to four natural hazards that create the greatest risk to human life, property, infrastructure, critical facilities, and buildings in vulnerable areas. For the purpose of the 2018 HMP update, the County narrowed its focus to 4 natural hazards posing the greatest risk to the community, which include the following:

- **Riverine and coastal Flooding**
- **Hurricane, Tropical Storm, and Nor'easter (wind)**
- **Tornado**
- **Severe Winter Storm**

As part of the 2018 HMP update, the HMPC conducted detailed research into potential vulnerabilities to natural hazards, for County assets, as well as private structures, populations and assets. Since the first version of the HMP was approved, the County has experienced some damage from Hurricane Isabel and other events such as the snowstorms of 2009-2010 and 2016. These are generally described here and in Section 6, *Hazard Identification and Profiling*. Given the relatively low damages from natural hazards in the past, the County can be considered to have limited vulnerability to hazards, except in the most extreme events. The County has well-established and successful programs for mitigation and prevention efforts, and intends to continue these indefinitely. Given the relatively low incidence of large-scale natural hazards, the County's efforts in this regard have focused mostly on areas of risk that have been identified either through this mitigation plan, or via various other approaches, such as monitoring flooding and erosion in various areas (and addressing them through implementation of public works projects, and developing and implementing a shelter plan that serves to mitigate loss of life. The County also has effective building controls that serve to limit the vulnerabilities of structures and people, so future risks will likely remain fairly low, and hopefully will be reduced even further as mitigation projects and policy efforts are initiated and completed.

This section addresses the risk related to the four hazards listed above, and estimates future expected losses from them, in accordance with FEMA requirements. The most significant natural hazard to which Anne Arundel County is exposed is floods. Flooding in Anne Arundel County is the result of various weather events including hurricanes, thunderstorms (convectional and frontal), storm surge and winter storms. See Section 6 of the HMP update for additional details about past flood occurrences in Anne Arundel County.

The second most significant hazard to which Anne Arundel County is exposed to is wind from hurricanes, tropical storms and nor'easters. As discussed in Section 6 of this document, according to NOAA's National Climatic Data Center (NCDC) database, two tropical storms have impacted Anne Arundel County between 1950 and 2008. As of September 2018, the database did not include information about Hurricane Sandy,

which occurred in 2012, and made landfall in Maryland as a tropical storm. The same was true of Hurricane Floyd (1999) and Hurricane Isabel (2003).

The County is also at some risk from tornadoes. The entire County is equally exposed to the potential effects of tornadoes. Past events in Anne Arundel County have ranged in severity from an F0 to an F3 event (Fujita Scale). The County is also exposed to the severe winter storm hazard. The NCDC indicates that the County has experienced 31 winter storms between 1999 and 2018.

7.3 Estimate of Potential Losses (Risk Assessment)

This section describes the risks to the County, including its citizens, residential, government and commercial assets, and County operations. As noted above, risk is an expression of expected future monetary losses resulting from the impacts of natural hazards. Risk assessment methodologies differ based on the nature of data that is available, the hazard, and the way results are expressed. The sections below provide brief descriptions of the methodologies.

7.3.1 Flood Risk in Anne Arundel County

This subsection provides estimates of future flood losses, i.e. risk. Each of the loss calculations is based on best available data, but they must be considered estimates because highly detailed engineering studies were not performed as part of this planning process. The present section is intended to provide a moderately-detailed overview of risk in the Anne Arundel County. Note that Appendix A includes additional details and graphics related to National Flood Insurance Program (FIP) claims data in the County.

Flood Risk Assessment Method 1
Analysis of NFIP Repetitive Loss and Severe Repetitive Loss Data

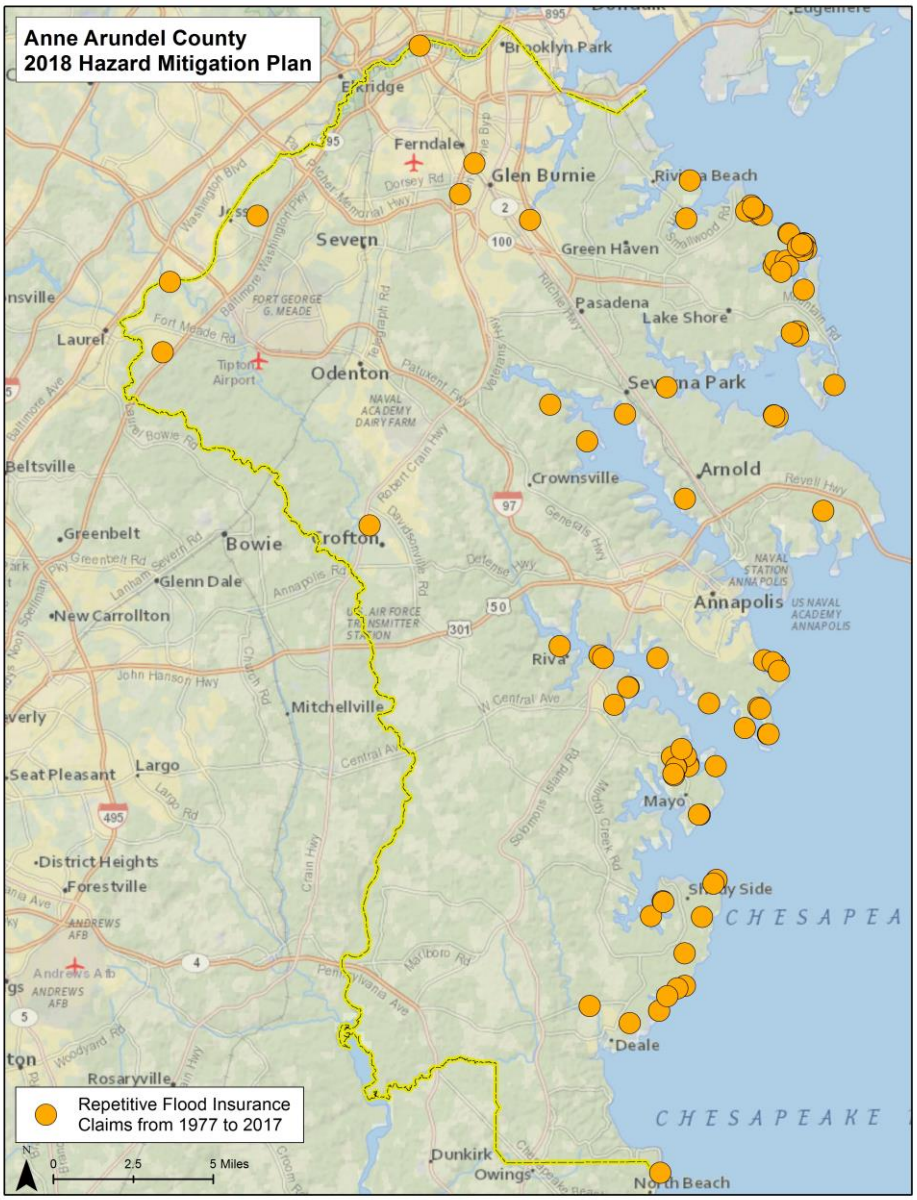
The first risk assessment method is based on analysis of NFIP data for repetitive flood loss properties. The NFIP defines repetitive loss properties as those that have received least two NFIP insurance payments of more than $1,000 each in any rolling ten-year period. As of February 2018, Anne Arundel County had 93 such properties, based on a query of the FEMA BureauNet NFIP interface. Of this number, seven are non-residential, and 86 residential. Table 7.3-1 summarizes the NFIP claims value and number of claims statistics for all repetitive loss properties. The table also indicates that the majority of the paid claims, 69 percent, are associated with residential building damages.

Table 7.3-1
Summary of Residential and Non-Residential NFIP Repetitive Loss Statistics, Anne Arundel County
(Source: FEMA/NFIP Query, February 2018)

Repetitive Loss Category	Properties	Structure	Contents	Total	# Claims	Average
Residential	86	$3,978,631	$738,933	$4,717,565	204	$23,125
Non-Residential	7	$1,142,095	$904,967	$2,047,062	24	$85,294
Total	93	$5,120,726	$1,643,900	$6,764,627	228	$29,669

Figure 7.3-1 shows the locations of the 93 residential and non-residential repetitive loss properties in the County. The map shows the majority of the repetitive loss properties are concentrated along the eastern border of the County, along the shoreline and tributaries of the Chesapeake Bay.

Figure 7.3-1
Residential and Non-Residential NFIP Repetitive Loss Properties, Anne Arundel County
(Source: FEMA/NFIP Query, Spring, 2018)



Residential Repetitive Loss Properties

As mentioned above, as of early 2018 Anne Arundel County has 85 residential repetitive loss properties in the NFIP database. Tables 7.3-2, 7.3-3 and 7.3-4 provide basic NFIP residential repetitive loss statistics, sorted in three ways: first by the number of such properties in each community, then by the total dollar value of claims to properties in the data set, then by the dollar amount of the average claim.

Table 7.3.2 indicates that Pasadena has the highest number of repetitive loss properties in Anne Arundel County. As of February, 2018, Pasadena had a total of 29 repetitive loss properties and is also ranked first in total dollar value of building and contents claims, total paid claims, and number of paid claims. The table shows that Pasadena is followed by the Edgewater and the City of Annapolis with 16 and 11 repetitive loss properties respectively.

Table 7.3-2
Summary of Residential NFIP Repetitive Loss Statistics, Anne Arundel County;
Ordered by Number of Repetitive Loss Properties in each Census-designated area
(Source: FEMA NFIP query Spring, 2018)

City Name	# RL Props	Building	Contents	Total Paid ($)	# of Claims	Average $ Claim
Pasadena	29	$1,381,396	$340,540	$1,721,936	71	$24,253
Edgewater	16	$895,080	$220,267	$1,115,347	36	$30,982
Annapolis	11	$470,632	$71,575	$542,207	27	$20,082
Arnold	5	$234,568	$28,106	$262,674	11	$23,879
Churchton	5	$415,215	$14,807	$430,022	11	$39,093
Shady Side	5	$152,745	$17,327	$170,072	12	$14,173
Glen Burnie	3	$109,795	$14,100	$123,895	10	$12,389
Crownsville	2	$46,164	$9,750	$55,914	5	$11,183
Deale	2	$62,148	$9,883	$72,031	4	$18,008
Severna Park	2	$81,798	$1,726	$83,524	4	$20,881
Crofton	1	$6,212	$0	$6,212	2	$3,106
Gibson Island	1	$9,864	$0	$9,864	2	$4,932
Laurel	1	$5,502	$0	$5,502	2	$2,751
North Beach	1	$49,718	$1,823	$51,541	3	$17,180
Riva	1	$6,492	$9,031	$15,522	2	$7,761
West River	1	$51,303	$0	$51,303	2	$25,651
Total	**86**	**$3,978,631**	**$738,933**	**$4,717,565**	**204**	**$23,125**

Table 7.3.3 ranks the residential repetitive loss properties in Anne Arundel County by the dollar value of the total paid claims for each **Census-designated area**. The top three communities include Pasadena, Edgewater, and Annapolis. Pasadena is ranked highest with paid claims totaling $1,721,936.

Table 7.3-3
Summary of Residential NFIP Repetitive Loss Statistics, Anne Arundel County;
Ordered by Total Dollar Amount of Claims Paid in each Community
(Source: FEMA NFIP query, Spring 2018)

City Name	# RL Props	Building	Contents	Total Paid	# of Claims	Average Claim
Pasadena	29	$1,381,396	$340,540	$1,721,936	71	$24,253
Edgewater	16	$895,080	$220,267	$1,115,347	36	$30,982
Annapolis	11	$470,632	$71,575	$542,207	27	$20,082
Churchton	5	$415,215	$14,807	$430,022	11	$39,093
Arnold	5	$234,568	$28,106	$262,674	11	$23,879
Shady Side	5	$152,745	$17,327	$170,072	12	$14,173
Glen Burnie	3	$109,795	$14,100	$123,895	10	$12,389
Severna Park	2	$81,798	$1,726	$83,524	4	$20,881
Deale	2	$62,148	$9,883	$72,031	4	$18,008
Crownsville	2	$46,164	$9,750	$55,914	5	$11,183
North Beach	1	$49,718	$1,823	$51,541	3	$17,180
West River	1	$51,303	$0	$51,303	2	$25,651
Riva	1	$6,492	$9,031	$15,522	2	$7,761
Gibson Island	1	$9,864	$0	$9,864	2	$4,932
Crofton	1	$6,212	$0	$6,212	2	$3,106
Laurel	1	$5,502	$0	$5,502	2	$2,751
Total	**86**	**$3,978,631**	**$738,933**	**$4,717,565**	**204**	**$23,125**

It should be noted that the numbers of claims or repetitive loss properties are not necessarily good indicators of risk, except on a community level. This is in part because communities with larger populations will normally have more insurance policies and more claims (holding constant the exposure to flood hazards). Table 7.3-4 shows the same data sorted by the dollar amount of the average NFIP claim. Particularly when a statistically significant number of claims are included in the data set, the dollar amount of the average claim is often a better indication of relative flood risk. The table indicates that Churchton has the highest **average** claim value ($39,093) in Anne Arundel County. Edgewater and West River follow Churchton in average claims value.

Table 7.3-4
Summary of Residential NFIP Repetitive Loss Statistics, Anne Arundel County;
Ordered by Average Dollar Amount of NFIP Insurance Claims in each Census-designated area
(Source: FEMA NFIP query Spring, 2018)

City Name	# RL Props	Building	Contents	Total Paid ($)	# of Claims	Average $ Claim
Churchton	5	$415,215	$14,807	$430,022	11	$39,093
Edgewater	16	$895,080	$220,267	$1,115,347	36	$30,982
West River	1	$51,303	$0	$51,303	2	$25,651
Pasadena	29	$1,381,396	$340,540	$1,721,936	71	$24,253
Arnold	5	$234,568	$28,106	$262,674	11	$23,879
Severna Park	2	$81,798	$1,726	$83,524	4	$20,881
Annapolis	11	$470,632	$71,575	$542,207	27	$20,082
Deale	2	$62,148	$9,883	$72,031	4	$18,008
North Beach	1	$49,718	$1,823	$51,541	3	$17,180
Shady Side	5	$152,745	$17,327	$170,072	12	$14,173
Glen Burnie	3	$109,795	$14,100	$123,895	10	$12,389
Crownsville	2	$46,164	$9,750	$55,914	5	$11,183
Riva	1	$6,492	$9,031	$15,522	2	$7,761
Gibson Island	1	$9,864	$0	$9,864	2	$4,932
Crofton	1	$6,212	$0	$6,212	2	$3,106
Laurel	1	$5,502	$0	$5,502	2	$2,751
Total	**86**	**$3,978,631**	**$738,933**	**$4,717,565**	**204**	**$23,125**

The RL claims can be further broken down by focusing on individual street level data. Table 7.3-5 provides a summary of residential RL claims for individual streets within Anne Arundel County with three or more NFIP repetitive loss properties as of February 2018. The data displayed in the table summarizes the NFIP RL data for 54 individual streets in the County that include an RL property. Address data about individual sites is omitted for reasons of confidentiality. The data shows that Lake Drive in Pasadena has the most RL properties in Anne Arundel County. Lake Drive has seven RL properties and 29 prior NFIP claims totaling $859,846.

Table 7.3-5
Summary of Residential NFIP RL Statistics, Streets with Three or More RL Properties
(Source: FEMA NFIP query Spring, 2018)

Street Name	Properties	Building	Contents	Total	# of Claims	Average (Per Policy)
Bay Street, Pasadena	3	$113,706	$18,531	$132,237	7	$18,891
Forest Drive, Arnold	3	$191,965	$19,689	$211,654	7	$30,236
Lake Drive, Pasadena	7	$713,147	$146,699	$859,846	29	$29,650
Total	**13**	**$1,018,818**	**$184,919**	**$1,203,737**	**43**	**$27,994**

Non-Residential Repetitive Loss Properties

As noted earlier, as of Spring 2018, Anne Arundel County had seven non-residential RL properties in the NFIP database. Table 7.3-6 provides a summary of non-residential RL claims for **Census-designated areas** within Anne Arundel County. The table identifies six **Census-designated areas** that have non-residential RL properties, and includes the number of RL properties in each municipality, building and contents damages, the total number of claims, and the average claim amounts.

Table 7.3-6
Summary of Non-Residential Repetitive Flood Loss Claims in Anne Arundel County, Ordered by the Number of Properties in Each Census-designated area
(Source: FEMA NFIP Spring, 2018)

City Name	Properties	Building	Contents	Total	# Claims	Average
Annapolis	1	$0	$4,326	$4,326	2	$1,746
Edgewater	2	$181,411	$6,873	$188,283	4	$47,071
Glen Burnie	1	$35,367	$769	$36,135	2	$18,068
Laurel	1	$369,531	$739,028	$1,108,559	5	$221,712
Linthicum	1	$494,593	$141,521	$636,113	5	$127,323
Pasadena	1	$61,194	$12,451	$73,645	6	$12,274
Total	**7**	**$1,142,095**	**$904,967**	**$2,047,062**	**24**	**$85,294**

Flood Risk Calculations for Residential Repetitive Loss Properties

Residential flood risk is calculated by a methodology that uses the NFIP claims history in conjunction with FEMA default present-value coefficients from the benefit-cost analysis software. To perform this calculation, the RL data were reviewed to determine an approximate period over which the claims occurred. This is not an exact method, because there are numerous properties in the database, and insurance policies come into force at different times, and are cancelled and reinstated periodically. These variables are not part of the data provided by the NFIP. With the exception of a few claims in 1979, almost all of the claims in the most recent NFIP query occurred between 1985 and the present, a period of 33 years.

Anne Arundel County has a moderate history of repetitive loss flood claims, and using this historical flood data it is possible to perform a relatively simple statistical risk assessment using average annual losses and a present value coefficient calculation to project losses over a planning horizon. As shown in Table 7.3-7, there have been 86 residential RL claims in this 33-year period, for an average of 2.6 claims per year. Based on a 100-year planning horizon and a present value coefficient of 14.27 (this expresses the combination of a 100-year planning horizon using the mandatory Office of Management and Budget (OMB) discount rate of 7%), the projected flood risk to these properties is shown at the bottom of the table. It must be understood that individuals can obtain and cancel flood insurance policies, and the flood hazard depends on many variables including the weather, so this projection is simply an estimate of potential damages. Nevertheless, it offers a useful metric that can be used in assessing the potential cost effectiveness of mitigation actions. If the County pursues mitigation measures on a site-specific basis, it will be necessary to perform risk assessment and benefit-cost analysis on the basis of individual properties or claims histories, something that is not appropriate for a County-level HMP.

Table 7.3-7
Projected 100-Year Flood Risk in Anne Arundel County -
Residential Repetitive Loss Properties
(Source: FEMA NFIP Query Spring, 2018)

Data	Value
Period in years	33
Number of claims	86
Average claims per year	2.6
Total value of claims	$4,717,565
Average value of claims per year	$142,957
Projected risk, 100-year horizon	**$2,039,989**

Note that there have been limited new flood claims in the last few years, so the projected risk has dropped from the last version of this HMP.

Flood Risk to Non-Residential Properties

The relatively small number and dollar amount of claims for these properties does not allow for accurate determination of annual values for flood losses. Because of this, it is also not possible to estimate losses over a longer time, such as the 100-year planning horizon that is used elsewhere in this section. If a risk projection is required in the future, it may be possible to use an approach based on survey and engineering information.

Natural Hazard Risk to Critical Facilities

Generally speaking, critical facilities are those assets and operations that are essential to a jurisdiction maintaining functionality, especially during and after emergencies or significant natural hazard events. There is a range of facilities that can be categorized as critical, including:

- Police and fire facilities
- Emergency operations centers
- Water and wastewater treatment plants
- Shelters
- Hospitals (in particular, trauma centers)
- Communications facilities and infrastructure
- Key infrastructure, such as bridges and roads
- Lifelines, in particular utility lines (water, electricity, gas)

The FEMA Public Assistance (PA) program provides grant funding to address damages to public facilities that is related to natural disasters, including snowstorms. After a disaster occurs, and when public facilities have been damaged, FEMA produces Project Worksheets that describe the damages and indicate dollar amounts that are eligible for federal reimbursement. Fortunately, Anne Arundel County does not have an extensive history of requiring FEMA PA assistance, but various events have resulted in FEMA providing funds to repair facilities or otherwise address hazard effects such as snow removal.

Table 7.3-8
Anne Arundel County – Declared Disaster Summary 1994 – 2018
(Source: FEMA Public Assistance)

Disaster Number	Declaration Date	Event Type	Disaster Description	PW Amount
DR-1016	3/16/1994	Ice Storm	Ice Storms of 1994	$827,001
DR-1081	1/11/1996	Heavy Snow	Blizzard of 1996 - January 11, 1996	$574,452
DR-1303	10/18/1999	Hurricane	Hurricane Floyd	$337,817
EM-1324	4/10/2000	Heavy Snow	Severe Winter Storm of 2000	$397,781
EM-3179	3/14/2003	Heavy Snow	February 14-17, 2003	$742,866
DR-1492	9/19/2003	Hurricane	Hurricane Isabel	$4,890,342
DR-4261	1/22/2016	Heavy Snow	Snowstorm of January 2016	$1,918,187
Total	**--**	**--**	**--**	**$9,688,446**

7.3.2 Hurricane Wind Risk in Anne Arundel County

This subsection describes the hurricane wind risk for Anne Arundel County. Wind is obviously a significant component of the risks presented by hurricanes, and this section of the updated Plan describes the potential future losses (risk) from this hazard. The calculations are done using the FEMA Full Data Hurricane Wind Benefit-Cost Analysis (BCA) module. Data about various asset classes were extracted from the FEMA HAZUS database version MR-4 in spring, 2012. The sections below describe the methodologies and results. The HAZUS asset data was not available for the 2018 HMP update, so the data from the 2012 version was used as the basis for the calculations.

The first step in the risk assessment process is to determine wind profiles for Anne Arundel County, using the FEMA wind hazard and damage function database (BCA software version 5.3). The figures in these tables are estimates based on best available data. Information sources are provided in the notes below the table headings, where applicable. Figure 7.3-1 shows the wind hazard profile for the County, from the FEMA wind hazard and damage function database. Within the database, the zip code 21114 for Crofton, Maryland was entered to identify the wind speeds for each of the recurrence intervals. The recurrence interval-wind speed pairs are used in the FEMA BCA module to calculate wind risk to County Assets.

Figure 7.3-1
Anne Arundel County Wind Hazard Profiles
(Source: FEMA wind hazard database, via BCA software version 5.3)

Recurrence Interval (yr)	Default Wind Speed (mph)
10	29
20	41
50	56
100	65
200	73
500	84
1000	90

The wind risk assessments for Anne Arundel County were conducted using the FEMA Hurricane Wind BCA software and the FEMA wind database on the BCA Toolkit Version 5.3. All figures are based on a 100-year time horizon and a 7% discount rate to determine the net present value of the risk, as required by OMB Circular No. A-94. Table 7.3-10 shows recurrence interval/wind speed pairs, and the expected damage level from hurricane winds for a single-story wood residential structure of 1,000 square feet, at an estimated structural replacement value of $200 per square foot. This approach is very general in nature, and if the County wishes to further evaluate these risks or pursue mitigation, analyses should be done on the basis of individual sites.

Table 7.3-10
Anne Arundel County Hurricane Wind Risk Profile (Example)
(Recurrence Interval and Wind Speed; Expected Damages by Recurrence Interval)
(Source: FEMA Full-Data Hurricane Wind BCA module, Version 5.3)

Hurricane Wind - Damage Functions

Building | Contents | Loss Of Function | Other Damages

Recurrence Interval (yr)	Wind Speed (mph)	Before Mitigation Pct.	Before Mitigation User Entered (Pct)	Before Mitigation Value ($)	After Mitigation Pct.	After Mitigation User Entered (Pct)	After Mitigation Value ($)
10	30	0.00%		$0	0.00%		$0
20	40	0.00%		$0	0.00%		$0
30	50	0.00%		$0	0.00%		$0
40	50	0.00%		$0	0.00%		$0
50	55	0.00%		$0	0.00%		$0
60	60	0.00%		$0	0.00%		$1
70	60	0.00%		$0	0.00%		$1
80	60	0.00%		$0	0.00%		$1
90	65	0.00%		$0	0.00%		$7
100	65	0.00%		$0	0.00%		$7
200	75	0.01%		$19	0.04%		$78
300	80	0.04%		$76	0.09%		$177
400	80	0.04%		$76	0.09%		$177
500	85	0.11%		$224	0.17%		$330
1000	90	0.25%		$494	0.27%		$536

Total Building Damages

Before Mitigation = $1.02
After Mitigation = $1.56

7.3.2.2 Estimated Hurricane Wind Risk to Public and Private Assets

Damage functions for all structure types are verbatim from the FEMA software; the FEMA/HAZUS structure and roof types used in the analysis are noted in Table 7.3-11. Note that these assumptions are intended only to provide a general estimate of potential wind risk. Specific mitigation projects will require more detailed engineering assessments. The major roadways, transportation, communications and utilities classes were not assessed as part of this HMP because most of these are unique and require detailed engineering studies to be accurate.

Table 7.3-11
Abbreviations for HAZUS Structure Types
(Source: HAZUS)

HAZUS Structure Type	Roof Type	Abbreviation
Wood framed non-engineered gable	Gable	WMUH1 #1
Steel frame engineered commercial	Flat	SECBL #28
Masonry Industrial – RM	Flat	MLRI #25
Pre-Engineered Metal Building	Flat	SPMBL #42
Masonry non-engineered reinforced gable	Gable	MERBL #13
Concrete engineered commercial	Flat	CECBL #35
Masonry non-engineering reinforced hip	Hip	MERBL #14

As noted elsewhere, HAZUS queries were not available for the 2018 County HMP update. As such, data from the 2012 plan was updated using the methodologies described in the text below. The associated HAZUS building types are estimated, and shown in the second column – the software uses building types to establish the correct wind damage functions.

Table 7.3-12
Anne Arundel County: Square Footage and Value for Predominant Asset Classes (in thousands)
(Source: HAZUS version MR4 Spring 2012)

Land Use Category	HAZUS Building Type	Total Square Footage
Agriculture	SPMBL #42	1,334
Commercial	SECBL #28	63,954
Education	MERBL #13	3,919
Government	CECBL #35	2,595
Industrial	MLRI #25	34,565
Religious	MERBL #14	4,013
Residential	WMUH1 #1	302,876
Total	**-------**	**413,256**

The online RS Means Quickcost Estimator was originally used to estimate the dollar per square foot cost for each use category. For the 2018 HMP update, the values in the 2012 document were inflated to present value using the U.S. Bureau of Labor Statistics on-line inflation calculator. The ZIP code 21114 for Crofton, Maryland was again used because of its central location in the County. For each asset, estimates were made about the average building square footage and a typical facility type for each land use category. Table 7.3-13 summarizes the assumptions and results for each land use category, with the exception of the residential category, which was estimated at $200 per square foot.

Table 7.3-13
Anne Arundel County: Predominant Asset Classes
Assumptions and Results of RS Means Quickcost Estimator
(Source: RS Means Quickcost Estimator, circa 2012)

Land Use Category	Average Building SF	Building Type	$ per s.f. Cost	Basis Construction Type	Construction Cost
Agriculture	25,000	Warehouse (Representing Barn/storage)	$101	Tilt-up Concrete Panels/Steel Frame	$2,530,000
Commercial	35,000	Office 2-4 Story	$167	Face Brick with Concrete Block Backup/Wood Joist	$5,852,000
Education	50,000	Jr. High School, 2-3 Story	$186	Face Brick with Concrete Block Backup/Steel Frame	$9,295,000
Government	30,000	Police Station	$184	Limestone with Concrete Block Backup	$5,511,000
Industrial	75,000	Factory (3 Story)	$133	Face Brick, Common Brick Backup/Steel Frame	$9,982,500
Religious	5,000	Church	$224	Decorative Concrete Block/Wood Arch	$1,122,000

The output from the Quickcost Estimator includes construction low, medium, and high cost ranges. The medium construction cost was used in the present analysis. Wind risk for Anne Arundel County assets is then calculated using the FEMA Full-Data Hurricane Wind BCA module and the wind damage functions in the FEMA wind hazard database (BCA Toolkit). The assessment uses a 100-year time horizon. Data parameters used in the Wind BCA Module as part of the risk assessment are described in Table 7.3-14.

Table 7.3-14
Data Parameters Entered into BC Module for each Asset Class

Data Field	Values per Category
Rental Cost of Temporary Building Space	▪ Government: $1 per SF/Month ▪ Agriculture: $1 per SF/Month ▪ Education: $1 per SF/Month ▪ Commercial: $1 per SF/Month ▪ Industrial: $2 per SF/Month ▪ Religious: $1 per SF/Month ▪ Residential: $1 per SF/Month
One Time Displacement cost	▪ Government: Equal to Building SF ▪ Agriculture: Equal to Building SF ▪ Education: Twice the building SF ▪ Commercial: Equal to Building SF ▪ Industrial: Twice the building SF ▪ Religious: Equal to Building SF ▪ Residential: Equal to Building SF
Annual Budget	▪ Education: $150 per SF ▪ Government: $200 per SF ▪ Remaining Categories: $0
Estimated Net Income of Commercial Business	▪ Commercial: $100 per SF ▪ Industrial: $200 per SF ▪ Agriculture: $25 per SF ▪ Remaining Categories: $0

The data parameters described above are then used in the FEMA Hurricane Wind BCA module to calculate hurricane wind risk for Anne Arundel County. Tables 7.3-15 and 7.3-16 summarize the results of the analysis. The last column *100-year Wind Risk* indicates the estimated cumulative wind damages over a 100-year planning horizon.

In Table 7.3.-15, the data is sorted by 100-year risk. This table shows the wind risk by building category and the total wind risk for Anne Arundel County assets from hurricanes. Although these figures seem relatively high, it should be noted that this hazard (hurricane wind) affects all the assets in Anne Arundel County about equally, whereas flooding generally affects only those assets or operations that are close to flood sources. The last column *100-year Wind Risk* indicates the cumulative expected wind damages over a 100-year planning horizon. This table shows that the residential category has the highest 100-year risk. Table 7.3.2-9 sorts the data by risk per square foot. When sorted by risk per square foot, the government and commercial categories move to the top of the list.

Table 7.3-15
Estimated Hurricane Wind Risk to Anne Arundel County Assets, ordered by 100-year Risk
(Sources: HAZUS, FEMA Hurricane Wind BCA Module)

Land Use Category	HAZUS Structure Type	Total SF (1000s)	Risk per SF	Annual Building Damages	Annual Content Damages	Annual Displacement Costs	Business Income Lost	Annual Public Services Lost	Total Annual Damages	100-yr Risk
Agriculture	SPMBL #42	1,334	$0.44	$22,758	$6,382	$11,565	$0	$290	$40,996	$584,981
Commercial	SECBL #28	63,954	$1.74	$3,417,478	$2,602,362	$1,361,097	$360,267	$37,807	$7,779,011	$111,000,671
Education	MERBL #13	3,919	$1.87	$158,095	$115,275	$190,453	$46,844	$1,957	$512,623	$7,314,755
Government	CECBL #35	2,595	$0.78	$58,498	$41,495	$32,326	$0	$10,362	$142,682	$2,035,934
Industrial	MLRI #25	34,565	$2.07	$2,104,831	$1,718,720	$757,778	$0	$419,198	$5,000,527	$71,353,917
Religious	MERBL #14	4,013	$0.56	$83,452	$43,571	$29,014	$0	$1,073	$157,109	$2,241,851
Residential	WMUH1 #1	302,876	$0.89	$8,749,725	$5,860,732	$3,790,149	$411,850	$104,663	$18,917,118	$269,937,896
Total	**-----**	**413,256**		**$14,594,837**	**$10,388,537**	**$6,172,382**	**$818,961**	**$575,350**	**$32,550,066**	**$464,470,005**

Table 7.3-16
Estimated Hurricane Wind Risk to Anne Arundel County Assets, ordered by Risk per Square Foot
(Sources: HAZUS Query, Spring 2012, FEMA Hurricane Wind BCA Module)

Land Use Category	HAZUS Structure Type	Total SF (1000s)	Risk per SF	Annual Building Damages	Annual Content Damages	Annual Displacement Costs	Business Income Lost	Annual Public Services Lost	Total Annual Damages	100-yr Risk
Commercial	SECBL #28	63,954	$2.07	$2,104,831	$1,718,720	$757,778	$0	$419,198	$5,000,527	$71,353,917
Government	CECBL #35	2,595	$1.87	$158,095	$115,275	$190,453	$46,844	$1,957	$512,623	$7,314,755
Religious	MERBL #14	4,013	$1.74	$3,417,478	$2,602,362	$1,361,097	$360,267	$37,807	$7,779,011	$111,000,671
Industrial	MLRI #25	34,565	$0.89	$8,749,725	$5,860,732	$3,790,149	$411,850	$104,663	$18,917,118	$269,937,896
Residential	WMUH1 #1	302,876	$0.78	$58,498	$41,495	$32,326	$0	$10,362	$142,682	$2,035,934
Religious	MERBL #14	3,919	$0.56	$83,452	$43,571	$29,014	$0	$1,073	$157,109	$2,241,851
Agriculture	SPMBL #42	1,334	$0.44	$22,758	$6,382	$11,565	$0	$290	$40,996	$584,981
Total	**-----**	**413,256**		**$14,594,836**	**$10,388,538**	**$6,172,382**	**$818,960**	**$575,350**	**$32,550,066**	**$464,470,004**

In this case, the risk per square foot metric may be the most effective way to prioritize decisions about where to focus additional resources and efforts, both in terms of further risk studies and in developing site-specific mitigation measures to reduce the risk.

7.3.3 Tornado Risk in Anne Arundel County

Although tornado risk is small in Anne Arundel County relative to other parts of the nation, there is nevertheless enough exposure to the hazard to make it worthwhile to perform a simple risk assessment to characterize potential future losses. The calculation is done using FEMA's Benefit-Cost Analysis Tool Version 5.3. and some relatively simple methods to estimate the total exposure of assets in the County. The first figure shows the expected number of tornadoes in the County, based on an analysis of tornado records from 1950 to 2014.

Table 7.3-17
Number of Tornadoes in Sample Area for Anne Arundel County
(Source: FEMA BCA software, version 5.3)

Tornado Category	Count
EF-0	20.0
EF-1	29.2
EF-2	9.2
EF-3	2.0
EF-4	0.7
EF-5	0.0

The FEMA tornado BCA analysis methodology and software are based on avoided injuries and fatalities. As a result, it is not necessary to separate public assets from private ones in order to estimate potential future losses (risk) – the calculation is based on the population at risk, rather than the square footage or value of buildings or functions.

The FEMA BCA module requires analysts to specify building dimensions in order to determine the probability of a tornado impacting a site. Although (as noted), it is not important to differentiate between residential and public/commercial assets in the present analysis, the total size of the residential "footprint" in the County is used to calibrate the analysis. The U.S. Census-estimated population of the County is also used in the risk calculation.

To calculate tornado risk, the analysis uses the 2015 U.S. Census count of 219,319 residential structures in Anne Arundel County, and assumes that each structure comprises approximately 2,000 square feet. Using this estimated square footage for each structure, the total square footage for the County is 438,638,000. The square root of this figure is then used in the software to calculate the probability of tornado impacting residential structures (this is a valid proxy for the total risk because individual structures are uniformly exposed to the risk in the County).

The software then uses inputs related to building occupancy by time of day to calculate the expected loss of life and number of injuries for tornado classes EF0 to EF5. The software calculates an expected risk value of $7.51 per structure. The figures in this table represent the expected annual losses due to tornadoes for a single residential structure in the County. The very low dollar figure simply expresses the fact that this area of the U.S. is not prone to tornadoes. The cell labeled "Present Value" shows the expected losses over a 100-year planning horizon – the figure is discounted using the mandatory 7% discount rate.

In order to assess the overall risk to residential properties in the County, these figures are simply multiplied by the number of housing units in the County (219,319) to yield annual expected losses of $1,648,840, and losses over a 100-year planning horizon of $23,528,949, again, discounted to present value. It should be recognized that although expected losses on a structure basis are very small, the cumulative amount of risk in the County (as above) may be sufficient to suggest County-wide mitigation measures would be cost-effective, though probably not sufficient to justify large or expensive projects.

7.3.4 Severe Winter Storm Risk in Anne Arundel County

This subsection describes the severe winter storm risk in Anne Arundel County. The National Oceanic Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) and FEMA Public Assistance (Project Worksheet) records were used to identify past events and the impacts on life and property in the County. The NCDC database listed 68 winter storm/snow/ice events from 1999 to 2018 (see note 1 below Table 7.3-18) for Anne Arundel County. The database does not indicate why the recorded events do not extend back to 1950. Nevertheless, the amount of data that is presently on the site is sufficient for a basic risk assessment for Anne Arundel County. Table 7.3-18 shows the basic data required for the assessment.

Table 7.3-18
Data Parameters for Anne Arundel County Winter Storm Risk Assessment;
Data from the NOAA/NCDC Database (1999-2018)
(Source: FEMA – Project Worksheet records, NOAA/NCDC)

Data	Value
Winter storm events	31 (note 1)
Average annual number of winter storm events	1.63
Total reported damages (Project Worksheets)	$9,885,441
Annual damages	$520,286
Reported deaths	1
Annual deaths	0.032
Value of single death (FEMA, 2009 value)	$5,800,000
Estimated annual cost of deaths from winter storms	$185,600
Reported injuries	1
Annual injuries	0.032
Value of single injury (FEMA, 2009 value)	$90,000 (note 2)
Estimated annual cost of injuries from winter storms	$2,880

Note 1. Since the last version of the HMP (2012), the NCDC database has apparently eliminated some of the data that is needed for such an analysis. This analysis and result includes only the 31 events that are currently listed on the NCDC site.

Note 2. From the FEMA guidance entitled *Benefit-Cost Analysis Re-engineering, Development of Standard Economic Values, 2009.*

After determining the annual figures for damages, deaths and injuries for the County, the risk assessment comprises a simple projection of future expected damages based on a standard present value coefficient of 14.27. This represents a 100-year time horizon and a 7% discount rate (the latter required by OMB). Review of the winter storm events in the NCDC indicate that the majority of the infrastructure damages (estimates from FEMA Project Worksheets) have not been included the total estimated property damage. Therefore these figures have been combined to calculate the winter storm risk presented below in Table 7.3-19.

Table 7.3-19
Estimate of Risk (100-year horizon) to Anne Arundel County from Winter Storms
(Source: NOAA/NCDC)

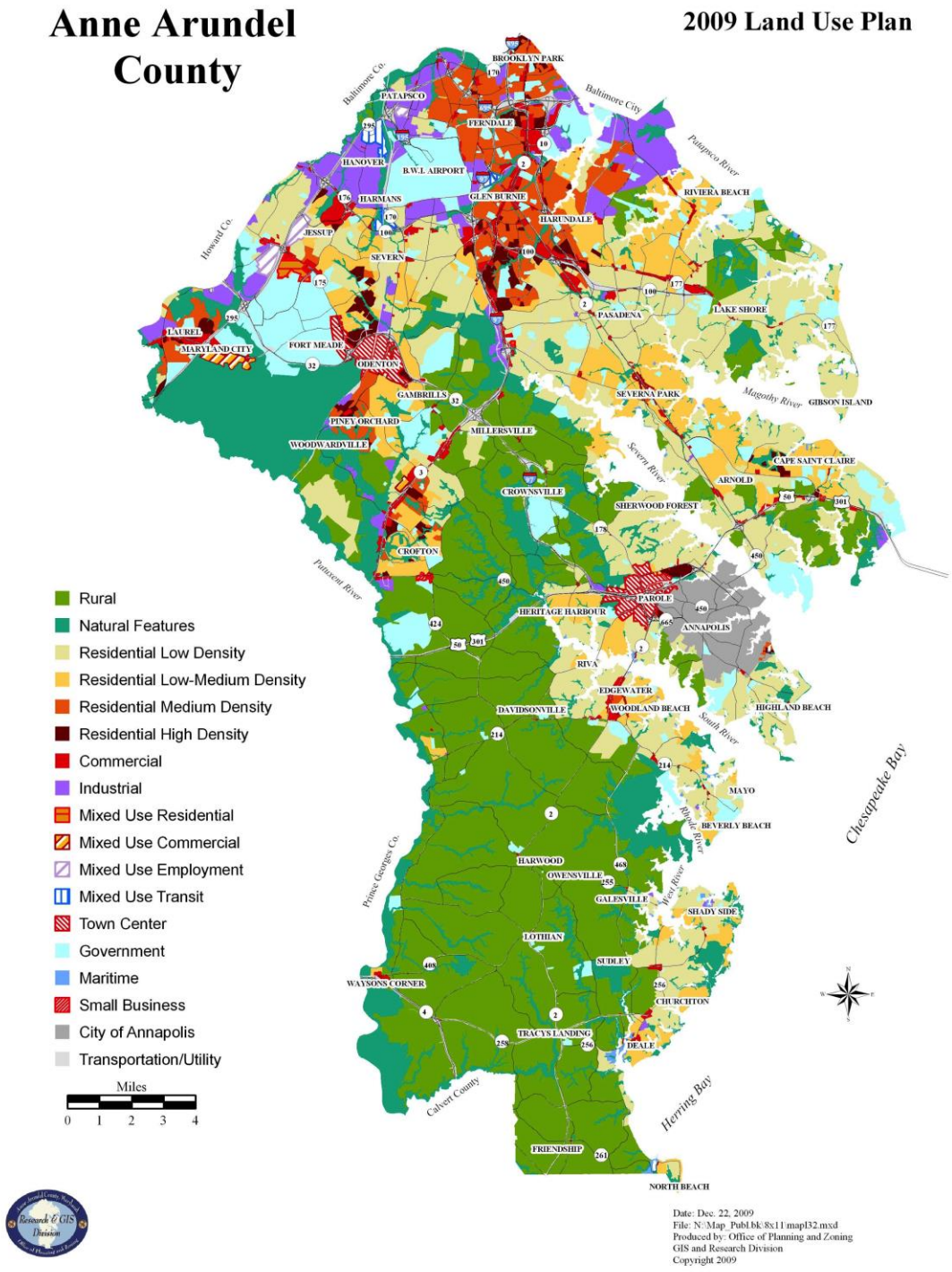
Data	Value
Annual damages to Anne Arundel County	$520,286
Projected 100-year risk from direct winter storm damages	$7,424,481
Estimated Annual cost of deaths	$185,600
Projected 100-year risk from winter storm-related deaths	$2,648,512
Estimated annual cost of injuries	$2,880
Projected 100-year risk from winter storm-related injuries	$41,098
Estimated total risk from winter storms (100-year horizon)	**$9,934,091**

7.4 Future Development Trends in Anne Arundel County

To identify future development trends in Anne Arundel County, the HMPC reviewed both the *2009 General Development Plan (GDP)* and more recent development activity data. The GDP provides a comprehensive overview of where growth is expected to occur in the County over a twenty year planning horizon. Figure 7.4.1 displays the current Land Use Plan for Anne Arundel County. The General Development Plan is being updated in 2020. See Section 3.3.6 for additional information on development trends.

There is no established metric for characterizing changes in risk in the County in the recent past, except insofar as FEMA NFIP claims and damage reports (from open sources and in some cases FEMA Project Worksheets) reflect this. These are discussed and summarized elsewhere in this Hazard Mitigation Plan update. As noted in various other places in this document, the County has well-established processes to control risks from natural hazards, especially in areas that are being developed (where current subdivision, flood control and engineering standards are implemented). There is always the possibility of anomalous events (extreme high winds or rainfall) damaging such areas, but this is well controlled.

Figure 7.4-1
Anne Arundel County Land Use Plan
(Source: 2009 General Development Plan)



Residential Development

The County's most current estimates of residential holding capacity were developed in 2015 and are shown in Table 7.4-1 below.

Table 7.4-1
Residential Development Holding Capacity (2015)
(Source: Office of Planning and Zoning)

	Potential Residential Units Available From		
Zoning Category	Vacant Lots	Redevelopment	Total Units
RA	1,621	173	1,794
RLD	775	141	916
R1	2,234	1,363	3,597
R2	4,703	2,581	7,284
R5	3,709	4,634	8,343
R10	2,520	0	2,520
R15	788	0	788
Totals	**16,549**	**8,892**	**25,441**

As of 2015, the County had remaining development capacity for approximately 25,000 residential units under the current zoning at that time. Most of this additional capacity exists in the low to medium density residential zones (R2 and R5, and to a lesser degree R1). In addition, most of the available capacity can be attributed to vacant lots, although there is a significant amount of redevelopment capacity in the residential zones, particularly in the R5 zone. Much of the development capacity in the R5 zone is located in Brooklyn Park, Glen Burnie, Pasadena, and Arnold, while much of the capacity in the R2 zone is located in Severn and Pasadena.

Population and household projections through the year 2040 are shown in Table 7.4-2 below. As seen, the County's population is projected to increase to over 620,000 residents.

Table 7.4-2
Population and Household Projections
(Source: Office of Planning and Zoning, Round 9 Forecasts Feb 2018)

Category	2015	2020	2025	2030	2035	2040
Population	562,867	572,340	582,566	594,303	608,928	621,771
Households	207,338	210,959	217,565	224,575	231,253	237,951

Commercial Development

In accordance with the County's General Development Plan, new commercial development continues to be focused in designated Town Centers, mixed use areas, commercial revitalization areas, and employment areas along the Baltimore Washington Parkway corridor. Targeted growth areas include the following:

- **Odenton Town Center** – Significant economic development efforts by the County are directed toward attracting development in this town center. It is strategically located near Fort Meade, NSA, and National Business Park, and is centered around the Odenton MARC Commuter Rail Station.
- **BWI Airport Vicinity** – This area is developed with many industrial and office technology park uses and continues to attract new businesses due to its strategic location. Many of these office parks are occupied by defense-related contractors and support services that desire to locate near BWI Airport.
- **Fort Meade Vicinity and the Baltimore Washington (BW) Parkway Corridor** – In addition to a recent expansion of the National Business Park, this corridor has seen several new mixed-use developments in recent years.
- **Parole Town Center** – Most of the major infill sites in the Parole Town Center have been developed over the past several years including the Annapolis Town Center at Parole. Redevelopment opportunities continue to occur.
- Redevelopment and Revitalization Opportunity Sites– Nine County-designated commercial revitalization areas are generally located in the northern and western parts of the County, and two more are proposed for adoption in 2020. The County also has three State-approved Sustainable Communities that are the focus of revitalization efforts. In addition, the 2020 GDP will identify key opportunity sites for redevelopment, primarily in older commercial areas. These will be the focus areas for future redevelopment and revitalization opportunities.

More recently, the County solicited an economic and real estate consultant to conduct a land use market analysis which was completed in 2019. The analysis assessed demographic and development trends, the real estate market, and land demand and capacity. The assessment was based on ten submarket areas that were identified as having similar real estate market and land use characteristics. Some of the key conclusions related to future development are summarized below.

• The County's average annual growth rate is slowing. During the period from 1970 - 2010 the annual growth rate averaged 2%. Between 2000 and 2010, the rate slowed to 1% annually. Between 2010 and 2018, growth averaged roughly 0.7%. This is in part due to the decreasing land development capacity.

• The County is still well positioned to capture its fair share of regional growth in the future, as it continues to urbanize its targeted growth areas.

• The urbanizing regional growth patterns are showing a preference for urban mixed-use and higher density developments near important transportation routes and transit lines linking residential communities to employment centers.

• A substantial amount of undeveloped land in the County is concentrated in rural areas that are not planned or zoned for future development. This preservation of rural areas will continue to be reflected in the land use policies of the new GDP to be completed in 2020.

• Under current zoning, the County does not have sufficient land development capacity in several of the submarkets to accommodate future land demand through 2035. The County will address this by shifting, via planning and zoning, additional development potential to targeted growth areas and redevelopment and revitalization opportunity sites, while staying consistent with adopted land use policies.

These conclusions have several positive implications as related to hazard mitigation. First, targeted growth areas are not located along or near the County's shoreline and therefore are not in areas most vulnerable to sea level rise impacts. Secondly, the policy focus on redevelopment and revitalization will serve to protect more greenfield areas from new development, preserving natural features, tree canopy, and other environmental features that help to reduce climate change impacts. Redevelopment also provides opportunities to provide improved stormwater management techniques and facilities in older developed areas that may have outdated or minimal stormwater management currently, which will help mitigate stream erosion, water quality impacts, and other negative consequences of stormwater runoff. Focusing on redevelopment and infill in currently developed areas also allows more opportunity for infrastructure upgrades and lessens the need for infrastructure expansions into new undeveloped areas.

Anne Arundel County recognizes the importance of assuring development within the 100-year floodplain is conducted in a manner that minimizes future risk to human life and potential damage and losses to property. To minimize current and future risk, Anne Arundel County has adopted a local floodplain ordinance and local Building and Construction Codes that ensures building standards are met for development within the 100-year floodplain. Future updates to the HMP will more closely evaluate the vulnerability of structures including historical and archaeological assets and critical infrastructure.

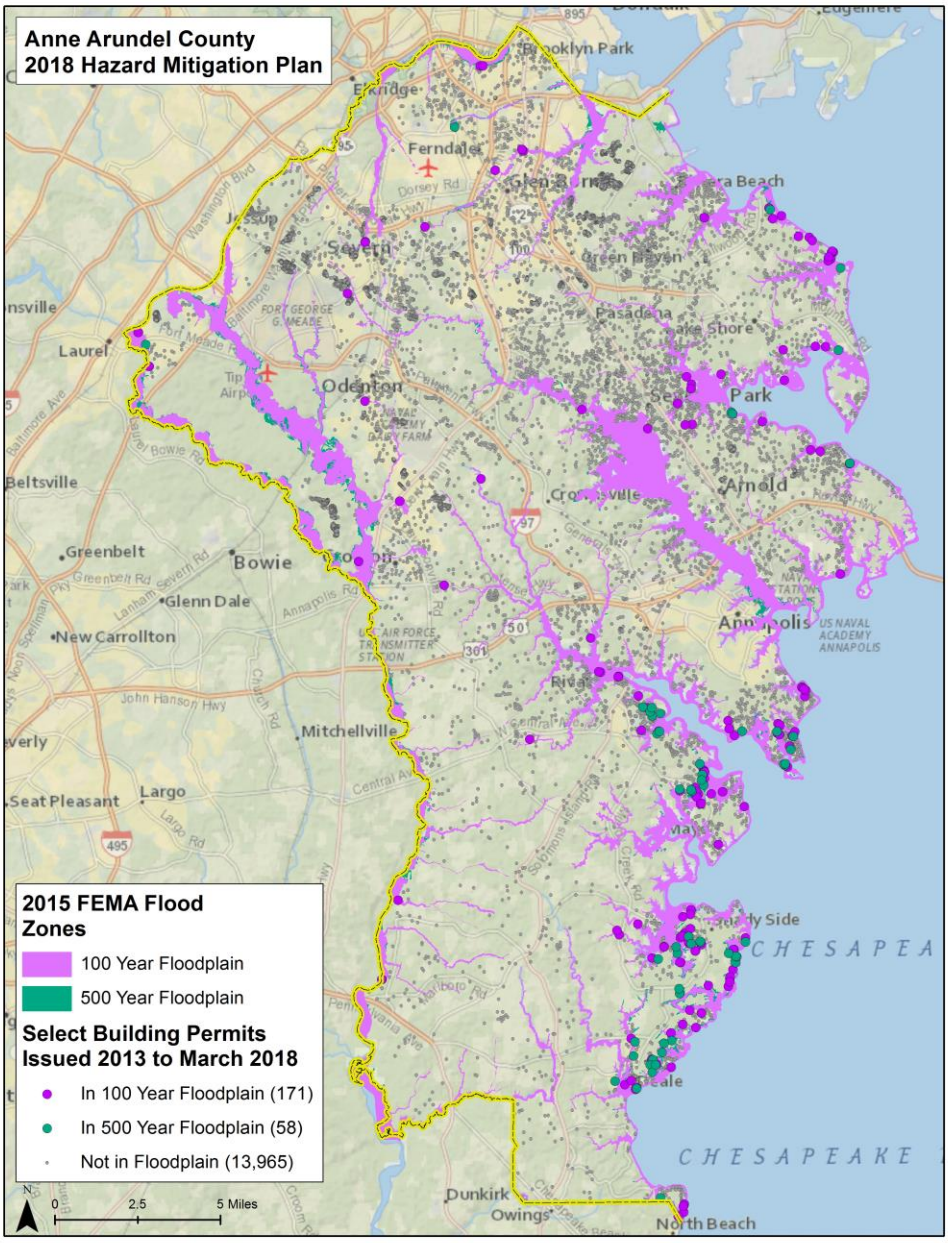
Figure 7.4-2 depicts the number of building permits issued in Anne Arundel County for the period between 2013 and March 2018. The map shows the spatial distribution of building permits across the County with slightly more than 1% of the permits issued were in the 100-year floodplain.

The Department of Inspections and Permits (I&P) reviews applications and conducts inspections on properties within the 100-year floodplain to assure compliance with Building and Construction Codes and the local floodplain ordinance. Between 2013 and 2018, a total of 171 building permits were issued in the 100-year floodplain.

On September 28, 2011, the Maryland Department of the Environment conducted a Community Assistance Visit (CAV) to evaluate the performance of the floodplain management program. MDE randomly selected permits within the 100 year floodplain for review. The results of the CAV concluded there were no issues of concern with regard to the performance of the floodplain management program. The CAV report stated the Department of Inspections and Permits is using the latest FEMA Elevation Certificate (March 2012); the program is modeled on the Maryland Model (September 2010) version; and the floodway maps are made available on the County's website. A separate CAV visit was performed in June 2019; however, a CAV report was not available at the time of the 2018 HMP update.

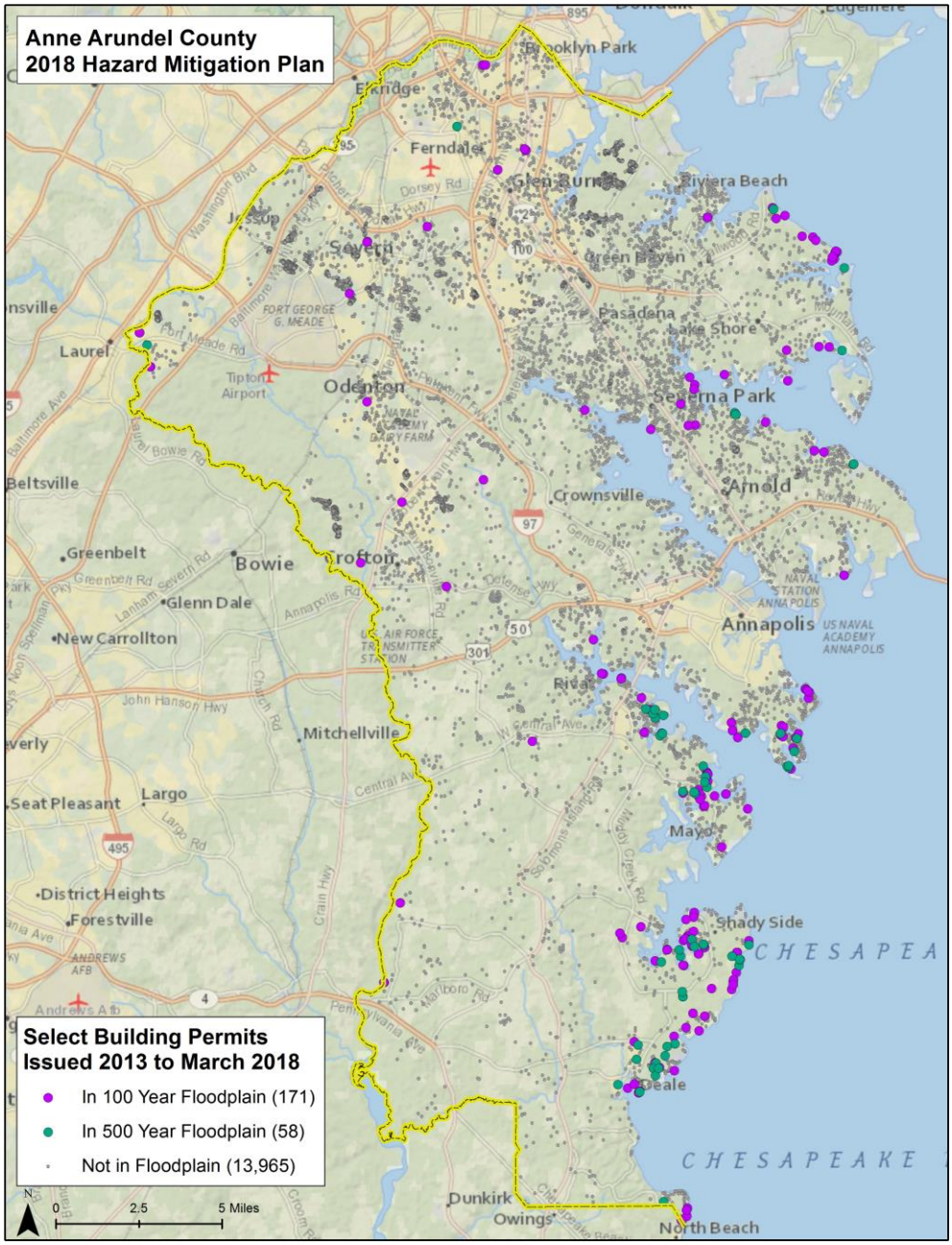
It is important to understand, however that in many cases permits were subject to FEMA and County LOMA or LOMR requirements that may not yet be reflected in the GIS floodplain layer.

Figure 7.4-2
Select Building Permits in Anne Arundel County, 2013 to 2018, with Floodplains



The next figure in this section (Figure 7.4-3) depicts building permits issued in floodplains County-wide in the indicated period.

Figure 7.4-3
Select Building Permits in 100- and 500-year Floodplains in Anne Arundel County, 2013 to 2018



7.5 Summary of Risk Assessment

Table 7.5-1 shows the results of the risk assessments for floods, hurricane wind, tornado and winter storm risks for Anne Arundel County.

Table 7.5-1
Summary of Anne Arundel County Flood, Hurricane Wind and Tornado Risks by Asset and Hazard Type (100-year horizon)

Asset	Hazard	Projected Risk (100-year horizon)
Residential repetitive loss properties	Floods	$2,039,989
All land use classes	Hurricane wind (physical damage)	$464,470,004
Residential properties	Tornado wind (life safety)	$23,528,949
Infrastructure and residential properties	Severe Winter Storm	$22,269,091

As noted elsewhere, these figures must be considered with some caution because of the underlying data and assumptions that were used in the analyses. Although these summary data compare risk by the same planning horizon, it is important to recognize that, generally speaking, mitigation efforts are highly localized. Although the table shows County-wide risk, many of the hazards are difficult or impossible to mitigate on a large scale. For this reason, it is important to read and consider the detailed results in the sections above.

Section 8
Mitigation Strategy

Contents of this Section

This 2018 update is the third iteration of the Anne Arundel County Hazard Mitigation Plan, with the first two dated 2004 and 2012. As with the 2012 update, the HMPC evaluated the strategies from the most recent adopted version of the HMP, consulted with County subject matter experts, and updated the mitigation strategies and actions. This update includes discussion about progress on the goals, strategies and actions from the 2012 version of the HMP.

.1.1 Requirements for Mitigation Strategy

44 CFR § 201.6 *(The Mitigation 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. This section shall include:

(i) A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

(ii) 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. All plans approved by FEMA after October 1, 2008, must also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.

(iii) An action plan describing how the actions identified in paragraph (c)(3)(ii) of this section 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.

(iv) For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the hazard mitigation plan.

.1.2 Mitigation Goals and Accomplishments

Goals are general descriptions of desired long-term outcomes. State and federal guidance and regulations pertaining to mitigation planning require the development of mitigation goals to reduce or avoid long-term vulnerabilities to identified hazards. Mitigation goals have been established by FEMA, the State of Maryland, and Anne Arundel County.

As part of the original (2004) HMP development process, the Hazard Mitigation Planning Committee (HMPC) and OEM met on numerous occasions to discuss possible mitigation measures to reduce or eliminate disaster-related damages in the County. Riverine and coastal flooding are the predominant hazards in the County, and were the focus of the discussions. The original HMPC developed a list of actions for the December 2004 version of the HMP; all the actions were developed as a means to move the County toward achieving its mitigation goals and objectives.

The 2004 HMPC developed an overall goal to reduce or eliminate the long-term risk of loss of life and property damage from a full range of natural and man-made hazards. In addition to this overall goal, the HMPC also established seven more specific goals:

8. Protect the residents of Anne Arundel County from natural and man-made hazards
9. Increase public understanding, support and demand for hazard mitigation
10. Protect existing and new properties
11. Build and support local capacity and commitment to become less vulnerable to hazards
12. Maximize resources for investment in hazard mitigation
13. Reduce the potential impact of natural and man-made disasters on the County's historic assets
14. Reduce the potential impact of natural and man-made disasters on the County's natural systems

As part of a follow-up review, Hazard Mitigation Planning in the County will be directed toward achieving the following goals in the future:

Anne Arundel County's Hazard Mitigation Goals

1. Protect residents and minimize loss of human life and damage to property from natural hazards affecting the County
2. Increase public awareness to hazard mitigation and natural hazards affecting the community
3. Build community resilience through the adoption of building, construction, and development standards for existing and new development and critical infrastructure
4. Build local capacity and commitment to adapt to the natural hazards and changing conditions affecting the community
5. Prioritize funding for hazard mitigation projects that maximizes the investment of County funded projects in high risk areas or for multi-hazard projects
6. Reduce the potential impact of natural hazards on the County's historic assets
7. Reduce the potential impact of natural hazards on the County's natural systems

8.3 Mitigation Objectives and Strategies

Objectives

Objectives are well-defined intermediate points in the process of achieving goals. For the seven goals listed above, the HMPC and the Anne Arundel County OEM established a list of objectives within each goal. County mitigation planning objectives for each goal include:

Goal 1: Protect residents and minimize loss of human life and damage to property from natural hazards affecting the County.

- **Objective 1.1** Educate the public and implement actions that protects lives and property by making homes, businesses, critical infrastructure, and other property less vulnerable to natural hazards.
- **Objective 1.2**: Target owners of properties within identified vulnerable areas to natural hazards for additional outreach regarding mitigation and disaster preparedness.
- **Objective 1.3**: Evaluate existing shelters to determine adequacy for current and future population needs.
- **Objective 1.4**: Maximize the use of technology to adequately warn the public about hazard events.
- **Objective 1.5**: Document and monitor hazard data for Anne Arundel County to build community resilience.

Goal 2: Increase public awareness to hazard mitigation and natural hazards affecting the community.

- **Objective 2.1: Develop education and outreach programs and materials to increase public awareness of the risks associated with natural hazards.**
- **Objective 2.2**: Educate the public on actions they can take to prevent or reduce the loss of life or property from natural hazards.
- **Objective 2.3**: Cultivate a spirit of cooperation between County residents and County government that ensures an ongoing commitment to future mitigation activities.

Goal 3: Build community resilience through the adoption of building, construction, and development standards for existing and new development and critical infrastructure

- **Objective 3.1**: Reduce losses and repetitive damages from chronic hazard events by encouraging adequate and well-understood insurance coverage, including separate personal property coverage, among property owners.
- **Objective 3.2**: Use cost-effective approaches to minimize risk and potential damage to existing buildings and public infrastructure from natural hazards.
- **Objective 3.3**: Ensure future development will not place people in harm's way or increase potential damage and losses to property.

Goal 4: Build local capacity and commitment to adapt to the natural hazards and changing conditions affecting the community.

- **Objective 4.1**: Build and support local partnerships to continuously become less vulnerable to natural hazards.

- **Objective 4.2**: Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities.
- **Objective 4.3**: Ensure adequate training, exercise, and resources for emergency organizations and personnel.
- **Objective 4.4**: Build a cadre of committed volunteers to assist in safeguarding the community before, during, and after a disaster.
- **Objective 4.5**: Continue to foster collaboration with County departments so that hazard mitigation concerns are consistently incorporated into normal County operations (i.e. budgeting, planning, and zoning).

Goal 5: Prioritize funding for hazard mitigation projects that maximizes the investment of County funded projects in high risk areas or for multi-hazard projects.

- **Objective 5.1**: Strengthen communication and participation between public agencies, citizens, non-profit organizations, businesses, and industry to facilitate the mitigation process.
- **Objective 5.2**: Maximize the use of County funding that prioritizes mitigation actions in high risk natural hazard areas.
- **Objective 5.3**: Encourage participation of property owners, community associations, and special tax districts in hazard mitigation projects that protects property in high risk natural hazard areas.

Goal 6: Reduce the potential impact of natural hazards on the County's historic assets.

- **Objective 6.1**: Identify and protect historic assets throughout the County that are at risk from natural hazards.

Goal 7: Reduce the potential impact of natural hazards on the County's natural systems.

- **Objective 7.1**: Balance natural resource management, and land use planning with natural hazard mitigation techniques.
- **Objective 7.2**: Preserve, rehabilitate, and enhance natural ecosystems to serve natural hazard mitigation functions.

As part of a follow-up review, the objectives of the 2018 HMP update were revised to align with future Hazard Mitigation Planning goals of the County.

Strategies

Table 8.3-1 identifies the Anne Arundel County mitigation planning **strategies** and status as of early 2018, with strategies for the Town of Highland Beach are found at the end of the table in gray highlighting.

Table 8.3-1
Anne Arundel County: Status of Mitigation Strategies

No.	Association with Goals and Objectives	Description of Strategy	Hazard	Status as of 2018
1	Goals 1 & 3	Acquire repetitively flooded structures and non-repetitive loss structures	Flood	There is currently very little funding available for this activity. Also, in this area of the State, purchase of properties tends to be prohibitively expensive, limiting the potential for acquisitions except in unusual circumstances. The County will continue to pursue funding that may be available after Presidential Disaster Declarations, and through non-disaster-related FEMA programs (such as the FMA, SRL and PDM), as appropriate. There is no change to this approach for the 2018 HMP update.
2	Goals 1 & 3	Elevate repetitively flooded structures	Flood	There is currently very little funding available for this activity. The County will continue to pursue funding that may be available after Presidential Disaster Declarations, and through non-disaster-related FEMA programs (such as the FMA, SRL and PDM), as appropriate. There is no change to this approach for the 2018 HMP update.

No.	Association with Goals and Objectives	Description of Strategy	Hazard	Status as of 2018
3	Goals 2 & 4	Maintain public awareness and education campaigns for all hazards	All Hazards, Extreme Heat	Completed and ongoing. The County Office of Emergency Management (OEM) has an all-hazards emergency preparedness program that includes a wide variety of methods to communicate preparedness and mitigation on the risks associated with natural hazards, on the actions the public can take to prevent or reduce the loss of life or property from natural hazards, and in cultivating an ongoing spirit and commitment with the community for future mitigation projects. Education materials include *Citizens' Guide to Emergency Preparedness, Pet Preparedness* (website and handout), *Hit a Home Run with Emergency Preparedness* (website and handout) for kids), *Key to the Emergency Preparedness Castle* (also for kids), *Four Steps to Preparedness* (website and handout), a Winter Weather trifold, and OEM refrigerator magnet, *Nuclear Weapon Detonation Emergency Guide* (a handout that is distributed only during emergencies), *Planning for Nuclear Facility Incidents* (website and handout) and *Emergency Planning Guide for Nuclear Facility Incidents* (website). Specific Hazard Updates 1. Coastal Erosion: Ongoing Emergency Management (EM) preparedness meetings, EM Preparedness Guide, Storm Surge Map on website. As of the 2018 HMP update, the State of Maryland is working with the U.S. Army Corps of Engineers to redesign hurricane evacuation zones. There is a "Know Your Zone" campaign that started in June 2018. The campaign includes all County jurisdictions. 2. Extreme Heat: An Extreme Temperature Plan was recently completed.
4	Goal 2	Educate residents about and promote the restraint of home heating oil tanks	Hurricane, Tropical Storm or Nor'easters	After Tropical Storm Isabel in 2008, this information was spread widely to the community. The information is currently on the County's website: https://www.fema.gov/media-library-data/1494007144395-b0e215ae1ba6ac1b556f084e190e5862/FEMA_2017_Hurricane_HTP_FINAL.pdf The County includes this information in social media and press releases before and during hurricane season.
5	Goal 1	Determine the adequacy and hazard resistance capability of existing shelters	Multi-hazard	Ongoing. In 2018, the County completed surveys with DSS, Red Cross, OEM, ARES/RACES, Animal Control, Public Schools, the Health Department and the County ADA Coordinator. Since the last version of the HMP, both Annapolis High School and Severna Park High School have been wired for generator transfer switches. Northeast High School is pending. The County completed a generator test at Severna Park in 2018.

No.	Association with Goals and Objectives	Description of Strategy	Hazard	Status as of 2018
6	Goal 1	Develop evacuation plans, policies, and procedures	Multi-hazard	Completed and ongoing. In March 2016 the County developed the Anne Arundel County Evacuation Plan and the Baltimore Regional Evacuation Coordination Supplement Plan.
7	Goals 1 & 5	Develop coordinated interagency debris removal plan	Multi-hazard	The Debris Management Plan was updated prior to the initiation of the HMP update process,
8	Goal 1	Identify roles and responsibilities of County response agencies	Multi-hazard	Completed with the revision of the Emergency Operations Plan. Roles and responsibilities further defined and classified through exercises. Various County initiatives are underway at the time of the 2018 HMP update. 1. An updated to the Emergency Operations Plan was completed in July 2018. 2. The County recently completed three assessment trainings to update and expand on roles and responsibilities of County agencies (Operations – 1/24/18, Planning – 2/14/18, Logistics – 3/14/18). 3. Three trainings were completed to address capabilities identified, resource management/mission ready packets, and Advance WebEOC (Operations – 4/26/18, Planning – 5/24/18, Logistics – 6/13/18). 4. A full-scale training exercise will be held in October/November 2018. 5. The County has created position-specific Job Action Sheets for the EOC. These include capabilities directly from the EOP. 6. Plans to support the following ESFs have been developed and/or updated: ESF 6: Mass Care & Sheltering (Sheltering Plan); ESF 10: Hazardous Materials (Fixed Nuclear Facility Plan). As of the 2018 HMP update, the ESF 6 and ESF 10 activities are awaiting approval from the County Office of Law. 7. The County has developed a Recovery Plan, and a Donations Plan was submitted to the Office of Law in November 2018. The Volunteer Management Plan is under development.
9	Goal1	Ensure and maintain sufficient redundancy for E911 service	All Hazards	The County has updated to a new Computer Aided Dispatch system (at all facilities).
10	Goals 1, 5, 6 & 7	Promote use of new technologies to detect and suppress fires	Wildfire	2018 update: ongoing, no change.

No.	Association with Goals and Objectives	Description of Strategy	Hazard	Status as of 2018
11	Goals 2 & 4	Enhance information base for future mitigation activities	Multi-hazard	The County is continuously evaluating needs in this subject area. The 2018 HMP update process was used in part as a way to develop additional information to support mitigation activities going forward.
12	Goal 1	Identify situations where sheltering in-place is appropriate	Multi-hazard	Completed and Ongoing. OEM has an all-hazards emergency preparedness program that includes community presentations, website, Facebook and twitter and materials from FEMA, Red Cross and the Ready Campaign that includes information about many hazards. 2018 update: ongoing, no change.
13	Goals 1, 3, 4, 6 & 7	Formalize hazard mitigation as factor in community development planning	Multi-hazard	The County has incorporated Public Safety Services into the draft General Development Plan (GDP) update. Includes policies and actions to promote and train citizens and encourage coordination between the public and County departments. 2018 update: GDP is currently undergoing a major revision.
14	Goal 2 & 4	Encourage citizens and County personnel to take CERT course	Multi-hazard	Completed and ongoing: Interested County personnel have taken classes offered to the public. OEM has trained citizens in CERT (Community Emergency Response Teams), and is currently instituting Teen CERT at Meade High School as part of the Homeland Security signature program. 2018 update: ongoing, no change.
15	Goals 1, 3, 6, & 7	Ensure adequate plans, procedures, and capabilities to respond to a dam failure	Dam Failure and Releases	The Maryland Department of the Environment has overarching responsibility for dam safety in the State, and requires dam owners to prepare dam failure Emergency Action Plans for high hazard dams. Anne Arundel County complies with this requirement. The County participates in Dam Awareness Day (May 31st) with press releases and social media posts. OEM has hosted meetings with MDE, surrounding jurisdictions, and County departments to educate on dam failures and discuss capabilities (in 2016 and 2017). 2018 update: ongoing, no change.
16	Goal 1	Create a plan for cooling centers and shelters	Extreme Heat	This is part of the Extreme Temperature Plan discussed elsewhere. At the time of the 2018 HMP update, an updated Sheltering Plan is ready for review by the County Offices of Personnel and Law. The County has developed a Warehouse Manual specific to operations as they relate to shelter supplies. The County hosted Sheltering Plan training in April and May 2018, and anticipating two more sessions the following winter. These trainings will be delivered annually.

No.	Association with Goals and Objectives	Description of Strategy	Hazard	Status as of 2018
17	Goals 1, 2 & 4	Create and build upon cooperative relationships with news media outlets for distributing information about All Hazards and future HMP updates	All Hazards	Since the 2012 HMP update, the County Office of Emergency Management established its own Public Information Officer, and distributes press releases. The Office has created a distribution list, and periodically does interviews with news media on All Hazards including extreme heat and cold. OEM will build upon our relationships with the news media and among County Public Information Officers (PIOs) in disseminating information of future HMP updates and All Hazard information.
18	Goals 1, 2 & 4	Promote use of NOAA "All Hazards" radios for early warning and post-event information to critical facilities	Multi-hazard	Complete and ongoing: this information is included in all hazards emergency preparedness program. The County is part of the Storm Ready Program. http://www.aaCounty.org/departments/office-of-emergency-management/about-us/storm-ready/index.html
19	Goals 1, 3, & 5	Research and evaluate hazards and data needs for the next iteration of the HMP	Multi-hazard	Completed and ongoing. All hazards of concern were re-evaluated as part of the 2018 HMP update, and the County will continue this effort indefinitely, revisiting the hazards and HMP as needed.
20	Goal 3	Increase use of insurance coverage	Multi-hazard	The County continually monitors and updates its insurance coverages as needed. 2018 update: ongoing, no change.
21	Goal 6	Identify and protect County historic assets	Multi-hazard	The County continually updates the list of County Historic Resources and monitors any development activity on these properties. Measures for protecting Historic Resources are found in Articles 17 and 18 of the County Code. The County has also identified some preparedness objectives to address in the Recovery Plan.
22	Goal 5	Conduct fire study using Geographical Information System (GIS)	Wildfire	Tridata Deployment Study completed in 2008 (http://www.aaCounty.org/Fire/Resources/ TriData_2008.pdf) and ISO Public Protection Classification Report completed in 2009.
23	Goal 1	Create a plan for warming centers and shelters	Severe Winter Storm	Shelter plan exists within the County EOP. The EOP was the subject of a very recent update that included a review of the Shelter Plan.
24	Goals 1, 2, & 4	Create cooperative relationships with news outlets for distributing information about winter storms	Severe Winter Storm	Ongoing. Pre-season, information is distributed via the County web site, informational letters to County Council & State politicians, snow information briefing goes to newspapers. A hotline is set up during major storm events with recorded operations information. 2018 update: no change; OEM recently established its own Public Information Officer position for the purpose of working with the media and public regarding natural hazard and emergency management issues.

No.	Association with Goals and Objectives	Description of Strategy	Hazard	Status as of 2018
25	Goal 4	Establish a relationship with BGE to reduce power outages	Multi-hazard	Completed and Ongoing. The County attends an annual Baltimore Gas & Electric (BG&E) meeting for emergency management. The County schedules interagency meetings to resolve questions and problems. GIS works with BG&E to create better reporting systems. BG&E hosts quarterly meetings with OEM, the Department of Aging, and DSS to discuss outreach activities and programs.
26	Goal 3	Implement a system to provide portable generators for water treatment and distribution facilities and shelters	Multi-hazard	Generators have been added to many critical areas. Several portable generators are maintained, and areas where they may be needed have been prewired to accept them. 2018 update: ongoing.
27	Goal 4	Existing enforcement plan for mandatory water rationing	Drought	The Plan is implemented as needed. 2018 update: The Plan and restrictions will be enforced as needed during periods of drought.
28	Goal 7	Identify environmentally sensitive areas for acquisition by the County	Coastal Erosion, Hurricane Winds	Ongoing. Environmentally sensitive areas that should be preserved are identified through several planning efforts in the County including the Land Preservation, Parks, and Recreation Plan, the Greenways Master Plan, and the Watershed Protection and Restoration Program. All preservation mechanisms are recommended and considered, including conservation easements, purchase by land trusts, development code regulations, and land acquisition.
29	Goal 7	Identify wetland sites for mitigation banking and establish a County wetland bank	Coastal Erosion, Hurricane Winds	As the principal wetlands regulatory agency in the State, the Maryland Department of the Environment, oversees wetland mitigation banks. The County is not currently pursuing the establishment of a County wetland mitigation bank. However, staff will direct developers or property owners to private wetland mitigation banks, as appropriate.
30	Goals 1, 3, 4, 5, 6 & 7	Enforce floodplain regulations	Flood and Coastal Flooding	Ongoing. Anne Arundel County is a member of the National Flood Insurance Program. As a participating community, the County has agreed to adopt and enforce ordinances that meet or exceed FEMA requirements to reduce the risk of flooding. 2018 update: no change; County continues to actively enforce floodplain regulations and intends to continue participation in the NFIP.
31	Goals 6 & 7	Use off-site drainage fees, Critical Area, and Tree Bill Reforestation fees to acquire mitigation sites	Coastal Erosion, Hurricane Winds	Ongoing. Currently, off-site storm drainage fees are not used for this purpose. Articles 16 and Article 17 of the County Code rewrite (not yet before Council) proposes to expand the types of fees that can be used for this purpose. 2018 update: Still on going. The County is planning on requesting funds in FY 21 to create projects to purchase flood prone properties and parcels for preservation based on a number of factors, including flooding risk. Please refer to Table 8.4-2 for more details.

No.	Association with Goals and Objectives	Description of Strategy	Hazard	Status as of 2018
32	Goal 7	Maintain the existing strategy to revise development regulations to require undisturbed buffers along upland streams	Coastal Erosion, Hurricane Winds	The County's Stormwater Management Practices and Procedures Manual requires a minimum undisturbed buffer width of 100 feet along all intermittent and perennial streams. Expanded stream buffer widths may be required if floodplains, wetlands, or steep slopes extend beyond the 100' buffer line. 2018 update: ongoing, no change.
33	Goal 7	Identify preservation areas and establish growth boundaries	Multi-hazard	Establishment of preservation and growth areas are required elements in the State-mandated Comprehensive Plan. These are identified in the 2009 General Development Plan and will be evaluated again in the 2019 update to the GDP. 2018 update: currently under evaluation as part of the review of the GDP.
34	Goal 6	Begin the process of integrating natural hazard mitigation with identification and preservation of historic and cultural resources.	Flood, storm surge, hurricane wind	Initiated as part of the 2018 HMP update.
35	Goal 1	Continue the process of integrating considerations of sea level rise into all aspects of hazard mitigation, risk assessment and planning. Initiate more detailed risk assessments to determine the potential losses related to this hazard.	Flood, storm surge	Initiated as part of the 2018 HMP update.
Town of Highland Beach				
34	Goal 1	Review Emergency Operations Plan annually	Multi-hazard	Ongoing. The EOP is updated as necessary. 2018 update: ongoing, no change.
35	Goal 2	Implement an awareness campaign for residents	Multi-hazard	Ongoing. Disaster preparedness information is always available at the Town Hall. 2018 update: ongoing, no change.
36	Goals 1, 3, 4, 5, 6 & 7	Abide by and enforce floodplain regulations of Anne Arundel County to ensure on-going participation in NFIP	Flood	On-going. The City of Highland Beach abides by the same regulations and policies as Anne Arundel County. As a participating community, Highland Beach has agreed to adopt and enforce ordinances that meet or exceed FEMA requirements to reduce the risk of flooding. 2018 update: no change.

8.4 Prioritized Mitigation Actions and Projects

As mentioned earlier in this section, a Mitigation Action Plan was prepared to develop specific actions to achieve the seven goals discussed in Section 8.2, Mitigation Goals and Accomplishments. The Action Plan identified an appropriate lead person for each action, a schedule for completion and possible funding sources. For the 2012 Plan update, the process that the MPC chose to help them consider potential action items in a systematic way was the **S**ocial, **T**echnical, **A**dministrative, **P**olitical, **L**egal, **E**conomic, and **E**nvironmental (STAPLEE) Method. This method helped the MPC to weigh the pros and cons of different alternative actions for each of the identified objectives and strategies. Table 8.4-1 provides an explanation of the criteria used for the STAPLEE methodology.

Table 8.4-1
STAPLEE Methodology

STAPLEE	Criteria Explanation
S – Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T – Technical	Mitigation actions are technically most effective if they provide long- term reduction of losses and have minimal secondary adverse impacts.
A – Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P – Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L – Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E – Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E - Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with Federal, State, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

The Anne Arundel County Office of Emergency Management (OEM) in coordination with the HMPC members developed and prioritized the strategies from the original HMP. For the 2018 update, the Action Plan from the 2018 version was distributed to the Committee, and members were requested to update and provide comments. These updates and comments were integrated into the 2018 version. The action items in Table 8.4-2 were prioritized by the HMPC based on the STAPLEE criteria, as well as their potential to reduce risk to the County, including its citizens, operations, and physical assets. As mentioned above, many of the actions included in the original HMP have been re-defined as strategies (See Section 8.3, Mitigation Objectives and Strategies). The highest priority actions are those that are most effective in reducing risks to multiple assets simultaneously.

The Steering Committee defined High, Medium, and Low priorities in the Action Plan to be as follows:

- High: Meets five of the seven STAPLEE criteria
- Medium: Meets four of the seven STAPLEE criteria
- Low: Meets three of the seven STAPLEE criteria

These same priorities were applied to update the Action Plan. The action items were sorted by high, medium, and low. As discussed in Section 7 (Risk Assessment), a key criterion in Anne Arundel County's prioritization of actions is the cost-effectiveness of actions and projects. High-priority actions and projects are assessed for feasibility and cost-effectiveness to determine if they are good candidates for mitigation actions. Cost effectiveness will continue to be central to the County's decision-making processes in identifying and funding mitigation actions. The table below includes all the specific actions listed in the original version of the HMP, and indicates their present status. There are also several new and ongoing projects and actions.

All of the original actions remain in the tables for reference purposes. Completed actions are noted in the status column. A few projects in the action table were identified from the 2012 Anne Arundel County Capital Budget Program. For these actions, the project reference number from the Capital Budget Program document has been included in the action item description column.

It is notable that the County has completed or is presently working on most of the actions that were listed in the 2004 version of the HMP, and as a result has made further advances in protecting its infrastructure and citizens against losses from natural hazards.

Table 8.4-2
Anne Arundel County: High, Medium, and Low Priority Mitigation Actions

H = High (Meets at least 5 STAPLEE criteria)				M = Medium (Meets at least 4 STAPLEE criteria)			L = Low (Meets 3 of fewer STAPLEE criteria)		
No.	**Priority**	**Action Item Description/ Benefits**	**Lead Department**	**Funding/ Support**	**Schedule**	**Hazard**	**Cost-Effectiveness**	**Status as of 2018**	**Type**
1	H	Update and adopt local Emergency Operations Plan (EOP)	Office of Emergency Management	UASI Regional Planning Grant and AA County operating budget	2018	Multi-Hazard	Cannot be determined; presumed highly cost-effective	2018 update: Completed July 2018 2020 update: In process of obtaining all Agency and Department Head signatures; expect to submit to County Council in fall 2020.	Local Plans and Regulations
2	H	Adopt future updates of International Building Code	Inspections and Permits	AA County operating budget	Ongoing	Multi-Hazard	Highly cost-effective reduces risk to existing buildings and future infrastructure as well as limit risk to new development and redevelopment	2018 update: Ongoing and as needed.	Local Plans and Regulations
3	H	Cape St. Claire – Stormwater Runoff Controls (Project #D381800)	Dept. of Public Works	AA Co Capital Improvement Bonds $4.71 M (est)	2012	Flood	Generally-cost effective, although sub-projects not examined on a case-by-case basis	2018 update: project completed. 2020 update: No further reporting required. Project complete.	Infrastructure Project
4	H	Assure back-up power source at Public Shelters (Project #C541200)	Office of Emergency Management	AA Co Capital Improvement Bonds $265,000 (est)	2018	Hurricane/Tropical Storm, Tornadoes, Flood	Depends on potential usage, but presumed highly cost-effective because of life-safety considerations.	Five shelter locations have been identified at County High School Sites. Two (Annapolis and Severna Park) have been wired for backup generators.	Infrastructure Project

H = High (Meets at least 5 STAPLEE criteria)				M = Medium (Meets at least 4 STAPLEE criteria)			L = Low (Meets 3 of fewer STAPLEE criteria)		
No.	**Priority**	**Action Item Description/ Benefits**	**Lead Department**	**Funding/ Support**	**Schedule**	**Hazard**	**Cost-Effectiveness**	**Status as of 2018**	**Type**
5	M	Shoreline Erosion Control (Project # P468700)	Dept. of Public Works	AA Co Capital Improvement Bonds $9.3 M (est.)	Ongoing as annual funding is available	Flood, Coastal Flood	Difficult to assess, but presumed low to moderate cost-effectiveness with usual criteria; long-term somewhat more cost-effective because of potential for significant erosion from a major surge event	Ongoing year-to-year, and as budget is available. Some projects completed annually. 2018 update: remains an ongoing activity. 2020 update: remains an ongoing activity	Natural Systems Protection
6	M	Shipley's Choice Dam Rehab (Project #Q543001)	Dept. of Public Works	AA Co Capital Improvement Bonds $5.6 M (est.)	Completion in 2020	Flood	Limited because of low probability of significant failure.	As of early 2018, the project design is 99% complete. Construction start for culvert improvements along West Benfield Road is anticipated To be complete in April 2020. Removal of the existing dam should begin in mid 2020.	Natural Systems Protection
7	M	Emergency Storm Drain Measures (Project #B551700)	Dept. of Public Works	AA Co Capital Improvement Bonds $6.5 M	Ongoing, as needed	Flood	Varies and depends on specific project site and conditions.	This project involves the installation of storm drain inlets, manholes, pipes, small culverts and systems to provide for immediate relief to localized ponding or flooding of roads, public infrastructure and private properties subject to runoff from public facilities. Projects initiated as needed. 2018 update: remains an ongoing activity. 2020 update: remains an ongoing activity.	Infrastructure Project

H = High (Meets at least 5 STAPLEE criteria)				M = Medium (Meets at least 4 STAPLEE criteria)			L = Low (Meets 3 of fewer STAPLEE criteria)		
No.	**Priority**	**Action Item Description/ Benefits**	**Lead Department**	**Funding/ Support**	**Schedule**	**Hazard**	**Cost-Effectiveness**	**Status as of 2018**	**Type**
8	H	Multiple Storm Drains: Storm Drainage Stormwater Management Infrastructure (Project #B551800)	Dept. of Public Works	AA Co Capital Improvement Bonds $13.4 M (est.)	Ongoing, as needed	Flood, Coastal Flood	Varies and depends on specific project site and conditions.	This project involves the study, design and construction of large, regional storm drain systems and stormwater management infrastructure to relieve widespread ponding or flooding of public and private properties and existing public infrastructure. This project also involves repair, rehabilitation and replacement of major culverts that are beyond their useful life. Projects initiated as needed. 2018 update: remains an ongoing activity. 2020 update: remains an ongoing activity.	Infrastructure Project
9	H	Harmans Road Culvert replacement (Project #D515600)	Dept. of Public Works	AA Co General County Bonds and General Fund PayGo $1.63 M	2011	Flood	Moderate cost-effectiveness	2018 update: project completed. 2020 update: project complete; no further reporting required.	Infrastructure Project
10	M	Conduct tabletop, functional, and full-scale disaster exercises	Office of Emergency Management	AA County OEM Operating budget	Ongoing	Multi-hazard	Cannot be determined; adds to County's preparation for disasters	The County has a three-year training and exercise plan, and conducts training and exercises frequently with both County and non-County partners. Training includes WebEOC, teleconferences at least two and as many as four times per year, and full scale at least once a year. 2020 update: Tabletop and Functional exercises were completed in May and June 2019 respectively. A full scale disaster exercise is scheduled for June 2020.	Local Plans and Regulations

H = High (Meets at least 5 STAPLEE criteria) M = Medium (Meets at least 4 STAPLEE criteria) L = Low (Meets 3 of fewer STAPLEE criteria)									
No.	**Priority**	**Action Item Description/ Benefits**	**Lead Department**	**Funding/ Support**	**Schedule**	**Hazard**	**Cost-Effectiveness**	**Status as of 2018**	**Type**
11	M	Increase public awareness on natural hazards affecting the county and actions the public can take to mitigate risk	Office of Emergency Management	AA County OEM Operating budget	Ongoing	Multi-hazard	Cannot be determined; presumed highly cost-effective because action has general effectiveness in reducing damages and preventing injuries and loss of life.	Completed and Ongoing: OEM has an all-hazards emergency preparedness program including community presentations, website, Facebook and twitter and materials from FEMA, and the Ready, Set, Good Campaign that includes information about multiple hazards. 2018 update: See item 3 in Table 8.3-1 and other items related to dissemination of hazards materials to the public.	Education and Awareness Program
12	M	Fort Smallwood Shore Restoration (CIP P468700)	Dept. of Recreation and Parks	AA Co Capital Improvement Bonds	2012 +	Shoreline erosion	Moderate; benefits include avoided regular maintenance, and loss of use, periodic damages from major storms.	Project is phased based on availability of funding and identified as Reach 1, 2 and 3. Reach 1: Bid Documents Reach 2: Design Reach 3: Construction Complete.	Natural Systems Protection
13	H	Certified Climate Change Professional (CC-P) Credential	OEM, OPZ	AA County Operating and Training budgets	2020+	Resiliency, Climate Change, Sea Level Rise	Highly cost effective – builds Climate Change competencies into local planners	Staff from OEM and OPZ are in the process of obtaining their CC-P credential to develop skills and knowledge to support climate change initiatives into their decision-making and professional activities.	Local Plans and Regulations
14	H	Build Community Resilience	OEM, OPZ, DPW, I&)	AA County Operating budget	2022	Multi-Hazard	Cost effective - reduces risk to existing buildings and future infrastructure as well as limits risk to new development and redevelopment	Departments will review existing codes, policies, plans, and standard practices and incorporate hazard mitigation and Climate Change policies and strategies into related Building, Construction, and Development Codes and Plan updates.	Local Plans and Regulations
15	M	Climate Change Action Plan	OEM, OPZ, DPW, I&P	AA County Operating budget	2021	Multi-Hazard	Cost effective - builds Climate Change into local Zoning and General Development Plans and Codes	Adopt a local Climate Change Action Plan that identifies the goals, policies, and strategies of the County that guides local comprehensive planning, building, construction, and development codes and policies related to climate change and sea level rise on property, life, and critical infrastructure in the County.	Local Plans and Regulations

H = High (Meets at least 5 STAPLEE criteria) M = Medium (Meets at least 4 STAPLEE criteria) L = Low (Meets 3 of fewer STAPLEE criteria)									
No.	**Priority**	**Action Item Description/ Benefits**	**Lead Department**	**Funding/ Support**	**Schedule**	**Hazard**	**Cost-Effectiveness**	**Status as of 2018**	**Type**
16	M	Long-term critical infrastructure vulnerability reduction	OEM, OPZ, DPW, I&P	AA County Operating budget	2022	Multi-Hazard	Cost effective - reduces risk to existing infrastructure	Assess the impacts of sea level rise and climate change on the existing water and sewer infrastructure; Identify at-risk roads, bridges and other infrastructure vulnerable to flooding, sea level rise, and climate change; Identify mitigation projects and funding sources to address existing and future hazards; Develop design criteria for future infrastructure to be resilient to climate change and sea level rise.	Infrastructure project
17	H	NWS StormReady program	OEM	AA County Operating budget	2020	Multi-Hazard	Cost effective - builds more resilient communities through education and awareness	2020 Completed Staff will maintain the StormReady recognition with FEMA, which qualifies the County to receive credits in NFIP community rating system	Education and Awareness Program
18	H	Mitigation actions and project progress report	OEM, OPZ, DPW, I&P	AA County Operating budget	2021, 2022	Multi-Hazard	Cost effective - reduces risk to existing buildings as well as limits risk to new development and redevelopment	The Planning Team will report on mitigation actions/ projects toward achieving the goals and strategies of HMP and in climate change resilience planning.	Structure and Infrastructure projects
19	H	Hazard Mitigation Planner (new County position)	OEM	AA County Operating budget	10/2020	Multi-Hazard	Cost effective - builds hazard mitigation planning competencies within the County	Monitor and track mitigation actions, projects, and incorporation of strategies into local building and construction codes, GDP, and Floodplain Management program; Review the HMP on an annual basis; Update the HMP, as needed, or at least once every 5 years. Local Plans and Regulations	Local Plans and Regulations
20	H	Update General Development Plan, Plan 2040	OPZ	AA County Operating budget	2021	Multi-Hazard	Cost effective - reduces risks to existing buildings and future infrastructure as well as limits risk to new development and redevelopment	Adopt a local General Development Plan that limits or restricts the extent of future development in areas subject to flooding and to sea level rise.	Local Plans and Regulations

H = High (Meets at least 5 STAPLEE criteria)		M = Medium (Meets at least 4 STAPLEE criteria)				L = Low (Meets 3 of fewer STAPLEE criteria)			
No.	**Priority**	**Action Item Description/ Benefits**	**Lead Department**	**Funding/ Support**	**Schedule**	**Hazard**	**Cost-Effectiveness**	**Status as of 2018**	**Type**
21	M	Shoreline Restoration	OEM, OPZ, DPW, I&P	AA County Operating budget	2022	Erosion, Sediment Control	Cost effective - reduces future risk to shorelines for County funded shoreline projects	Adopt local standards to incorporate living shoreline techniques, where possible, for County funded shoreline restoration projects.	Local Plans and Regulations
22	H	Adopt Hazard Mitigation legislation	OEM, OPZ, DPW, I&P	AA County Operating budget	2022	Multi-Hazard	Cost effective - reduces risk to existing buildings and future infrastructure as well as limits risk to new development and redevelopment	The County will consider future legislation that limits new construction, substantial improvements, and future development in high risk and hazard prone areas within the county.	Local Plans and Regulations
23	M	Acquire repetitively flooded structures and non-repetitive loss structures	OEM, OPZ, DPW, I&P	Federal and State grant funding opportunities	As deemed necessary	Flooding	Prohibitively expensive - reduces potential loss of human life and future risk of damage to existing buildings from flooding	The County will pursue funding following a Presidential Disaster Declaration, upon request and when deemed necessary for specific projects in the County.	Acquisition of repetitive loss (RL) properties to flooding
24	M	Facilitate the elevation of repetitively flooded structures	OEM, OPZ, DPW, I&P	Federal and State grant funding opportunities	As deemed necessary	Flooding	Generally considered prohibitively expensive and a time-consuming process - reduces potential loss of human life and future risk of damage to existing buildings from flooding	The County will develop strategies to facilitate the elevation of repetitively flooded structures following a Presidential Disaster Declaration, and pursue funding, upon request and when deemed necessary for specific projects in the County.	Structure project
25	H	Maintain local capability to respond to natural hazards	Local County Agencies and Departments	AA County Operating budget	Ongoing	Multi-Hazard	Highly cost effective builds more resilient communities and reduces potential loss of human life and risk of future damage to existing buildings	Multi-Year Training and Exercise Plan 2020-2022 was adopted; Operations, Logistics, and Planning capability assessment training was completed in 2018; review and adoption of all Agencies and Departments COOP Plans;	Local Plans and Regulations

H = High (Meets at least 5 STAPLEE criteria)		M = Medium (Meets at least 4 STAPLEE criteria)				L = Low (Meets 3 of fewer STAPLEE criteria)		
No.	**Priority**	**Action Item Description/ Benefits**	**Lead Department**	**Funding/ Support**	**Schedule**	**Hazard**	**Cost-Effectiveness**	**Status as of 2018**	**Type**
26	H	IPAWS certification	OEM	AA County Operating budget	2020	Multi-Hazard	Highly Cost effective - provides timely notification to the public of hazards within targeted areas of the County	Completed: Anne Arundel County received FEMA certificate (2020) and conducts monthly testing of the Integrated Public Alert Warning System to alert and warn the public of natural and man-made hazards affecting the County	Education and Awareness Program
27	H	Enforce local floodplain ordinance	I&P, OPZ	AA County Operating budget	Ongoing	Flooding	Highly cost effective - reduces risk to future development and redevelopment of property in the floodplain	Anne Arundel County is a participating member of the National Flood Insurance Program (NFIP). The County has adopted and enforces local ordinances that meet FEMA requirements that minimizes loss of human life and damage to property from the flooding. The County will continue to actively participate in the NFIP and enforce the local floodplain ordinance.	Local Plans and Regulations

Section 9
Plan Monitoring and Maintenance

Contents of this Section

9.1 IFR Requirements for Plan Monitoring and Maintenance

44 CFR § 201.6 Local Mitigation Plans (4) (the) plan maintenance process (shall) include:

(i) *A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.*

(ii) *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.*

(iii) *Discussion on how the community will continue public participation in the plan maintenance process.*

9.2 Method and Schedule for Monitoring and Updating the Plan

As part of the FY20221 budget, the Office of Emergency Management is requesting approval of a new County position, which will serve as the Hazard Mitigation Planner for the County. The new Hazard Mitigation Planner will be responsible for monitoring, evaluating, and updating the Hazard Mitigation Plan (HMP) to keep the HMP current. The job duties and responsibilities of the Hazard Mitigation Planner will include the following:

1. Monitor and track the implementation of High, Medium, and Low Priority Mitigation Actions and projects identified in Table 8.4-2, and the County's progress towards incorporating the hazard mitigation goals and strategies into local building and construction codes, the General Development Plan, and the Floodplain Management program.
2. Evaluating the HMP on an annual basis to ensure its continued effectiveness in achieving the stated purpose, goals, mitigation strategies and actions that best addresses the needs of the community.
3. Undertaking a full review and update of the Hazard Mitigation Plan at a frequency of once every 5 years to ensure the County is in compliance with FEMA, the Maryland Hazard Mitigation Plan and other

planning requirements, which maintains the County's eligibility for federal disaster assistance funding and hazard mitigation grants. Following approval of the 2018 HMP update, the Hazard Mitigation Planner will be responsible for completing the following activities:

- Initiating and undertaking a public information, outreach, and stakeholder campaign to engage partners, stakeholders, and citizens in the planning and update process of the HMP, and ensure the final HMP represents the needs of the community.
- Managing and coordinating a series of public meetings to include a public comment period and maintenance of all public records, documents and comments related to public meetings, and the public information, outreach, and stakeholder campaign; providing access to current and proposed HMP documents at local libraries and on the OEM website; and ensuring sufficient opportunity is provided to receive public input and participation in the planning, update, and maintenance of the HMP. Each public meeting will cover the following topics and key issues:
    - An overview of the Federal requirements to receive assistance following a disaster and purpose of Hazard Mitigation planning;
    - The types of natural hazards that are likely to impact the County;
    - The potential effects and losses to property and life from the identified natural hazards;
    - The number of claims made to the National Flood Insurance Program since 1977;
    - The mitigation goals, strategies, actions and projects the County is considering for the upcoming cycle that is expected to reduce potential damages and losses from natural hazards;
    - The location(s) of the current Hazard Mitigation Plan and materials for public comment and review; and
    - The public comment period and manner in which public comments will be collected by the County.
- Utilizing information technology, information systems and social media to disseminate, collect and assess public input and comments;
- Announcing public meetings, work sessions, and public hearings using electronic and print media to engage the media and broader participation by the public and ensure the update of the HMP represent the needs of the community;
- Reviewing and documenting the HMP should the County be impacted by a disaster for which there is a Presidential Disaster Declaration to capture any "lessons learned" and to ensure the evolution of the document continues to meet the needs of the community. Review of the HMP following a disaster declaration will consider the following:
- Assess what mitigation actions and projects should be considered by the County to reduce or prevent future losses and damage to property, infrastructure, critical facilities, and other vulnerable structures that were experienced in the community during the disaster event.
- Based on the assessment, recommend mitigation strategies, actions, and projects to be included in the maintenance and update of the HMP.

The Office of Emergency Management (OEM) will remain the lead agency for coordination of future HMP updates and planning activities.

- Future HMPC, partners, and stakeholders will continue to serve in the same capacity as provided in Section 5. Additional partners and stakeholders beneficial to serving in the planning process may be identified by the HMPC and the Hazard Mitigation Planner for future HMP updates.

The Hazard Mitigation Planner will ensure Highland Beach understands it must formally adopt the HMP in order for the jurisdiction to be included in the Plan, and to remain eligible for certain types of FEMA disaster assistance.

9.3 Circumstances that will Initiate Plan Review and Updates

This section identifies additional circumstances or conditions, other than the scheduled 24-month review or a disaster event occurrence, under which the County will initiate HMP reviews and updates.

- On the recommendation of the Office of Emergency Management, or on its own initiative, the County Council may initiate an HMP review at any time.
- When activities of Anne Arundel County, or other jurisdictions including the State, significantly alter the potential effects of natural hazards on County assets, operations and/or constituents. Examples include when mitigation projects are completed, when public works or building projects are initiated in other areas and negatively impact the County, and when laws or regulations are changed.
- When new mitigation opportunities or sources of funding are identified.

9.4 Continued Public Involvement

As described above, the County will undertake an annual HMP review process in order to ensure the document reflects the most current understanding of natural hazard risks, and the County's priorities in addressing them. The annual HMP update process will incorporate an inclusive and open process in which public participation is solicited and encouraged. This will be initiated by the County posting notice describing the review process, and how the public may be involved. The notice will be published in the local newspaper and posted on the County's website. It will include a detailed description of the HMP and its purpose, how it was developed, the update process, and the ways in which the public may participate. The notice will include a link to the existing mitigation plan, and also a means by which the public may review a paper version. The notice will also include an explanation of how the public can ask questions and comment on the document, changes that are proposed, and how to provide additional input for consideration in the update. The County will encourage telephone calls, emails and written comments, and will provide all necessary contact information. There will be at least one public presentation and meeting regarding the plan update, and the public will be advised of this via notice in the local newspaper, and on the County website.

The County will compile input from the public responding to the notice of the annual review, and will include this in materials provided to the HMPC as it undertakes the review and update process. Although not all the input will necessarily make it into the HMP, the County will summarize it in the plan, and retain it for future reference, as appropriate.

If changes are made to the HMP (other than as a result of the annual review process described above), the Hazard Mitigation Planner will post the changes in a location where the public can easily access the information, provide feedback and make comments. The public will be provided with a 30 day comment period before any

proposed changes become final. Before comments are incorporated in the HMP, the Hazard Mitigation Planner will review and provide recommendations to the HMPC on the number and type of public comments received.

A copy of the most recently approved HMP will stay posted on the County's website until a new update occurs or changes are made. A copy of the document will also stay on file with OEM, and be accessible to the public by calling or emailing OEM and requesting to review it. The County will continue to monitor opportunities for the public to become involved in hazard mitigation planning through attendance at small area planning meetings, and through targeted public outreach. Comments received by OEM will be documented and retained as an official record until final approval of the HMP update is granted by FEMA

Appendix A National Flood Insurance Program Claims Data and Maps

Contents of this Appendix

7.1 The National Flood Insurance Program in Anne Arundel County

FEMA's National Flood Insurance Program is the predominant flood insurer in the U.S. The Program maintains a very large database of claims information for millions of policies nationwide. As of 2018 Anne Arundel County participates in the NFIP, but not in FEMA's Community Rating System (CRS).

According to the FEMA website[1], as of October 2017, there are 5,496 NFIP flood insurance policies in force in Anne Arundel County. The total value of written policies in force was $1,536,909,600, and the written premiums-in-force total $3,620,626.

FEMA maintains detailed records of flood insurance claims, dating back to the late 1970s, and while these records cannot by definition characterize flood risk with complete accuracy (because not everyone in the County that floods is insured, and because insurance does not always cover all losses even when claims are paid), they nevertheless offer excellent insights into the locations and magnitudes of claims over long periods of time. This is a good way to understand risks from a spatial perspective, as the series of maps below shows. The first such map (Figure A-1) shows all claims in the County extending back to 1977. Note that the majority of the claims over the entire time period appear to be in coastal areas, suggesting that flood issues in the County are predominately related to coastal events such as storm surges and nor'easters.

FEMA and the NFIP categorize policies in several ways, as part of their ongoing effort to focus mitigation program resources on properties with the highest risk. One such category is *Repetitive Loss* properties, which are defined as those that have been paid at least two claims of $1,000 or more over a rolling ten-year period. In recent years, FEMA has focused considerable attention on these insured, Repetitive Loss properties. By NFIP standards, these properties have received two or more claim payments of at least $1,000 each over a rolling ten-year period. As part of this HMP update, the County asked MEMA/FEMA to update the County Repetitive Loss list. As of February 2018, Anne Arundel County has a total of 93 properties classified as Repetitive Loss. For these 93 properties, a total of 228

1 https://bsa.nfipstat.fema.gov/reports/1011.htm#MDT

insurance claims have been filed for a total of $6,764,627. Section 7 of this HMP includes additional detailed discussion about flood risks and repetitive loss properties.

There are three general categories of NFIP claims data:

1. All NFIP Insurance Claims
2. NFIP Repetitive Loss (RL) Properties
3. NFIP Severe Repetitive Loss (SRL) Properties

The overall insurance claims database reflects all structure and contents flood insurance claims paid by the NFIP, in this case from the beginning of the program in 1977.

The Repetitive Loss category 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.

The Severe Repetitive Loss category is defined as any insurable building with four or more separate claim payments of more than $5,000 each (including building and contents payments); or two or more separate claim payments (building payments only) where the total of the payments exceeds the current value of the property. In either case, two of the claim payments must have occurred within 10 years of each other. Multiple losses at the same location within 10 days of each other are counted as one loss, with the payment amounts added together.

Table A-1 summarizes current NFIP statistics for Anne Arundel County.

Table A-1 National Flood Insurance Program Claims Data for Anne Arundel County, as of February 2018 (Source: Maryland Emergency Management Agency and Federal Emergency Management Agency)

All Properties (1977 – 2018) 1,584 (1) 1,681 $43,713,389 $26,004 Repetitive Loss Properties 93 228 $6,764,627 $29,669 Severe Repetitive Loss Properties 4 19 $523,996 $108,753

Note 1. Note that the total of all properties with claims going back to 1977 is the total number of claims in the FEMA database less the repetitive loss and severe repetitive loss property count. The structure of the data did not allow the figure to be counted directly from the reporting output, but this figure is approximately correct.

The next series of Figures (A-1 through A-9) shows NFIP insurance claims in Anne Arundel County. Note that the periods vary because in some cases long stretches passed with few claims, and in other cases a single year comprised more than a thousand claims (2003, Hurricane Isabel).

Anne Arundel County, Maryland -- *2018 Hazard Mitigation Plan Update*
Appendix A National Flood Insurance Program Claims Data and Maps

Figure A-1 NFIP Claims in Anne Arundel County, 1977-2017

Appendix A National Flood Insurance Program Claims Data and Maps

Figure A-2 NFIP Claims in Anne Arundel County, 1997 - 2001

Figure A-3 NFIP Claims in Anne Arundel County, 2003

Figure A-4 NFIP Claims in Anne Arundel County, 2004 - 2009

Figure A-5 NFIP Claims in Anne Arundel County, 2010

Figure A-6 NFIP Claims in Anne Arundel County, 2011

Figure A-7 NFIP Claims in Anne Arundel County, 2012 – 2013

Figure A-8 NFIP Claims in Anne Arundel County, 2014

Anne Arundel County, Maryland -- *2018 Hazard Mitigation Plan Update*
Appendix A National Flood Insurance Program Claims Data and Maps

Figure A-9 NFIP Claims in Anne Arundel County, 2015 - 2017

Appendix B
Hazard Mitigation Planning Committee Meeting Minutes

Contents of this Appendix

B.1 Hazard Mitigation Planning Committee Meeting Minutes

Minutes of the Hazard Mitigation Planning Committee Meeting, March 9, 2018

These minutes summarize proceedings of the March 9, 2018 meeting of the Anne Arundel County Hazard Mitigation Planning Committee (HMPC). A sign-in sheet is attached to these minutes. Participants included:

Ms. Christina Cornwell	Anne Arundel County Office of Emergency Management
Ms. Lynn Miller	Anne Arundel County Department of Planning & Zoning
Mr. Bill Bryant	Anne Arundel County Department of Inspections & Permits
Ms. Nancy Noonan	Anne Arundel County Department of Central Services
Mr. Jason Fetterman	Anne Arundel County Office of Law
Mr. Steve Pardue	Antares Planning Group (consultant)

1. Introductions

Mr. Pardue opened the meeting. All the participants introduced themselves and signed in. **Task 1**: Mr. Pardue will include the sign-in sheet with the meeting minutes.

2. **Background and current status of plan update**

Mr. Pardue provided a detailed explanation of the purpose and structure of the plan update process, and a brief background regarding the legislation that established the requirement for a hazard mitigation plan. This is Anne Arundel County's second plan update. **Tasks:** none.

3. Role of the Office of Emergency Management

The Anne Arundel County Office of Emergency Management is responsible for managing the planning process and ensuring that the plan update is completed on time, and that all FEMA requirements are addressed. **Tasks:** none.

4. **Role of the Hazard Mitigation Planning Committee**

The Hazard Mitigation Planning Committee comprised of the County representatives who are listed at the top of this agenda. The group is responsible for reviewing and approving plan update drafts, and for providing technical information and guidance on specific elements of the plan. In addition to the individuals included on this memo, the HMPC indicated that Karen Henry (Public Works, to be verified) and Owen McElvoy (County Executive Office) will be added as members of the HMPC. **Task 1:** Mr. Pardue will add these individuals to the HMPC list in the plan update, after verification.

5. Role of Consultant

The County contracted with Antares Planning Group to carry out many of the basic tasks of the mitigation plan update. Antares is responsible for updating all sections, and for overall coordination of the process, including interactions with the HMPC, coordination with various County Departments and staff, maintaining notes and minutes about the process, public presentations, and preparing draft and final plan update documents. **Tasks:** none.

6. Role of Stakeholders

The stakeholders are a combination of various organizations in and around the County, including the school district, chamber of commerce, surrounding Counties, various County departments, etc. **Task 1**: Ms. Cornwell will review the list of stakeholders from the last plan update, and provide Mr. Pardue with a revised list of stakeholders, and contact information. **Task 2:** Mr. Pardue will prepare an initial email to be sent to stakeholders by the County.

7. Overall update process and schedule

The overall update process, including state and FEMA reviews, is projected to take approximately one year. Mr. Pardue will provide a draft schedule to the HMPC in the near future. The first milestone is a draft version of the updated document, the target date for which is early June. At that point, the HMPC will reconvene and approve the draft, and a public presentation will be delivered. The date of the early June meeting will be determined by consensus of the HMPC. **Task 1:** Mr. Pardue will propose a date for the second HMPC meeting. **Task 2:** HMPC members will respond with preferred dates for the second meeting. **Task 3:** Mr. Pardue will provide a proposed plan update schedule to the HMPC.

8. Public meetings/presentations

FEMA has a requirement that communities completing plan updates must provide information to communities about the process and outcomes. This is nearly always satisfied by one public presentation at the draft plan stage, and a public notice and placement of final draft documents near the end of the process. The HMPC concurred this is acceptable for the County plan update. **Task 1:** Mr. Pardue will prepare presentation materials for the first meeting, and conduct the presentation at a time and place to be determined. He will also prepare a legal notice for publication in the local newspaper and County website.

Task 2: Ms. Cornwell will ensure the legal notice is posted. **Task 3:** Mr. Pardue will prepare all final draft materials for community review as the process concludes.

9. Communications

Aside from periodic meetings, communications with the HMPC will be via email. Communications with stakeholders will be via email. **Tasks:** none.

10. Review of specific plan sections

- **Approval and Adoption.** Mr. Pardue briefly discussed the required approval and adoption processes. **Task 1:** Mr. Pardue will circulate to the HMPC the approval and adoption section from the current version of the mitigation plan. **Task 2:** The HMPC will review the section and provide comments as needed.

- **Planning Process.** Mr. Pardue provided a brief background about the overall planning process and FEMA statutes and guidance that determine the process and contents of a plan. **Tasks:** none.

- **Hazard Identification and Risk Assessment.** This section of the plan is one of the most important. It includes descriptions of hazards that can affect Anne Arundel County, and a prioritization process for determining which hazards are afforded a risk assessment. The HMPC reviewed the list of 12 overall hazards and concurred that it is still appropriate and should be included in the update. There was some discussion about recent earthquake activity. Mr. Pardue indicated that this would be added to the hazard history section. **Tasks:** none.

- **Risk Assessment.** The risk assessment section of the plan update provides quantitative projections of future losses. It is among the most important sections of the plan. The structure of this section will be retained, with new calculations to incorporate the most current data. This will include National Flood Insurance Program information, which is an area of FEMA emphasis. **Task 1:** Mr. Pardue will prepare a request for updated NFIP information to MEMA and FEMA. **Task 2:** Ms. Cornwell will send the request to MEMA and FEMA after determining appropriate points of contact at the agencies.

- **Mitigation Strategy.** The mitigation strategy section of the plan provides information on the various actions the County is undertaking to reduce damages from natural hazards. This section requires extensive updating to reflect the current status of projects and actions that were listed in the current version of the plan. **Task 1:** Mr. Pardue and Ms. Cornwell will review the section and

determine how best to divide it, so that appropriate County representatives can be contacted for information about projects. **Task 2:** After Task 1 is completed, Mr. Pardue will send emails to specific department representatives to request status information on projects and actions. This part of the plan will be updated based on the responses.

- **Monitoring.** Mr. Pardue described the required monitoring and update process. **Tasks:** none.

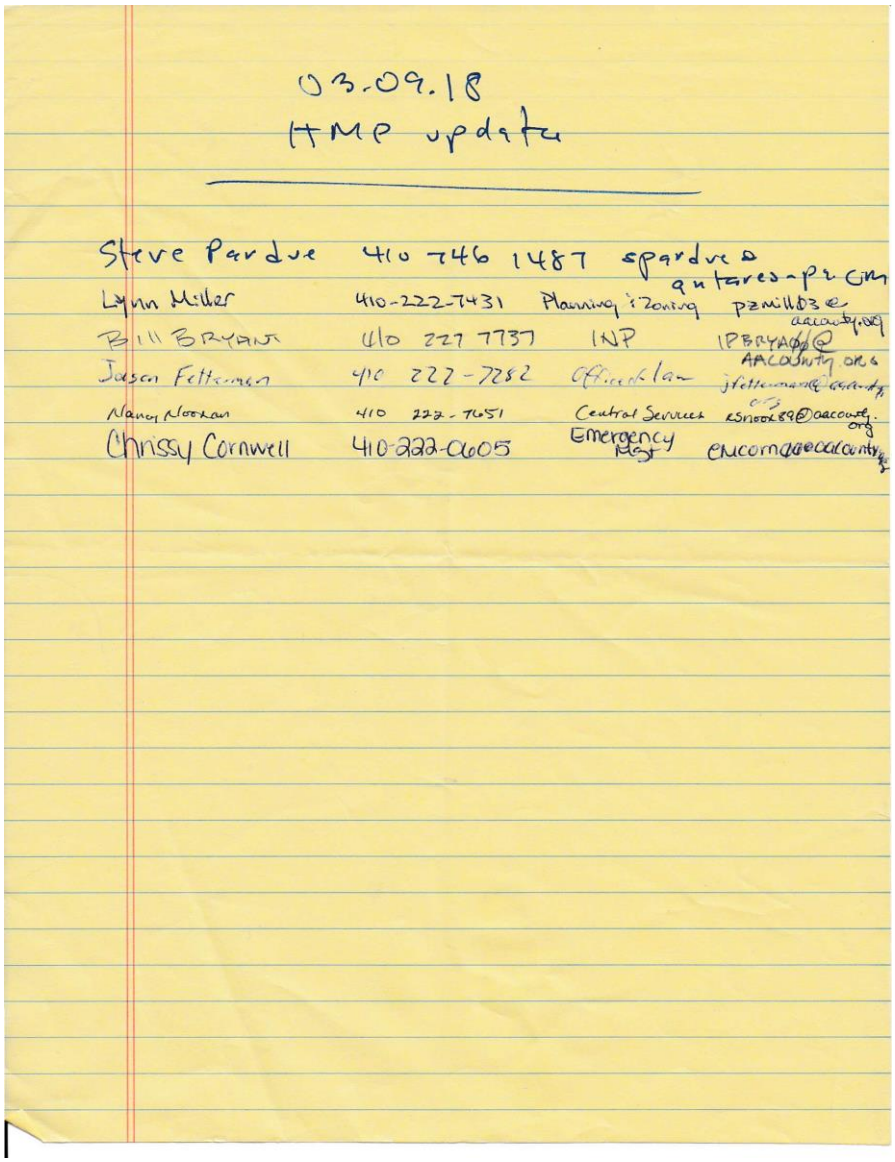
11. Questions and feedback

There was no further discussion. **Tasks:** none.

12. Adjourn

The meeting adjourned at 2:00 p.m. **Tasks:** none.

Figure B-1
Sign-in Sheet, March 9, 2018 Anne Arundel County HMPC Meeting



03.09.18
HMP update

Steve Pardue	410 746 1487		spardue@aacounty.org
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Bill Bryant	410 222 7737	INP	IPBRYA00@AACounty.org
Jason Fetterman	410 222-7282	Office of Law	jfetterman@aacounty.org
Nancy Noonan	410 222-7651	Central Services	RSNOOK89@aacounty.org
Chrissy Cornwell	410-222-0605	Emergency Mgt	EMCORN00@aacounty.org

Minutes of the Second Hazard Mitigation Planning Committee Meeting, June 4, 2018

These minutes summarize proceedings of the June 4, 2018 meeting of the Anne Arundel County Hazard Mitigation Planning Committee (HMPC). A sign-in sheet is included at the end of these minutes. Participants included:

Ms. Christina Cornwell	Anne Arundel County Office of Emergency Management
Ms. Karen Henry	Anne Arundel County Department of Public Works
Ms. Lynn Miller	Anne Arundel County Office of Planning & Zoning (call-in)
Mr. Jason Fetterman	Anne Arundel County Office of Law (call-in)
Mr. Steve Pardue	Antares Planning Group (consultant)

1. Current status of HMP update

The consultant provided a detailed overview of the current status of the hazard mitigation plan update. He explained that all sections of the plan have been updated in accordance with FEMA requirements. There was a particular focus on three sections: hazard identification, risk assessment and mitigation strategies. The hazard identification section was updated to reflect various hazard events that have impacted the County since the last version of the HMP was approved and adopted in 2012. There have been only a few such events that caused damage. The consultant noted that one of the best sources of hazard information, NOAA's National Climatic Data Center, appears to have changed some of its data collection and reporting methodologies, with the result that there are some inconsistencies in the organization's reporting periods. This is explained in various parts of the County HMP.

The hazard identification section was updated to include Hurricane Sandy and two recent, significant winter storms, and various other data points from the NOAA/NCDC database. The risk assessment section was updated to include new data values, with a particular focus on FEMA National Flood Insurance Program information that was obtained through the Maryland Emergency Management Agency (MEMA). That information shows flood insurance claims information for the County going back to 1977. The data clearly show that there was been a marked decrease in the average annual number of claims since the last version of the HMP was approved. This is mostly due to the region having experienced only a few coastal storms in the period. The mitigation strategy section was updated to show the current status of a range of actions and projects that were included in the 2012 version of the mitigation plan, and to add various strategies and actions for the new version.

The consultant briefly discussed other sections of the mitigation plan update, most of which were substantially unchanged from the last version. There were no questions. Karen Henry indicated that she would be providing input for several additional mitigation actions that should be included in the strategy section. These will be incorporated. Tasks: None, and see below.

2. Public meeting/presentation

There is a public meeting/presentation regarding the HMP update scheduled for June 4 at 6:30 p.m.

3. Remaining tasks

- **HMPC draft review and comment.** The draft HMP document has been sent to all the HMPC members for review. After a two-week review period, any suggested changes will be evaluated and incorporated into the document. **Task 1:** HMPC members to review the document and provide comments. **Task 2:** Consultant and County OEM to review comments.
- **Incorporate HMPC comments.** After the HMPC comments have been compiled, evaluated and reconciled, they will be incorporated into the draft HMP. Task 1: Consultant to incorporate comments and other new data into the HMP.
- **Outreach to stakeholders.** After the plan has been updated, the Stakeholder group will be offered an opportunity to review it and provide input. **Task 1:** Consultant and County OEM to determine best method to distribute the HMP to stakeholders and solicit comments.
- **Incorporate any stakeholder input.** Stakeholder feedback to be incorporated into draft HMP. **Task 1:** Consultant to incorporate stakeholder feedback and comment.
- Meet or otherwise interact with Highland Beach. In order to be included in the mitigation plan and retain eligibility for certain categories of FEMA grants, Highland Beach must review and adopt the 2018 HMP. **Task 1:** County OEM and Consultant to determine best method for outreach to Highland Beach, and to initiate contact for the purpose of ensuring involvement in the process by the jurisdiction.
- **Additional actions and strategies.** Add any additional actions and strategies based on input from HMPC and other sources such as the Stakeholder group. **Task 1.** Consultant to solicit and incorporate additional input.
- **Prepare final draft, send to MEMA for review.** Following final HMPC review, the document will be put into final draft form and sent to the Maryland Emergency Management Agency for initial review. **Task 1:** Consultant will prepare the document for review and complete final formatting in whatever form required by MEMA. The document package will include a completed plan review document.
- **Revise based on MEMA feedback**. After MEMA review and comment, the document will be revised and recirculated to the HMPC for final review. **Task 1:** Consultant will make revisions based on whatever comments are provided by MEMA.
- **Return to MEMA and FEMA for final review and approval pending adoption.** The updated document will be reviewed by County OEM, re-packaged and sent to MEMA and FEMA for final review and approval pending adoption. **Task 1:** Consultant will re-package and send the HMP to MEMA and FEMA after County OEM review and approval.
- **Legal review.** The County Office of Law will review the document, ask any relevant questions, and concur that OEM may forward the document back to MEMA and FEMA. **Task 1:** HMPC Office of Law representative (Jason Fetterman) to coordinate legal review.
- **County resolution of adoption.** The County Council will review the document and adopt it via resolution.
- **Return to MEMA/FEMA in final form (with the County adoption resolution) for approval. Task 1:** OEM and Consultant will collaborate on the process to provide MEMA/FEMA with the final document.

4. Questions and feedback

Lynn Miller indicated that she had provided comments on parts of the draft that appear not to have been incorporated. Consultant said he would check this and ensure that the comments will be compiled and incorporated. **Task 1:** Consultant to review emails and incorporate feedback into the HMP.

5. Adjourn

The meeting adjourned at 4:30 p.m. Tasks: none.

Figure B-2
Sign-in Sheet, June 4, 2018 Anne Arundel County HMPC Meeting

Anne Arundel County, Maryland
2018 Hazard Mitigation Plan Update
2nd HMPC Meeting, June 4, 2018
Sign-in Sheet

Name	Organization
Karen Henry	Public Works
Jason Fatkeman	via teleconference Office of Law
Steve Pardue	consultant
Lynn Miller	PRZ
Chrissy Cornwell	OEM

Appendix C
Public Notice Documents and Meeting Minutes

Contents of this Appendix

C.1 Public Notice Documents and Meeting Minutes

Figure C-1
Public Notice Document for June 4, 2018 Public Meeting

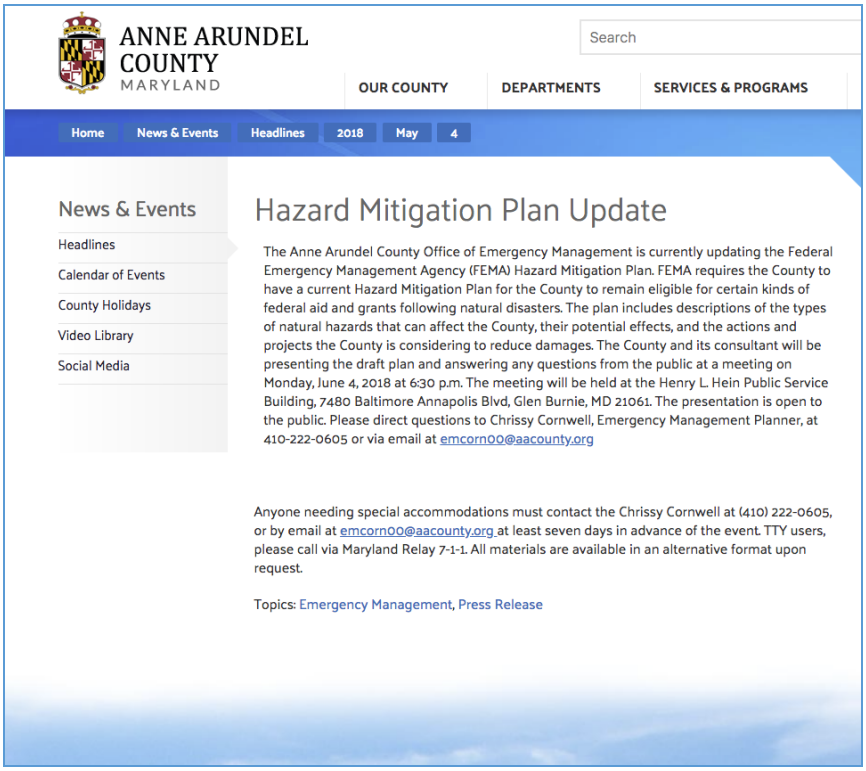
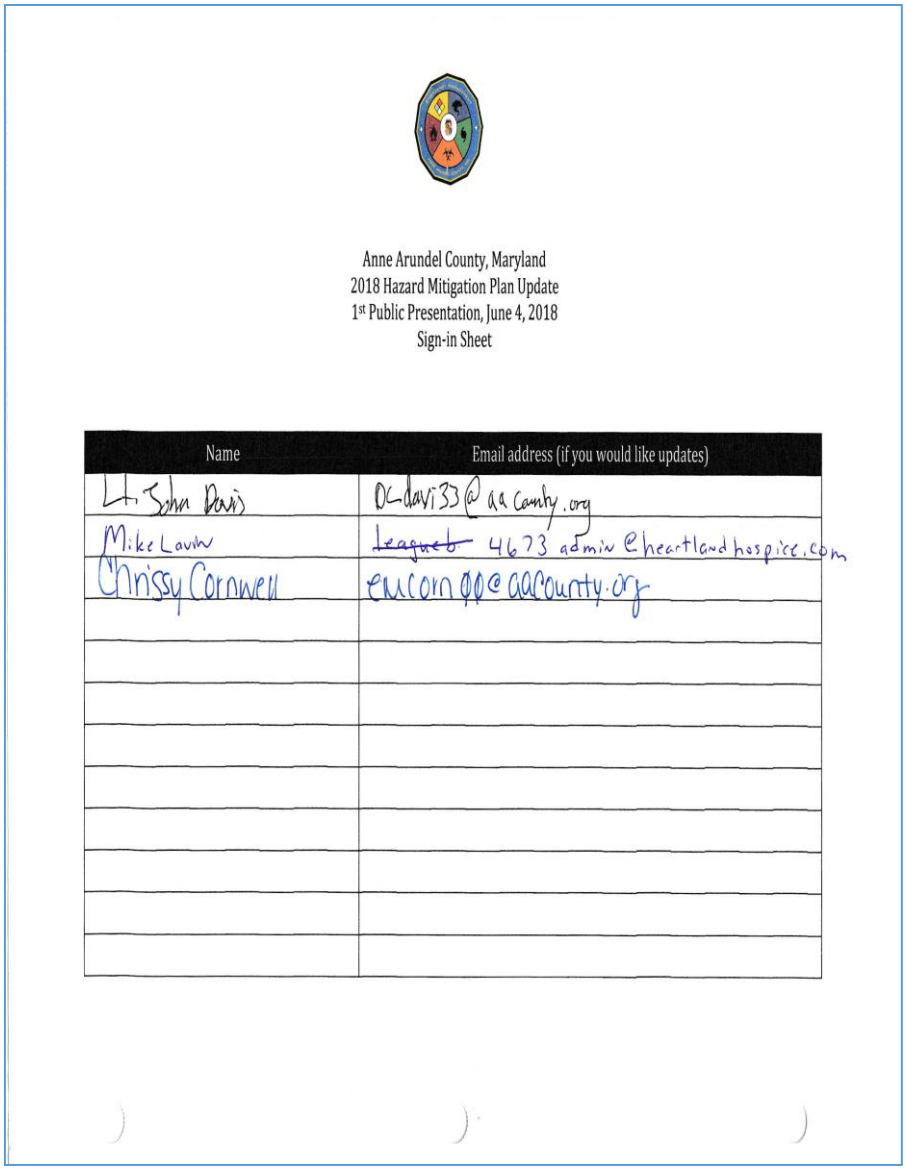


Figure C-2
Sign-In Sheet for First Public Presentation, June 4, 2018



Anne Arundel County, Maryland
2018 Hazard Mitigation Plan Update
1st Public Presentation, June 4, 2018
Sign-in Sheet

Name	Email address (if you would like updates)
Lt. John Davis	OC-davi33@aacounty.org
Mike Lavin	~~League~~ 4673 admin@heartlandhospice.com
Chrissy Cornwell	emcom00@aacounty.org

Minutes of the June 4, 2018 Public Presentation

These minutes summarize proceedings of the June 4, 2018 public presentation regarding the Anne Arundel County Hazard Mitigation Plan update. A sign-in sheet is included at the end of these minutes. The presentation was attended by Christina Cornwell, representing the County Office of Emergency Management, Steve Pardue, Antares Planning Group, and two members of the public.

The presentation began at 6:30 p.m. Mr. Steve Pardue of Antares Planning Group, the County's consultant for the plan update, introduced himself and briefly explained the purpose of the public presentation.

The consultant had prepared a powerpoint presentation, but given the small number of participants, it was determined to proceed with a less formal approach. The following subjects were discussed, in the order of the powerpoint presentation:

- The purpose of a mitigation plan, and federal requirements related to the update. The overall process of how a plan is updated, including who is involved, and technical and procedural aspects of updating individual sections of the document

  - Background
  - National Flood Insurance Program data
  - Hazard data
  - Recalculating risks

- The general process for a plan update

  - Preliminary draft
  - Hazard Mitigation Planning Committee review and edits
  - Public presentation
  - Edits based on any public feedback
  - Final check by County OEM and Office of Law
  - MEMA and FEMA review

- The two main elements of a mitigation plan

  1. Hazard Identification and Risk Assessment – the full range of natural hazards that can affect the County and its citizens, and estimates of potential losses from a subset of these hazards.
  2. Mitigation Strategies – actions and projects intended to reduce the effects of future natural hazards.

- Hazards considered in the Hazard Identification subsection

  6.3.1 Riverine Flooding
  6.3.2 Coastal Flooding
  6.3.3 Dam Failure and Release
  6.3.4 Hurricane, Tropical Storm, and Nor'easter
  6.3.5 Drought
  6.3.6 Earthquakes
  6.3.7 Extreme Heat
  6.3.8 Severe Thunderstorm and hailstorm

6.3.9 Severe Winter Storm
6.3.10 Tornado
6.3.11 Wildfire, urban interface fire
6.3.12 Erosion

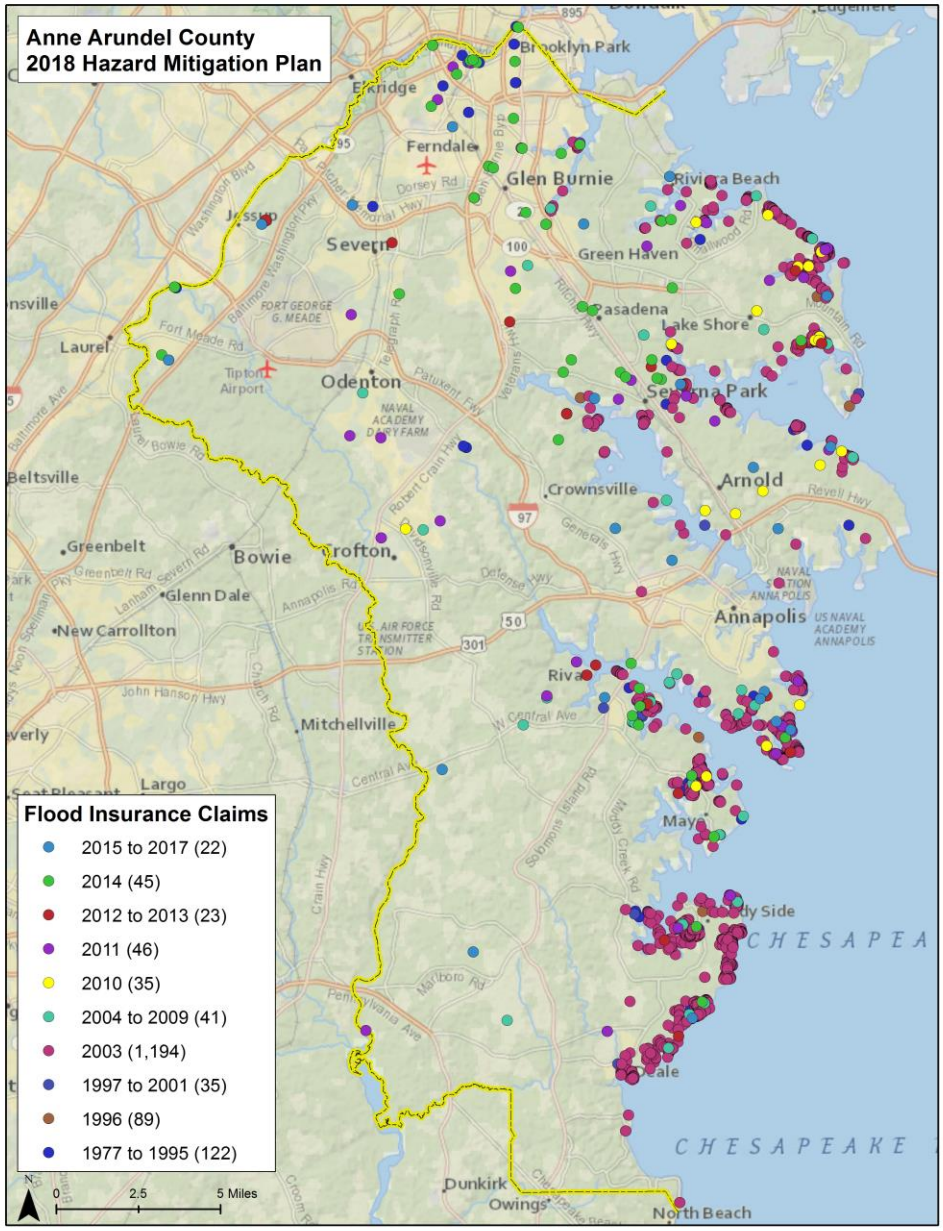
- An example of one of the standard sources for hazard histories, the NOAA National Climatic Data Center (NCDC) database.

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	1	7.121M	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	07/02/1953	20:00	CST	Tornado	F1	0	0	0.25K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	04/26/1960	15:30	CST	Tornado	F1	0	0	2.50K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	06/09/1961	15:30	CST	Tornado	F3	0	0	250.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	07/13/1961	15:00	CST	Tornado	F1	0	0	25.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	05/12/1974	14:15	CST	Tornado	F1	0	0	2.50K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	07/14/1975	05:15	CST	Tornado	F1	0	0	25.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	08/14/1976	16:20	CST	Tornado	F1	0	0	250.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	09/05/1979	12:55	CST	Tornado	F1	0	1	25.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	08/28/1992	15:15	CST	Tornado	F0	0	0	0.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	08/28/1992	15:32	CST	Tornado	F0	0	0	0.00K	0.00K
ANNE ARUNDEL CO.	ANNE ARUNDEL CO.	MD	05/12/1993	17:55	EST	Tornado	F0	0	0	5.00K	0.00K
Crownsville, Arnold,1	ANNE ARUNDEL CO.	MD	10/05/1995	16:57	EST	Tornado	F1	0	0	60.00K	0.00K
Odenton to	ANNE ARUNDEL CO.	MD	10/05/1995	20:31	EST	Tornado	F1	0	0	250.00K	0.00K
Arnold	ANNE ARUNDEL CO.	MD	10/05/1995	20:32	EST	Tornado	F0	0	0	1.00K	0.00K
UPPER MARLBORO	ANNE ARUNDEL CO.	MD	06/24/1996	16:39	EST	Tornado	F1	0	0	100.00K	0.00K
MARYLAND CITY	ANNE ARUNDEL CO.	MD	07/10/2000	16:32	EST	Tornado	F1	0	0	5.00K	0.00K
SEVERNA PARK	ANNE ARUNDEL CO.	MD	09/28/2006	17:34	EST	Tornado	F1	0	0	6.000M	0.00K
LAKE SHR	ANNE ARUNDEL CO.	MD	09/30/2010	08:46	EST-5	Tornado	EF0	0	0	15.00K	0.00K
CONAWAYS	ANNE ARUNDEL CO.	MD	04/05/2011	03:56	EST-5	Tornado	EF0	0	0	2.00K	0.00K
(FME)TIPTON AAF FT M	ANNE ARUNDEL CO.	MD	06/01/2012	16:46	EST-5	Tornado	EF0	0	0	3.00K	0.00K
TIPTON AAF ARPT	ANNE ARUNDEL CO.	MD	06/01/2012	18:06	EST-5	Tornado	EF0	0	0	100.00K	0.00K
Totals:								0	1	7.121M	0.00K

- Subset of hazards considered in the risk assessment, which is used to determine future losses from hazards, including those to property, people and functions in the community

  - Flood (riverine and coastal)
  - Hurricane, Tropical Storm, and Nor'easter
  - Tornado
  - Severe Winter Storm

- An example of one of the maps that was produced for the plan update. National Flood Insurance Program claims since 1977.



- Mitigation Goals

  - Protect the residents, built environment and functions of Anne Arundel County from natural hazards
  - Increase public understanding, support and demand for hazard mitigation
  - Protect existing and new properties
  - Build and support local capacity and commitment to become less vulnerable to hazards
  - Maximize resources for investment in hazard mitigation
  - Reduce the potential impact of natural hazard events on the County's historic assets
  - Reduce the potential impact of natural hazard events on the County's natural systems

- Mitigation Strategies

  - Used interchangeably with "actions"
  - Many strategies currently included in the mitigation plan
  - Some focus on training and exercises
  - Some "bricks and mortar" strategies from the capital improvement plan

- Monitoring and Maintenance

  - How the county keeps the plan current

- Next Steps

  - Some revisions
  - Stakeholder review
  - Submit draft
  - Revisions
  - Submit final
  - FEMA APA
  - County resolution
  - FEMA final approval

- Conclusion

- Questions and Answers

Question 1 Where is the County in the process now?

Answer 1 We are at the point of a first draft, and it will likely be around six weeks until the draft is ready to go to MEMA.

Question 2 Does the plan consider any hazards other than "natural" ones, like terrorism and accidents?

Answer 2 The first version of the mitigation plan included about twice as many hazards as this one, including so-called "man-caused" ones like terrorism and so forth. Since then, FEMA has indicated it's okay to include these in a mitigation plan, but FEMA does not require them and will not review such material in a mitigation plan. Because of this, these have been dropped from later versions.

Question 3 There was a question about the relationship between emergency response planning report reports required for hospices as part of Medicare/Medicaid compliance versus hazard mitigation plans.

Answer 3 Although there is clearly some relationship between these two as related to the potential effects of natural hazards, the hazard mitigation plan does not have any such component. This is more a function of the County's emergency response plan.

- The presentation adjourned at 7:00 p.m

Appendix D
Adoption Resolutions for Anne Arundel County and Highland Beach

Contents of this Appendix

These documents to be inserted in final version of the HMP, after it has received APA notice from FEMA

Appendix E
FEMA Approval Letters

Contents of this Appendix

These documents to be inserted in final version of the HMP, after the County has received APA notice and final approval from FEMA

Appendix F
Key Terms

CFR	Code of Federal Regulations
COOP	Continuity of Operations Plan
CRS	Community Rating System
DMA2K	Disaster Mitigation Act of 2000
DR	Disaster (number)
EAP	Emergency Action Plan
EOP	Emergency Operations Plan
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance (Program)
GDP	General Development Plan
HAZUS	Hazards U.S. (FEMA software)
HMA	Hazard Mitigation Assistance (Program)
HMP	Hazard Mitigation Plan
HMGP	Hazard Mitigation Grant Program
HMPC	Hazard Mitigation Planning Committee
HOA	Homeowner Association
IFR	Interim Final Rule
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MEMA	Maryland Emergency Management Agency
MGS	Maryland Geologic Survey
NCDC	National Climatic Data Center
NFIP	National Flood Insurance Program
NOAA	National Oceanographic and Atmospheric Administration
OEM	Office of Emergency Management
OMB	Office of Management and Budget
PA	Public Assistance (FEMA Program)
PDM	Pre-Disaster Mitigation (Program)
POC	Point of Contact
RFC	Repetitive Flood Claims (Program)
SFHA	Special Flood Hazard Area
SRL	Severe Repetitive Loss (Program)
USACE	U.S. Army Corps of Engineers

Appendix G
Anne Arundel County High Risk Area Flood Maps
Contents of this Section

List of Flood Risk Maps