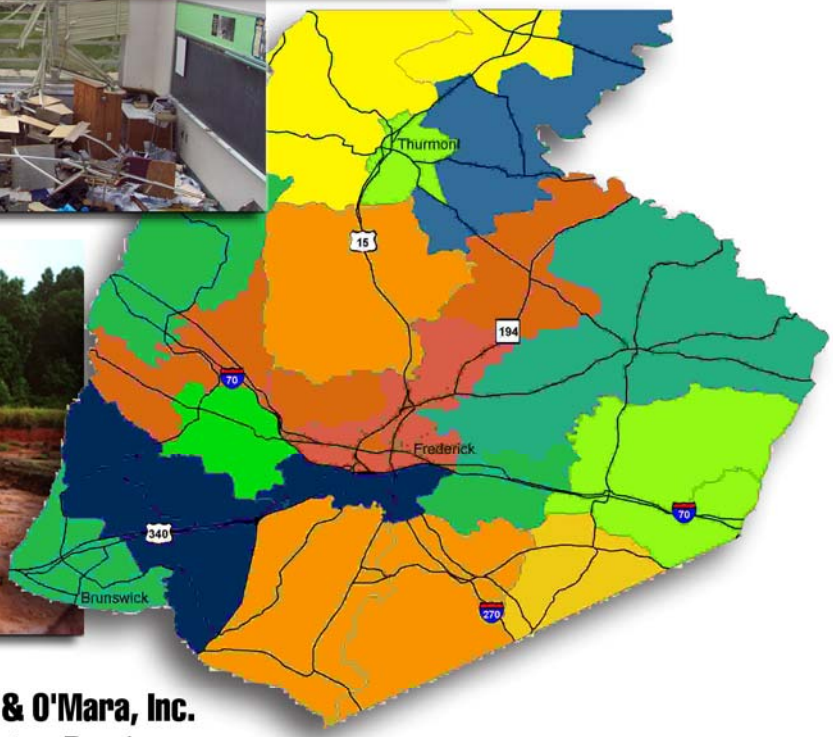
DRAFT

Hazard Mitigation Plan

Frederick County, Maryland and its Municipalities

Frederick County, Maryland
Office of Emergency Management
340 Montevue Lane
Frederick, MD 2170

July 2004



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CHAPTER 1- INTRODUCTION

Introduction and Purpose

The Hazard Mitigation Plan has been developed for Frederick County and its municipalities. Frederick County has twelve municipalities: Brunswick, Burkittsville, Emmitsburg, Frederick, Middletown, Mount Airy, Myersville, New Market, Rosemont, Thurmont, Walkersville, and Woodsboro. The purpose of this Plan is to assess the communities' vulnerabilities to natural hazards and prepare a long-term strategy to address these hazards and prevent future damage and loss of life. The Plan focused on active participation from county and municipality officials or residents in these communities.

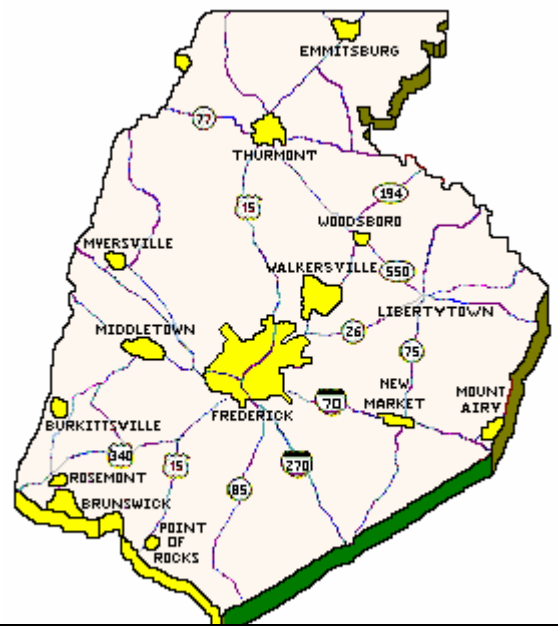


Figure 1.1: Frederick County and its Municipalities

Location

Frederick County is bound by Pennsylvania to the north, Carroll County to the east, Montgomery County to the south, Howard County to the southeast, Washington County to the west and Virginia to the southwest. The City of Frederick City is the County seat.

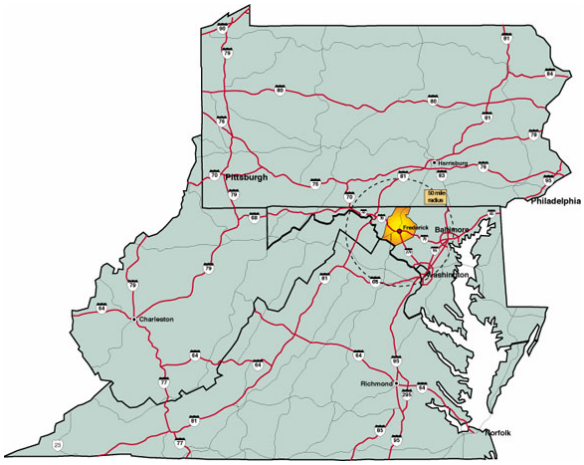


Figure 1.2: Frederick County and the Region

County Profile

Background

Frederick County is Maryland's largest county in size—663 square miles. The City of Frederick, the County seat, is intersected by five interstate and national highways that provide easy access to Baltimore (46 miles), Washington, D.C. (43 miles), Gettysburg, Pa. (32 miles), Harpers Ferry, W.Va. (21 miles), and Leesburg, Va. (25 miles). It is home to the 5,700-acre Catoctin National Park, site of the Camp David Presidential Retreat, Fort Detrick, Saint Mary's and Hood Colleges, and the Emergency Management Institute (EMI) and National Fire Academy (NFA).

Population

Frederick County covers a total of 663 square miles and contains approximately 294.6 persons per square mile. Based on the U.S. Census, Frederick County's population in 2000 was 195,277, a 57.6 percent increase since 1980. Table 1-1 indicates the change in population by jurisdiction. Mt. Airy, Myersville, Walkersville showed large increases in population during the 20-year period. Frederick City increased its population by 88 percent during the same time. The large increase in population in recent years has been due to in-migration from surrounding Maryland counties. Only two towns, Rosemont and Burkittsville indicated a population decrease during this time.

Table 1.1 – Population Change by Jurisdiction

Municipality	1980	1990	2000	Increase	% Increase
Brunswick	4,572	5,117	4,894	**322**	**7.0%**
Burkittsville	202	194	171	**(31)**	**-15.3%**
Emmitsburg	1,552	1,688	2,290	**738**	**47.6%**
Frederick City	28,086	40,148	52,767	**24,681**	**87.9%**
Middletown	1,748	1,834	2,668	**920**	**52.6%**
Mt. Airy	540	1,497	3,415	**2,875**	**532.4%**
Myersville	432	464	1,382	**950**	**219.9%**
New Market	306	328	427	**121**	**39.5%**
Rosemont	305	256	284	**(21)**	**-6.9%**
Thurmont	2,934	3,398	5,588	**2,654**	**90.5%**
Walkersville	2,212	4,145	5,192	**2,980**	**134.7%**
Woodsboro	506	513	846	**340**	**67.2%**
Municipal Total	43,395	59,582	79,924	**36,529**	**84.2%**
Non Municipal	71,397	90,626	115,353	**29,597**	**41.5%**
Frederick County	**114,792**	**150,208**	**195,277**	**66,126**	**57.6%**

Source: US Census and Frederick County Planning Department

Housing

The total number of households in the County in 2002 was 70,060, and the total housing units was 77,911. Of these total housing units, approximately 76 percent were found to be owner-occupied. The median value of these owner-occupied housing units was $160,200.

Frederick County experienced tremendous growth between 1970 and 1998 (121% increase). Since 1990, there has been a 25 percent increase in population. This rapid growth is expected to continue until 2020. To keep pace with this growth, annual housing construction has also risen steadily over the past few decades. The late 1980's and the early 1990's saw an increase in housing units constructed, to a high of 2,899 units in 1989 and a low of 1,504 units in 1995 (source: 1998 Frederick County Comprehensive Plan).

Economy

Frederick County consists of approximately 4,470 businesses that employ 56,665 workers. An estimated 89 of these businesses have 100 or more workers. Manufacturing accounts for 10 percent of total employment. The County's largest employers include Alcoa-Eastalco Works, Bechtel Power, First USA, First Nationwide Mortgage, Fort Detrick, Frederick Memorial Hospital and State Farm Insurance. Frederick County is also Maryland's largest dairy producer, providing one-third of the State's milk production.

Frederick County is becoming a new mecca for development. The County is growing increasingly attractive as a location for businesses. New development ranges from a regional headquarters for State Farm Insurance to a pair of the largest warehouse/industrial buildings in the state for Georgia Pacific and Toys "R" Us (Warfield's Daily Record). The County has experienced a significant increase in high-tech companies locating here, allowing more residents to work near where they live.

Transportation

The highway network in Frederick County can be best described in the following categories:

- Freeway: includes I-70, I-270, US Route 15 inside the City of Frederick, and US Route 340 and Route 15 South of 340 split.
- Four-Lane Rural Highway: US Route 15 north of the City of Frederick
- Two-Lane Rural Highway: includes the State secondary highways (i.e., MD 75, MD 355, etc.) as well as County roads

The Frederick Municipal Airport, a City owned and operated facility, is an integral component of the County's overall transportation system. The Federal Aviation Administration (FAA) has designated the Frederick Municipal Airport as a "reliever airport," which is a general aviation facility designed to reduce congestion at airports which have substantial scheduled commercial passenger service (Dulles, Washington National, and B.W.I. Airports). The Frederick Municipal Airport is the State's busiest general airport with almost 200,000 annual operations. The airport ranks third in the State in terms of the number of based aircraft with an estimated 263 based in Frederick. (source: 1998 Frederick County Comprehensive Plan).

Rail transportation includes CSX Transportation and Maryland Midland (short line service). In terms of mass transit, the MARC (commuter rail) and Amtrak provide service to Washington, D.C. Public bus transportation is available throughout Frederick City, connecting to other municipalities. In terms of water transportation, the County is served by the Port of Baltimore.

Utilities

Electricity is provided by the Allegheny Power System and Thurmont Municipal Light Company. Natural gas is supplied by Frederick Gas Company, a division of Washington Gas. Baltimore Gas and Electric serves Mount Airy. Rocky Ridge and Emmitsburg are served by the South Penn Gas Company. Municipal water systems are located in Brunswick, Emmitsburg, Frederick, Middletown, Mount Airy, Myersville, Thurmont, Walkersville, Woodsboro, and 18 County operated plants, which serve a wide geographical area. Municipal sewer systems are located in Brunswick, Emmitsburg, Frederick, Middletown, Mount Airy, Myersville, and Thurmont. The County operates 16 plants serving a wide geographical area.

Telecommunications: Predominant Local Carrier is Verizon Communications-MD. Long Distance Carriers include AT&T, MCI WorldCom, Sprint, LCI, and over 250 additional carriers, resellers and providers of WATS, MTS, voice, paging systems, data, video networking, CATV, satellite communications systems and other wireless systems. Fiber optics are available at many locations throughout the County.

Why Plan for Mitigation?

In the past, federal legislation has provided funding for disaster relief, recovery, and some hazard mitigation planning. The Disaster Mitigation Act (DMA) of 2000 is the latest legislation to improve this planning process and came into existence in October 2000. The new legislation reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur. As such, this Act established the Pre-Disaster Mitigation (PDM) program and new requirement for the national post-disaster Hazard Mitigation Grant Program (HMGP). DMA 2000 is intended to facilitate cooperation between State and local authorities, prompting them to work together. It encourages and rewards local and State pre-disaster planning and promotes sustainability as a strategy for disaster resistance. This enhanced planning network will better enable local and

State governments to articulate needs for mitigation, resulting in faster allocation of funding and more effective risk reduction projects.

The Frederick County Hazard Mitigation Plan is a multi-jurisdictional plan, i.e., a plan that includes municipalities and unincorporated areas of the county. Any future funding for mitigation projects is contingent upon having this plan adopted, and any jurisdiction that does not participate in and adopt the plan will not be eligible for pre and post disaster mitigation funds.

Purpose

Hazard Mitigation is any action taken to permanently reduce or eliminate long-term risks to people and their property from the effects of natural hazards. Natural hazards come in many forms: tornadoes, floods, hurricanes, severe storms, winter freezes, droughts, landslides, or dam failures resulting from natural disaster crises. Communities can take steps to prepare and implement mitigation techniques for almost any type of hazard that may threaten its citizens, businesses and institutions.

This Plan establishes an ongoing hazard mitigation planning program by identifying and assessing potential natural hazards that may pose a threat to life and property, evaluating local mitigation measures that should be undertaken, and outlining procedures for monitoring the implementation of mitigation strategies. The plan provides guidance to county officials and staff local mitigation activities over the next five-year planning cycle. It encourages activities that are most effective and appropriate for mitigating the effects of all identified natural hazards.

Consistency with State and Federal Mitigation Policies

The goals, objectives and policies, of this plan intend to implement the national and state directives for mitigation of natural hazard through local strategies intended to:

- Substantially increase public awareness of natural hazards and the measures available to create safer, more disaster-resistance communities; and
- Significantly reduce the risk of loss of life, injuries, economic costs and destruction of natural and cultural resources that result from natural hazards.

FEMA has developed 10 fundamental principles for the Nation's mitigation strategies which likewise underlie the strategies of this plan:

1. Risk reduction measures ensure long-term economic success for the community as a whole rather than short-term benefits for special interests.
2. Risk reduction measures for one natural hazard must be compatible with risk reduction measures for other natural hazards.
3. Risk reduction measures must be evaluated to achieve the best mix for a given location.
4. Risk reduction measures for natural hazards must be compatible with risk reduction measures for technological hazards and visa versa.
5. All mitigation is local.
6. Disaster costs and the impacts of natural hazards can be reduced by emphasizing pro-active mitigation before emergency response; both pre-disaster (preventive) and post-disaster (corrective) mitigation is needed.
7. Hazard identification and risk assessment are the cornerstones of mitigation.
8. Building new Federal-State-local partnerships and public-private partnerships is the most effective means of implementing measures to reduce the impacts of natural hazards.

9. Those who knowingly choose to assume greater risk must accept responsibility for that choice.
10. Risk reduction measures for natural hazards must be compatible with the protection of natural and cultural resources.

Figure 1.3 – DMA 2000 Planning Process

In April 2004, a Greenbelt, Maryland, consulting firm, Greenhorne & O'Mara, Inc., was contracted to develop Frederick County's Hazard Mitigation Plan in compliance with the requirements of the Disaster Mitigation Act (DMA) of 2000.

Planning Process

In compliance with DMA 2000 requirements, public participation was encouraged throughout the mitigation planning process. A Hazard Mitigation Planning Committee was formed, that was comprised of various County agencies and representatives from each of the participating communities. A series of monthly meetings resulted in the development of an effective Countywide Hazard Mitigation Plan.

The Committee was actively involved in identifying hazards within the communities, review of the County's vulnerabilities to natural hazards, and recommendations to reduce and prevent potential damage from these hazards. The Committee then worked together to select the most appropriate and feasible mitigation measures.

The planning process involved four basic steps (Table 1.1):

<u>Step 1 - Organize Resources</u>

The first step of the hazard mitigation planning process was for the County to organize their resources and ensure that they had adequate technical assistance and expertise to form a hazard mitigation committee. The committee included representatives from key County agencies such as planning, emergency management, GIS, and public works and representatives from each of the incorporated municipalities. Technical support for the planning effort was provided by engineers, planners, and floodplain managers from Greenhorne & O'Mara, Inc.

Committee

Select members for the local municipalities and the County were invited to be on the Hazard Mitigation Planning Committee (HMPC) who was tasked with conducting a DMA 2000 compliant hazard mitigation planning process and preparing the hazard mitigation plan. The following list includes the members of the committee and the agencies they represent:

Data Collection

The development of the mitigation plan began with data collection. A kick-off meeting was held on 8 April 2004 with the Frederick County Emergency Management Director and representatives from Planning and Emergency Management departments. The planning process was discussed in detail, along with the proposed deliverables.

Table 1.2 – Frederick County Hazard Mitigation Planning Committee

Name	Agency	Position
Seamus Mooney	Frederick County Office of Emergency Management	County Emergency Planner
Carole Larsen	Frederick County Planning & Zoning	County Planner
Stephen Bahech	Frederick County Highways & Transportation	County Engineer
Monika Jenkins	Town of Mt. Airy	Town Planner
Gary Pozzouli	Town of Mt. Airy	Town Engineer
Terry Frushour	Thurmont Police Department	Chief of Police
Peter Schulz	City of Frederick	City Planner
Jackie Ebersole	Village of Rosemont	Burgess
Gloria Long Rollins	Town of Wlalkersville	Town Manager
Robert	Town of Walkersville	Public Works Director
David Dunn	Town of Brunswick	City Administrator
Kristin Aleshore	Towns of Middletown/Myersville	Town Planner

Community, County, state, and Federal resources were identified and contacted to collect pertinent inventory information. Policy and regulatory information from each of the communities and the County was collected. This included comprehensive plans, zoning ordinances, development ordinances, and building codes. The consultant collected information about natural hazards including past occurrences, and projected frequencies of future occurrence/the anticipated risk, where available.

Information was collected from public works, planning, emergency management, and GIS departments. Several State agencies were contacted including the Maryland Emergency Management Agency (MEMA), Maryland Department of Natural Resources (DNR), the Department of Homeland Security/FEMA, Maryland Department of Planning, and the Maryland Department of the Environment, to inform them of the planning effort and to collect pertinent information.

Step 2 - Assess Risks

The next step in the planning process was to perform a hazard identification and vulnerability assessment for the entire county. This process involved analyzing the County's greatest hazard threats and determining its most significant vulnerabilities with respect to natural hazards and hazardous materials. The Hazard Identification and Vulnerability Assessment were performed in large part using GIS data from the County, HAZUS-MH, a GIS based loss estimation software, and State sources. At the first Hazard Mitigation Planning Committee Meeting held on 12 May 2004, an overview of the planning process was presented to the Committee to review the identified hazards, a brief history and profile of each hazard and areas vulnerable to various hazards. Questionnaires were provided to garner public comment about past hazard events and suggestions on potential mitigation measures.

Step 3 - Develop a Mitigation Plan

The next step was to assess the mitigation capabilities of the County and its municipalities. A Capability Assessment was performed whereby the existing programs and policies addressing natural hazards were reviewed. A thorough analysis of the adequacy of existing measures was performed, and potential changes and improvements were identified. The Committee reviewed the Capability Assessment at the second Hazard Mitigation Planning Committee Meeting held on 26 May 2004. At this meeting, the committee worked to identify goals and objectives for countywide mitigation efforts. These goals represent the County's and communities' vision for disaster resistance.

Also at the 26 May 2004 meeting, the Committee worked to identify and develop potential mitigation actions for implementation. Issues that could affect hazard event-related damage in the County was considered by the Hazard Mitigation Planning Committee. These actions were further refined at the third Committee meeting on 9 July 2004. The Committee also helped draft an action plan that specifies recommended projects, who is responsible for implementing these projects, and when they are to be completed.

A final Committee meeting was held on 21 July 2004 to categorize and prioritize the identified mitigation measures.
It should be noted that this plan recommends mitigation measures that should be pursued and implemented after funds are obtained. Implementation of these recommendations depends on adoption of this plan by the County Council and each of the municipalities' and the cooperation and support of the offices and contacts designated as being responsible for each action item.

Step 4 - Implement the Plan and Monitor Progress

The County will continue to implement the plan and perform periodic reviews and revisions through on-going Hazard Mitigation Planning Committee reviews and revisions. The review and revision process will be attached to the regional planning efforts and follow that update process. The Committee will meet annually to review the plan and will also hold public meetings to solicit citizen input.

Public Involvement

The public involvement element of the planning process involved two public meetings. The first public meeting (10 June 2004) held at the Community Room at the C. Burr Artz Library, was held to inform citizens of hazards identified and to obtain their input on the risk analysis and to educate the public on the planning process and Plan's intent to identify steps the community could take to make the community more disaster-resistant. Attendees were encouraged to provide input as to what type of mitigation measures they wanted the county and communities to pursue.

A second public meeting was held on 26 July 2004 at the C. Burr Artz Library to present the final draft of the plan to the public and to garner their input and comments. Notification was sent to radio stations, television stations, and the local newspapers (Frederick News-Post and the Gazette) informing them of the public meeting and that the draft plan would be available for review at the Frederick County Office of Emergency Management after the meeting.

The Maryland Emergency Management Agency will serve as the State review agency and clearing house. The following agencies will also receive a draft of the plan for review and comment:

- FEMA Region III

- Maryland Department of Natural Resources and Maryland Department of the Environment (MDE)

Organization of the Report

The next few chapters comprise of the Hazard Mitigation Plan. Chapter 2 involves the Hazard Identification and Risk Assessment. Chapter 3 comprises the Vulnerability Analysis. Chapter 4 includes the Vision, Goals and Objectives for the Plan. Chapter 5 discusses the Mitigation Actions that address the goals and objectives. Chapter 6 comprises the Action Plan and table. An appendix includes information from the meetings, questionnaires, and a detailed description of some to the funding sources.

CHAPTER 2 – HAZARD IDENTIFICATION

Introduction

This chapter discusses a portion of the Risk Assessment for Frederick County. The four major steps in the Risk Assessment include Hazard Identification, Hazard Profiles, Vulnerability Assessment, and Loss Estimation. This Chapter comprises the first two steps in the risk assessment, wherein hazards that may affect Frederick County are identified, profiled, and potential effects are quantified. The nature of the specific hazard, history of previous occurrences, and the impact and potential severity of an occurrence have been documented. Steps 3 & 4 of the Risk Assessment (vulnerability assessment and loss estimation) will be discussed in the next chapter.

Figure 2.1: Risk Assessment Steps

Step 1 - Hazard Identification

Frederick County involved investigating various types of natural hazards faced by the County over the past several decades. Since it is assumed that hazards experienced by the County in the past may be likely to occur in the future, the hazard identification process included a history and an examination of various hazards and their occurrences. Information of past hazards was based on history and research from historical documents and newspapers; County plans and reports; conversations with county residents and public officials, and internet websites. Data and maps that were available online included sources such as the United States Geological Survey (USGS), Spatial Hazard Events and Losses Database for the United States (SHELDUS), and the National Weather Service.

Step 2 - Hazard Profiles

This step involves determining the frequency or probability of future events, their severity, and factors that may affect their severity. Each hazard type has unique characteristics that can impact the County. For example, no two flood events will impact a community in the same manner. Also, the same hazard events can affect different communities in different ways based on geography, development, population distribution, age of buildings, etc. Developing hazard event profiles enables us to answer the question "how bad could a hazard get?"

Hazard Identification

The following natural hazards have been documented in Frederick County and have been assessed as risks for the purpose of this study, and have been categorized into the following but not listed in any particular order:

Atmospheric hazards

- Thunderstorms
- Lightning
- Tornadoes
- Hurricanes
- Hailstorms
- Severe Winter Storms
- Extreme Summer Heat

Wildfire Hazards

- Wildfire
- Urban Interface Fires

Hydrologic Hazards

- Floods
- Drought

Geologic Hazards

- Earthquakes
- Landslides/Land subsidence
- Sinkholes/Karst Topography

Thunderstorms

Overview

Thunderstorms are forms of convection produced when warm moist air is overrun by dry cool air. As the warm air rises, thunderhead clouds (cumulonimbus) form and cause the strong winds, lightning, thunder, hail and rain associated with these storms. Instability can be caused by surface heating or upper-tropospheric (~50,000 feet) divergence of air (rising air parcels can also result from airflows over mountainous areas). Generally, the former "air mass" thunderstorms form on warm-season afternoons and are not severe. The latter "dynamically-driven" thunderstorms generally form in association with a cold front or other regional-scaled atmospheric disturbance. These storms can become severe, thereby producing strong winds, frequent lightning, hail, downbursts and even tornadoes.

The National Weather Service's definition of a severe thunderstorm is a thunderstorm event that produces any of the following: downbursts with winds of 58 miles (50 knots) per hour or greater (often with gusts of 74 mph or greater), hail 0.75 of an inch in diameter or greater, or a tornado. Typical thunderstorms can be three miles wide at the base, rise to 40-60,000 feet in the troposphere, and contain half a million tons of condensed water.

Historic Activity

According to the National Climatic Data Center, approximately 164 thunderstorm and high wind events were reported in Frederick County, Maryland, between January 1950 and December 2003. The following events are worthy of mention:

- On 4 February 1998, a powerful nor'easter, carrying copious amounts of moisture from the Gulf of Mexico and Caribbean region, dumped between 2 and 4 inches of rain across much of Maryland between the foothills and the Chesapeake Bay. Several counties in Maryland, including Frederick County, were affected. Minor sewage backups were reported farther north in Frederick County. A tractor-trailer flipped over along Interstate 70 in western Frederick County near the Myersville exit (State Route 17). The total property damage incurred across the State totaled $145,000 and crop damage was $200,000.

- On 19 July 1996, the supercell which was producing weak to moderate tornadoes across southern Washington and Frederick Counties had an associated rear-flank downburst which struck immediately west of the tornado track. Numerous trees were uprooted or snapped over a wide area from just west of Rosemont to the banks of the Potomac River. Wind speeds maximized along the shoreline, likely a result of a channeling effect through the mountain gap just east of Harpers Ferry, West Virginia. Power outages were substantial in these areas; 10,000 customers in Loudoun County, Virginia and Frederick County, Maryland, were briefly without electricity. The total crop damage incurred was $50,000 and property damage was $25,000.

- On 21 July 1998, a small but potent line of severe thunderstorms raced from western Maryland through the Washington, DC metropolitan region, producing wind gusts between 60 and 70 mph along the leading edge. The storm gained strength as it plowed southeast into Frederick and Montgomery Counties. In Frederick Co, damage included felled scattered trees and power lines in the Middletown/Braddock Heights area. More substantial damage occurred in the south portion of Frederick city, where two roofs partially collapsed at a shopping center near the intersection of State Route 85 and Interstate 270. An unfastened trailer was flipped off cinder block supports and fell onto an automobile, pinning the car against a curb. Homes at a nearby neighborhood sustained minor damage, including one whose garage was partially destroyed. The total property damage was approximately $90,000.

Lightning

Overview

Lightning is defined as a sudden and violent discharge of electricity from within a thunderstorm due to a difference in electrical charges and represents a flow of electrical current from cloud-to-cloud or cloud-to-ground. Nationally, lightning causes extensive damage to buildings and structures, kills or injures people and livestock, starts untold numbers of forest fires and wildfires and disrupts electromagnetic transmissions. Lightning is extremely dangerous during dry lightning storms because people remain outside due to the lack of precipitation; however, lightning is still present during the storm.

At any given time, there are nearly 2,000 thunderstorms in progress over the earth's surface. There are at least 100,000 thunderstorms annually across the United States.

To the general public, lightning is often perceived as a minor hazard. However, lightning-caused damage, injuries and deaths establish lightning as a significant hazard associated with any

thunderstorm in any area of the State.

Damage from lightning occurs four ways: (1) Electrocution/severe shock of humans and animals; (2) Vaporization of materials along the path of the lightning strike; (3) Fire caused by the high temperatures associated with lightning (10,000-60,000°F); and (4) The sudden power surge that can damage electrical/electronic equipment. Large outdoor gatherings (sporting events, concerts, campgrounds, etc.) are particularly vulnerable to lightning strikes that could result in injuries and deaths.

Historic Activity

There have been 25 major lightning events in Frederick County between 1950 and 2003 and some of these have been elaborated below:

- On 21 August 1994, lightning struck and burned a historic barn in the city of Frederick at the School for the Deaf. The County incurred a total damage of $500,000.

- On 28 July 1999, a series of thunderstorms swept across north central Maryland producing heavy downpours, frequent lightening, and damaging winds in excess of 55 MPH. The storms moved through Washington, Frederick, Carroll, and Howard Counties. In Frederick County, trees and power lines were downed onto Route 180 at the intersection of Mt. Zion Road, Main Street in New Market, Route 75 between Route 80 and Ed McClain Road, and Route 144. A concentrated area of tree damage also occurred between Monrovia and Bartholows Road. Monrovia was hit especially hard. One home lost part of its roof when several trees fell onto the structure. A car in the driveway was also damaged by a fallen tree. A nearby 150-year-old log home valued at $130,000 was hit by lightning and burned to the ground. The fire department reported delays reaching the structure because of roads blocked by downed trees. In the city of Frederick, one house was damaged and 22 intersections were blocked by fallen trees. Approximately 150,000 customers in and around Frederick County lost power as a direct result of the storm. The total property damage was estimated at $130,000.

- On 7 August 2000, lightning-scattered thunderstorms moved across central Maryland during the afternoon and early evening. These storms produced winds in excess of 55 MPH, frequent lightning, and hail. In Frederick County, an apartment complex in Frederick was hit by lightning. The total property damage during this lightning event (included Howard, Prince Georges, Montgomery counties) was $750,000.

- On 29 August 2003, a home caught fire after being struck by lightning. An afternoon thunderstorm produced a lightning bolt that struck a home in Brunswick. The home on East A Street was heavily damaged from the resulting fire and two families were displaced. The damage was estimated at $50,000.

Tornadoes

Overview

A tornado is a relatively short-lived storm composed of an intense rotating column of air, extending from a thunderstorm cloud system. Average winds in a tornado, although never accurately measured, are thought to range between 100 and 200 miles per hour, but some may have winds exceeding 300 miles per hour. The following are National Weather Service definitions of a tornado and associated terms:

- Tornado - A violently rotating column of air that is touching the ground.
- Funnel cloud - A rapidly rotating column of air that does not touch the ground.
- Downburst - A strong downdraft, initiated by a thunderstorm, which induces an outburst of straight- line winds on or near the ground. They may last anywhere from a few minutes in small-scale microbursts to periods of up to 20 minutes in larger, longer macro-bursts. Wind speeds in downbursts can reach 150 mph and therefore can result in damages similar to tornado damages.

Tornadoes are classified on a scale of 0 to 5 by the degree of damage they cause. This tornado classification is called the Fujita Scale and is shown in Table 2.1.

Table 2.1: Tornado Damage Scale

Scale	Wind Speeds	Damage	Frequency
F0	40 to 72 MPH	Some damage to chimneys, TV antennas, roof shingles, trees and windows	29%
F1	73 to 112 MPH	Automobiles overturned, carports destroyed, trees uprooted	40%
F2	113 to 157 MPH	Roofs blown off homes, sheds and outbuildings demolished, mobile homes overturned	24%
F3	158 to 206 MPH	Exterior walls and roofs blown off homes. Metal buildings collapsed or are severely damaged. Forests and farmland flattened.	6%
F4	207 to 260 MPH	Few walls, if any, standing in well-built homes. Large steel and concrete missiles thrown far distances.	2%
F5	261 to 318 MPH	Homes leveled with all debris removed. Schools, motels and other larger structures have considerable damage with exterior walls and roofs gone. Top stories demolished.	Less than 1%

Nearly 70 percent of the deaths from tornadoes happen to people located in residential structures. Of these, over 40 percent are located in mobile home which are easily overturned and destroyed due to the low wind resistance of the structure. Table 2.2, breaks down the tornado deaths in the United States based on location or other circumstances.

Table 2.2: United States Tornado Deaths by Location/Circumstances 1985-1999

Year	Mobile Home	Permanent Home	Vehicle	Business	School or Church	Outdoors	Unknown	Total
1999	39	35	6	8	0	6	1	94
1998	65	40	15	7	0	3	0	130
1997	30	23	3	3	0	7	1	67
1996	14	8	2	0	0	0	1	67
1995	8	15	4	0	0	3	0	30
1994	26	14	3	0	20	6	0	69
1993	13	6	7	3	1	3	0	33
1992	20	18	0	0	0	1	0	39
1991	20	3	4	0	0	12	0	39
1990	7	11	14	15	5	1	0	53
1989	12	8	16	4	9	0	1	50
1988	21	6	3	2	0	0	0	32
1987	24	7	3	0	22	3	0	59
1986	7	3	3	0	0	0	2	15
1985	28	40	4	0	0	0	22	94
Total	334	237	87	42	57	45	28	871
Percent	38.3%	27.2%	9.9%	4.8%	6.5%	5.1%	3.2%	100%

Source: National Weather Service **Http://www.spc.noaa.gov/climo/torn/locations.html**

While the magnitude and location of tornadoes are unpredictable, most of those that occurred in the County over the last 50 years have been classified as low intensity (F1). There were 2 cases of F2 tornadoes and one F3 tornado event. These tornadoes have had no history of fatalities although they have resulted in roadblocks and delays, and increased workload of clearing fallen trees and debris.

Historic Activity

Based on data from the National Climatic Data Center, Frederick County experienced 21 tornado events between 1950 and 2003. Some of these are elaborated below.

- On 31 July 1978, a tornado was visible in Frederick County. The exact location was unknown. Property damage was estimated at $25,000. No fatalities or injuries were reported.

- On 19 July, 1996, a supercell thunderstorm which produced the F2 tornado in Yarrowsburg (Washington Co) dropped a second tornado in Rosemont. The tornado first touched down in Rosemont, damaging numerous trees as it crossed State Route 17 and moved into Brunswick. A service station's roof was partially damaged by a fallen tree. Many of the homes in Brunswick were protected by the trees and the steep sloping terrain towards the Potomac. The total property damage was estimated at $80,000 and total crop damage was estimated at $50,000.

- On 14 August 1999, an area of thunderstorms moved across much of Maryland, producing damaging wind, frequent lightning, and brief heavy downpours. The thunderstorm complex intensified rapidly as it moved into Frederick County. The northwest side of the city of Frederick took the brunt of the storm. As the storm reached the Abbington Farms area, a tornado developed. The tornado was F1 strength with winds between 75 and 112 MPH and ranged from 50 to 200 yards wide as it traveled east for 3 miles. The twister did extensive damage to trees as it moved through the communities of Eastview, Walnut Springs, Shookstown, and Fort Detrick. Some trees fell onto cars and houses, and a few homes under construction were damaged. One home under construction in Walnut Ridge was torn to pieces by the tornado and the debris turned into airborne missiles which heavily damaged two finished homes nearby. Two homes in the Eastview subdivision were condemned after trees fell onto the structures. A chimney was blown off a Willowdale Drive home. Yellow Springs Road had to be closed for several hours until power and telephone poles blocking the road could be cleared. A metal storage building on Rosemont Avenue was crumbled. Part of the roof of the Food Lion grocery store on Rosemont Avenue was torn off and thrown toward the gates of Fort Detrick. The store suffered water damage and the loss of frozen foods and perishables from the resulting power outage. Next, the storm moved across Fort Detrick, causing $260,000 in damage. The twister moved onto the main post where it uprooted trees, downed power lines, and blew off parts of buildings. The headquarters building and post chapel lost part of its roof. Nearly 30 cars along Rocky Springs Road and near post housing were damaged by downed trees and debris. In addition, the central portion of Frederick was hit by destructive straight line winds estimated between 60 and 70 MPH. Thirty Bradford pear trees were downed on Heather Ridge Drive. Sixteen city streets were closed by fallen trees. A one mile stretch of Route 40 west of the Golden Mile had to be closed for an hour to clear fallen trees. A glider valued at $11,000 was ripped from its mooring at the airport and totaled. The storm downed a total of 300 trees across Frederick, and resulted in outages for 8,000 power customers. High winds also downed trees in Brunswick, leaving 100 customers without power. The total damage to property was $800,000.

- On June 14, 2004, unconfirmed reports of funnel clouds and tornadoes were received by the National Weather Service Office in Sterling. Several areas across northern Maryland reported wind damage mainly due to downed trees and powerlines. Areas of damage included the region between Thurmont and Libertytown. The tornado was rated F1 with an estimated winds of 75 miles per hour. The initial tornado touchdown occurred one-half mile north of Woodsboro along Route 194 near a cement plant. The tornado tracked southeast mostly across farmland and wooded areas, uprooting and topping trees along its path.

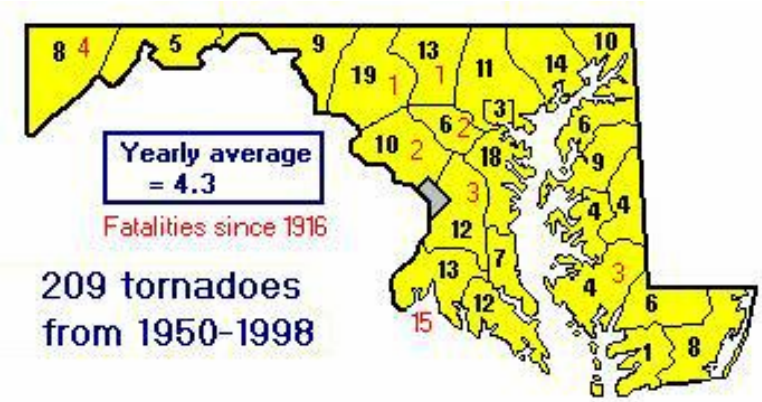
Profile

A tornado path averages four miles, but may reach up to 300 miles in length. Widths average 300-400 yards, but severe tornadoes have cut swaths a mile or more in width, or have formed groups of two or three funnels traveling together. On the average, tornadoes move between 25 and 45 miles per hour, but speeds over land of up to 70 mph have been reported. Tornadoes rarely last more than a couple of minutes over a spot for more than 15-20 minutes in a ten-mile area, but their short periods of existence do not limit their devastation of an area. The destructive power of the tornado results primarily from its high wind velocities and sudden changes in pressure. Damages from tornadoes result from extreme wind pressure and windborne debris. Since tornadoes are generally associated with severe storm systems, they are often accompanied by hail, torrential rain and intense lightning. Depending on their intensity, tornadoes can uproot trees, bring down power lines and destroy buildings. Flying debris is the main cause of serious injury and death.

Figure 2.2: FEMA's Design Wind Speed for Community Shelters

Downbursts are characterized by straight-line winds. Downburst damage is often highly localized and resembles that of tornadoes. There are significant interactions between tornadoes and downbursts and a tornado's path can also be affected by downbursts. Because of this, the path of a tornado can be very unpredictable, including veering right and left or even a U-turn.

Figure 2.3: History of Maryland Tornadoes



FEMA's publication, *Design and Construction Guidance for Community Shelters,* July 2000, presents a map of four wind zones in the U.S. (consistent with ASCE 7-98) and provides design wind speeds for shelters and other critical facilities. Zone IV shows the areas of highest wind activity which are situated in the Midwest and Tornado Alley, while Zone I shows the areas of lowest activity which are in the western part of the United States.

The map indicates that approximately 209 tornadoes have occurred in Maryland between 1950 and 1998. There have been 19 incidents in Frederick County during that period.

Hurricanes

Overview

Hurricanes and tropical storms, as well as tropical depressions, are all tropical cyclones defined by the National Weather Service's National Hurricane Center (NHC) as warm-core non-frontal synoptic-scale cyclones, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation around a well-defined center. Once they have formed, tropical cyclones maintain themselves by extracting heat energy from the ocean at high temperatures and releasing heat at the low temperatures of the upper troposphere. Hurricanes and tropical storms bring heavy rainfalls, storm surge, and high winds, all of which can cause significant damage. These storms can last for several days, and therefore have the potential to cause sustained flooding, high wind, and erosion conditions.

Storm Surge - Storm surge can be modeled by various techniques; one such technique is the use of the National Weather Service's (NWS) sea, lake and overland surges from hurricanes (SLOSH) model. The model is used to predict storm surge heights based on hurricane category. Surge inundation areas are classified based on the category of hurricane that would cause flooding. From the SLOSH maps, it may be concluded that the VE zones would be inundated during a Category 1 storm. As the category of the storm increases, more land area will become inundated. Storm surge is a major component of Nor'easter storms along the East Coast of the U.S. Because winds are moving from a north and/or eastward position, winds move across the ocean towards shore and form large waves.

Hurricanes are classified using the Saffir-Sampson Hurricane Scale (Table 2.3) which rates the intensity of hurricanes based on wind speed and barometric pressure measurements and is used by the National Weather Service to predict potential property damage and flooding levels from imminent storms.

Table 2.3 - Saffir-Sampson Scale and Typical Damages

CATEGORY	SUSTAINED WIND SPEEDS (MPH)	SURGE (FT)	PRESSURE (MB)	TYPICAL DAMAGE
Tropical Depression	<39	--	--	
Tropical Storm	39-73	--	--	
Hurricane 1	74-95	4-5	> 980	*Minimal* – Damage is done primarily to shrubbery and trees, unanchored manufactured homes are damaged, some signs are damaged, no real damage is done to structures on permanent foundations.

CATEGORY	SUSTAINED WIND SPEEDS (MPH)	SURGE (FT)	PRESSURE (MB)	TYPICAL DAMAGE
Hurricane 2	96-110	6-8	965-980	*Moderate* – Some trees are toppled, some roof coverings are damaged, major damage is done to manufactured homes.
Hurricane 3	111-130	9-12	945-965	*Extensive Damage* – Large trees are toppled, some structural damage is done to roofs, manufactured homes are destroyed, structural damage is done to small homes and utility buildings.
Hurricane 4	131-155	13-18	920-945	*Extreme Damage* – Extensive damage is done to roofs, windows, and doors; roof systems on small buildings completely fail' some curtain walls fail.
Hurricane 5	> 155	> 18	< 920	*Catastrophic Damage* – Roof damage is considerable and widespread, window and door damage is severe, there are extensive glass failures, some buildings fail completely.

Historic Activity

No hurricane incidents have been reported in Frederick County between 1950 and 2003, however the impact of hurricanes Agnes and Isabel resulted in very strong winds and flooding. Two houses in the City of Frederick were flooded by an inadequate drainage ditch. This cost the City over $400,000 for purchase, demolition, cleaning asbestos and spilled heating oil from the properties.

Hurricanes

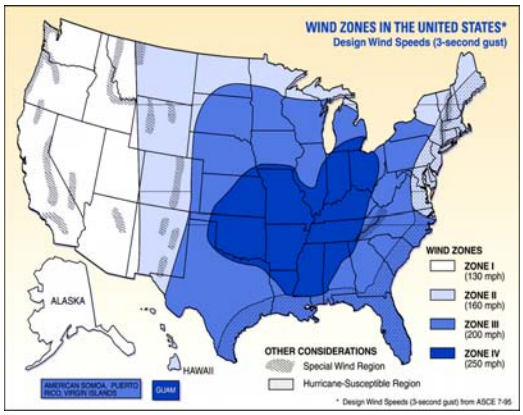


Figure 2.4: Wind Zones in the United States

Profile

Since hurricanes can disrupt power and inundate roads, they can cause havoc on the entire community. FEMA's publication, *Taking Shelter from the Storm*, October 1998, presents a map of four wind zones in the U.S. and provides design wind speeds for shelters and other critical facilities. Zone IV shows the areas of highest wind activity, which are situated in the Midwest and Tornado Alley, while Zone I shows the areas of lowest activity, which are in the western U.S. All of Frederick County is mapped in Zone III. For shelters in this zone, a design wind speed of 160 mph is recommended.

Hailstorms

Overview

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

Hailstones grow in size when the frozen droplet is repeatedly blown into the higher elevations. The hailstone ascends as long as the updraft velocity is high enough to hold the hailstone. As soon the size and weight of the hailstone overcomes the lifting capacity of updraft, it begins to fall freely under the influence of gravity. The falling of hailstones, under thunderstorm conditions, is accompanied with a cold downdraft of air.

Historic Activity

A total of 25 hailstorms were reported in the County between 1950 and 2003. The following recent events of hail have been elaborated below.

- On 16 July 2000, scattered thunderstorms that produced winds in excess of 55 miles per hour, heavy rainfall, large hail, and frequent lightning moved across Maryland. In Frederick County, quarter sized hail destroyed a cornfield in Thurmont and a car was hit by lightning but no one was injured.
- On 22 June 2001, severe storms contained very heavy rainfall, frequent lightning, and occasionally produced high winds and large hail. In Frederick County, nickel sized hail was reported on Route 40 west of Frederick. In Frederick, pea-sized hail fell and a wind gust of 50 MPH was estimated. Trees were downed by high winds in the Putman Road area 5 miles north-northwest of Frederick. Pea-sized hail was reported in Poolesville. A spotter in Braddock Heights reported 2 inches of rainfall in 20 minutes. At Point of Rocks, the railroad crossing on Route 28 was flooded. A three-story mansion was struck by lightning and the resulting fire caused $300,000 damage. Another lightning fire in Kemptown caused $20,000 damage. No casualties or fatalities were reported.
- In August 2002, several thunderstorms with high winds, large hail, and frequent lightning moved through western and central Maryland. In Frederick County, a 52-year-old man was killed by lightning while standing on the back porch of his Frederick home. It was not raining at the time he was struck. A 17-year-old swimming pool lifeguard at Fort Detrick was injured when lightning struck nearby. A 36-year-old Frederick County man was also injured by lightning in an unknown location. At least four homes across the County were damaged by lightning and 2000 bales of hay were set on fire near Emmitsburg. Wind damage was reported in Park Mills. Marble to quarter sized hail fell just south of Frederick for nearly 10 minutes. No fatalities or casualties were reported and there was no damage to crop or property.

Profile

Most of the "damaging" hailstones vary between the size of a golf ball ("severe") to the size of a softball or larger ("oversized"). According to the National Weather Service, most of the United States experience "severe" and "oversized" hailstorms. The largest recorded hailstone in the United States fell in Coffeyville, Kansas on September 3, 1970 and measured more than 7.0

inches in diameter and weighed 1.7 pounds, generating an impact force of 578 lb-ft. Hailstorms occur all year round at all times of the day but are more frequent in the summer months, in the evenings, and after sunset.

Severe Winter Storms

Overview

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

- Heavy snowfall - the accumulation of six or more inches of snow in a 12-hour period or eight or more inches in a 24-hour period.
- Blizzard - the occurrence of sustained wind speeds in excess of 35 miles per hour accompanied by heavy snowfall or large amounts of blowing or drifting snow.
- Ice storm - an occurrence where rain falls from warmer upper layers of the atmosphere to the colder ground, freezing upon contact with the ground and exposed objects near the ground.
- Freezing drizzle/freezing rain - the effect of drizzle or rain freezing upon impact on objects that have a temperature of 32 degrees Fahrenheit or below.
- Sleet - solid grains or pellets of ice formed by the freezing of raindrops or the refreezing of largely melted snowflakes. This ice does not cling to surfaces.
- Wind chill - an apparent temperature that describes the combined effect of wind and low air temperatures on exposed skin.

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

Historic Activity

There have been about 67 major winter storm incidents in Frederick County between 1950 and 2003. A few of these are elaborated below.

- On 14 February 2003, a complex storm system produced copious amounts of wintry precipitation across Maryland, west of the Chesapeake Bay. Nicknamed the President's Weekend Snowstorm of 2003, this storm will go down in history as the heaviest snowstorm in

the Baltimore region since records began in 1870. A total of 28.2 inches of snow was recorded at Baltimore-Washington International Airport. This massive storm took a heavy toll on residents, structures, transportation systems, emergency responders, businesses, livestock, and travelers. A state of emergency was declared by the Governor of Maryland and people across the State were ordered to stay off the roads during the height of the storm between the morning of the 16th and the morning of the 17th. Roads were covered by deep snow and sleet and were nearly impassible. Main highways were partially cleared by the 18th but it took up to 5 days to reach some secondary and residential roads. In Frederick County, 5 sheds or barns caved-in. Portable classrooms at 4 county schools collapsed. A meeting hall and a tennis court bubble were crushed. A 42-year-old man died from a heart attack after shoveling snow in New Market. A 12-year-old boy died from carbon monoxide poisoning in a snowbound car in Mt. Airy. Property damage incurred by the Maryland counties was approximately $5.2 million. There were 2 fatalities and 10 injuries.

- On 14 January 1999, a strong arctic cold front moved slowly southeast across the Mid-Atlantic region. This front brought a thick layer of sub-freezing air to the lowest levels of the atmosphere, but just off the surface warmer air moved in. This created ice accumulations of one quarter to one half inch north and west of a line from Montgomery County to Harford County. The total damage to Maryland counties was estimated at 3.2 million. No fatalities or casualties were reported.
- On 26 March 1997, a strong surface high pressure area over New England pushed a shallow layer of subfreezing air into the northern tier of Maryland. Caroll, Frederick, northern Baltimore, and Washington Counties were affected. Total property damage to these counties was estimated at $ 150,000.
- On 5 December 2003, a winter storm produced 5 to 6 inches of snow across North and Central Maryland. A medical condition rendered a Frederick woman unconscious after she walked outside to check her mailbox and she eventually died of hypothermia. No property or crop damage was reported during this event.

Profile

All areas of Frederick County are subject to the effects of winter storms. These storms may include snowstorms, sleet storms, ice storms, and blizzards. Major winter storms and occasional blizzard conditions bring bursts of heavy snow accumulating 3-6 inches in short periods or 1-2 feet in 12-24 hours. Blizzard conditions develop with winds over 35 mph. Freezing rain and drizzle will create a coating of ice that is hazardous to walk on. Other impacts include hazardous conditions caused by falling trees and powerlines, requirement of additional manpower to clear debris, snow removal and salting, and large scale use of public shelters, and traffic delays.

Extreme Summer Heat

Overview

Temperatures that hover 10 degrees or more above the average high temperature for the region and lasts for several weeks are defined as extreme heat. A heat wave is primarily a public health concern. During extended periods of very high temperatures or high temperatures with high humidity, individuals can suffer a variety of ailments including heat stroke, heat exhaustion, heat syncope, and heat cramps.

- Heat stroke, in particular, is a life threatening condition that requires immediate medical attention. It exists when the body's core temperature rises above 105°F as a result of

environmental temperatures. Patients may be delirious, stuporous, or comatose. The death-to-care ratio in reported cases in the US averages about 15%.

- Heat Exhaustion is much less severe than heat stroke. The body temperature may be normal or slightly elevated. A person suffering from heat exhaustion may complain of dizziness, weakness or fatigue. The primary cause of heat exhaustion is fluid and electrolyte imbalance. The normalization of fluids will typically alleviate the situation.
- Heat Syncope is typically associated with exercise by people who are not acclimated to exercise. The symptom is a sudden loss of consciousness. Consciousness returns promptly when the person lies down. The cause is primarily associated with circulatory instability as a result of heat. The condition typically causes little or no harm to the individual.
- Heat Cramps are typically a problem for individuals who exercise outdoors but are unaccustomed to heat. Similar to heat exhaustion it is thought to be a result of a mild imbalance of fluids and electrolytes.

In 1979, R.G. Steadman, a meteorologist, developed the heat index, which is shown in Table 2.4 to illustrate the risk associated with extreme summer heat.

Table 2.4 - Heat Danger Categories

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

Historic Activity

Based on data from the National Climatic Data Center, there have been 27 incidents of extreme heat between 1950 and 2003, some of which are explained below.

- On 22 August 2002, high temperatures rose into the mid 90s and heat index values soared near 105 degrees during the afternoon. Three people died as a result of the excessive heat. No damage to property or crop was reported.

- High pressure sitting off the Atlantic coastline pumped hot and humid air into the region between August 12 and 19 August, 2002. Temperatures soared well into the 90s during the afternoon each day and heat index values approached 100 degrees. Four Marylanders died during the eight day heat wave. No property or crop damage was reported.

- High pressure off the Atlantic Coast pumped hot and humid air into the Mid-Atlantic region. This caused high temperatures to reach between 92 and 100 degrees August 1st through the 5th and heat indexes soared between 98 and 110 degrees. In Frederick County, eleven people participating in an outdoor activity in Ijamsville were treated for heat illnesses. The heat was also blamed for buckling pavement on Interstate 70 near the Route 355 exit. Several regional power companies noted record energy consumption during this heat wave, the hottest in 5 years.

- A large area of high pressure sat off the Mid-Atlantic coast during the last week of July 2002. This caused a warm and moist south wind to blow into the region for several days, resulting in another heat wave. The hottest days were the 28th and 29th of July when temperatures rose into the 90s and heat index values reached 100 to 110 degrees. Power companies reported record electricity use on the 29th. Three fatalities were recorded in the Maryland area.

- High pressure remained stationary off the Delmarva coastline during the 1st week of July 2002. This resulted in a prolonged period of hot and humid weather across the Mid Atlantic region. Between July 2nd and 4th, high temperatures rose into the lower to middle 90s and dew points reached into the lower 70s. This resulted in heat index values reaching 100 to 110 degrees during the afternoon. In Frederick County, a 23 year-old firefighter who went jogging collapsed and went into cardiac arrest. By the time he arrived at the hospital, his body temperature had reached 107 degrees. He died of heat stroke a short time later. Twenty other people were treated at hospitals for heat illnesses countywide between July 2nd and 4th. Twenty-one fatalities were recorded in the Maryland area. There was no damage to crop or property.

Profile

In addition to posing a public health hazard, periods of excessive heat usually result in high electrical consumption for air conditioning, which can cause power outages and brown outs. The elderly, disabled, and debilitated in the county are especially susceptible to heat stroke. Large and highly urbanized cities such as Frederick City can create an island of heat that can raise the area's temperature by 3 to 5° F. Therefore, urban communities with substantial populations of elderly, disabled, and debilitated people could face a significant medical emergency during an extended period of excessive heat.

Hydrologic Hazards

Flash Floods and Flooding

Overview

Flash floods, as the name suggests, occur suddenly after a brief but intense downpour. They move fast and terminate quickly. Although the duration of these events is usually brief, the damages can be quite severe. Flash floods also result as a secondary effect from other types of disasters including large wildfires and dam breaks. Wildfires remove vegetative cover and alter soil characteristics, increasing the quantity and velocity of stormwater runoff and dam breaks release large quantities of water into receiving drainage ways in a very short timeframe. Flash floods are the number one weather-related killer with approximately 140 deaths recorded in the United States each year.

Riverine floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies use historical records to determine the probability of occurrence for different extents of flooding. The probability of occurrence is expressed as the percentage chance that a flood of a specific extent will occur in any given year. On the other hand, flash floods cannot be predicted accurately and happen whenever there are heavy storms.

Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. The probability of a flood is based on a statistical chance of a particular size flood (expressed as cubic feet per second of water flow) occurring in any given year. The annual flood is usually considered the single greatest event expected to occur in any given year. Flood studies use historical records to determine the probability of occurrence for different extents of flooding. The probability of occurrence is expressed as the percentage chance that a flood of a specific extent will occur in any given year. The extent of flooding associated with a 1% annual probability of occurrence; the base flood is used as the regulatory boundary by a number of agencies.

Also referred to as the "Special Flood Hazard Area," this boundary is a convenient tool for assessing vulnerability and risk in flood prone communities since many communities have maps available that show the extent of the base flood and likely depths that will be experienced. The base flood is often referred to as the "100-year flood." Experiencing a 100-year flood does not mean a similar flood cannot happen for the next 99 years; rather, it reflects the probability that over a long period of time, a flood of that magnitude should occur in only 1% of all years. Smaller floods occur more often than larger and more widespread ones. The table shows a range of flood recurrence intervals and their probabilities of occurrence. So every year, a 10-year flood has a greater likelihood of occurring (10% chance) than a 100-year flood (1% chance).

Table 2.5 – Flooding vs. Flash Floods - Causes

Causes of Flooding	Causes of Flash Floods
Low lying, relatively undisturbed topography	Hilly/mountainous areas
High season water tables	High velocity flows
Poor drainage	Short warning times
Excess paved surfaces	Steep slopes
Constrictions – filling	Narrow stream valleys
Obstructions – bridges	Parking lots & other impervious surfaces
Soil characteristics	Improper drainage

Table 2.6 - Flood Probability Terms

Flood Recurrence	Chance of occurrence in any given year
10-year	10%
50-year	2%
100-year	1%
500-year	0.20%

Historic Activity

54 flood events were reported in Frederick County, Maryland between January 1950 and December 2003. A few of the major flood events are elaborated.

- On 14 June 1972 Hurricane Agnes began as a tropical disturbance off the coast of Mexico. By 19 June, Agnes became a hurricane and made initial landfall along the Florida

panhandle on June and made her way up the Atlantic Coast. The most impressive aspect of the hurricane was the widespread nature of its floods, resulting in extremely rare floods on major rivers and streams. The flood recurrence frequency in many locations exceeded 100 years, most notably on the Susquehanna River downstream of Waverly, New York, and on the Potomac River, downstream, from Point of Rocks, Maryland. The Monocacy River in Frederick rose from a height of 30 to 35.9 after Agnes. Hurricane Agnes was the costliest natural disaster in the United States at that time. Damage was estimated at $3.1 billion and 117 deaths were reported. In Maryland, the damage was estimated at $110 million and 19 deaths were reported.

- On 19 January 1996, snowmelt combined with 1 to 3 inches of rain to produce heavy river flooding in Allegany, Montgomery, Washington, and Frederick Counties. The flooding was the worst in the region since 1985. Almost all dwellings in the town of Point of Rocks were damaged by the flood waters in some way. There were several water and sewage plant failures. Water line breaks occurred in Lavale and failures at Sharpsburg and Hagerstown forcing residents to boil water for 3 to 5 days (thousands of others were without water for 1 to 2 days). The plant in Brunswick was shut down for 1 to 3 days due to flood waters and high turbidity. Three counties in central Maryland were declared under a Federal state of emergency: Washington, Allegany, and Frederick. Total property damage to the area was estimated at $ 60 million. No fatalities or injuries were reported.
- On 19 June 1996, the northern part of the County experienced a major flood. There was 1 fatality and approximately $5 million of property damage.
- On 6 September 1996, a flood was experienced throughout the County. No casualties or injuries were reported. Property damage and crop damage to the area was $ 75,000 and $10,000, respectively.
- On 1 August 2000, scattered thunderstorms produced very heavy rainfall, gusty winds, and frequent lightning. In Frederick County, the chimney of a two-story home in Jefferson was struck by lightning. A fire resulted which heavily damaged the structure. A heavy downpour sent Martin's Creek out of its banks in Brunswick. Rushing water from the creek inundated nearby buildings. A City building made of cinder blocks had the rear and part of a side wall washed away. Cars, trucks, and other equipment stored inside were also damaged. Some culvert pipes were washed out and a foot bridge and a fence were washed away. A home across the street from the creek also reported flood damaged to appliances. Property damage to the County was approximately $100,000. No fatalities or injuries were reported.
- On 18 September 2003, Hurricane Isabel made landfall on the North Carolina Coast. The high winds gusts to 70 mph came with bands of showers that mixed down to the surface causing streaks of damage that sometimes appeared as though a tornado had moved through instead of a strong narrow ribbon of wind. Wind damage to structures was limited while wind damage to trees in the area was extensive and widespread. Soil moisture was high from previous rains making it easier for trees to uproot. Also, the trees were still in full canopy which acted like a sail to catch the wind. Trees fell on electrical and utility wires taking out power and phone lines. Trees fell on roads, cars, and homes. In Frederick County, a State trooper was injured when a tree fell on his car in the storm and another was injured when a tree fell on him. Two homes had some damage and there were 40 road closures from trees falling on them. Approximately 29,000 customers lost power in Frederick County due to this flooding event. The region incurred property damage of approximately $130,000. No fatalities or injuries were reported.

Profile

Flash floods are more likely to occur in places with steep slopes and narrow stream valleys, and along small tributary streams. In urban areas, parking lots and other impervious surfaces that shed water rapidly contribute to flash floods. In rugged, hilly, and steep terrain, the high-velocity flows and short warning time make these floods hazardous and very destructive. Flash floods could also be a result of improper drainage.

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

Drought

Overview

Drought is a condition of climatic dryness that is severe enough to reduce soil moisture and water and snow levels below the minimum necessary for sustaining plant, animal, and economic systems. Drought is a complex physical and social process of widespread significance. It is not usually a statewide phenomena, with differing conditions in the State often making drought a regional issue. Despite all of the problems that droughts have caused, drought has proven to be difficult to define and there is no universally accepted definition because drought, unlike floods, is not a distinct event. Drought are often the result of many complex factors such that drought often has no well-defined start nor end and the impacts of drought vary by affected sector; thus, often making definitions of drought specific to particular affected groups.

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

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

Historic Activity

Data reveals that Frederick County experienced 10 drought periods between 1950 and 2003. Some of these are explained in detail.

- July 1997 was a very dry month, containing one 7-day heat wave, exacerbated drought-like conditions across much of the fertile farmland of Maryland. The weather in July proved disastrous for much of the crop yields, including corn, hay, alfalfa, and soybeans. Agricultural states of emergency were declared in many areas west of the Chesapeake Bay. Hardest-hit counties included Carroll, Frederick, Howard, Montgomery, and Washington. Some of the more impressive damage estimates were as follows: in Frederick County nearly $9 million in corn, an approximate 90 percent loss; an additional $5.5 million in corn for silage and soybean, a 60 percent loss. The total crop damage to the 12-county region in Maryland was estimated at $43.7 million.

- November 1998 was the fifth month in a row that drought conditions were seen across Central and Northern Maryland. Only 1.13 inches of rain fell at the Baltimore/Washington International Airport in Anne Arundel County during the month of November, 2.07 inches below normal. Other monthly rainfall totals from affected counties included 0.6 inches in Washington, 0.7 in Howard, 0.9 in Frederick, 1.0 in Charles, 1.1 in Carroll and Anne Arundel, and 1.2 in Montgomery and Prince Georges. Water levels and reserves were greatly affected by the persistent drought. The total crop damage incurred by 13 counties in Maryland including Frederick was approximately $20 million.

- From September 1998 through August 1999 precipitation was a staggering 12 to 16 inches below average. During August, 6.14 inches of rain fell at Baltimore/Washington International Airport, 2.22 inches above normal. Additional August rainfall totals included Allegany County at 2.5 inches, Washington County at 2.3 inches, Frederick County at 3.1 inches, Prince Georges County at 5.3 inches, Carroll County at 4.7 inches, Anne Arundel at 6.6 inches, Northern Baltimore County at 5.4 inches, Howard County at 4.3 inches, Montgomery County at 4.6 inches, Charles and Calvert Counties at 5.5 inches, and St. Mary's County at 5.8 inches. The lack of rainfall through the third week of August continued to affect water levels along the Potomac River and the Chesapeake Bay. Nineteen Maryland counties were declared federal drought disaster areas. The worst agricultural drought in Maryland continued to devastate farmers. Approximately 55% of pasture land, 45% of corn, 39% of sorghum, 29% of tobacco, and 34% of soybeans across the state were reported in poor or very poor condition and 42% of topsoil and 84% of subsoil were reported as short or very short of moisture. Frederick County lost 90% of their corn and soybean crop, and $9 million in lost revenues. Crop damage for several Maryland Counties totaled to $30 million.

- During the summer of 2002, drought that gripped the State of Maryland. The ground and reservoir water supply in Frederick County was low. By September 2002, the area was being strangled by the worst drought in more than 30 years. The first nine months of 2002 were dangerously dry, with 25 inches of rain recorded at Dulles International Airport during that time (average for that time period, is 32 inches). On Aug. 31, 2002, Virginia Governor implemented mandatory drought restrictions through nearly half the state, including the Winchester area, just as the area recorded an inch of rain.

Profile

Droughts result from prolonged periods of dry weather accompanied by extreme heat and usually occur during the summer months (July and August). The warmest time of the year is July when maximum temperatures average 89 degrees. Extreme temperatures of 100 degrees occur occasionally. The occurrence of drought cannot be predicted. The usual length of time does not exceed six weeks in mid summer.

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

Drought also has a major impact on livestock. Based on information from the United States Department of Agriculture, a total of 215,927 acres of land is currently devoted to agriculture in Frederick County. This represents approximately 51 percent of Frederick County's land. The topography in Frederick County varies from gently rolling hills in the southern part of the county to near mountain-like conditions in towards the north. Frederick County has a very diverse crop and livestock agriculture, but its focus is dairy. It ranks first in the State in milk production. In 2002, there were 25,000 head of milk cows in the County, producing 338 million pounds of milk.

Current Trends

As the County's Comprehensive Plan indicates, agriculture remains a leading and vital sector of Frederick County's economy. Agricultural Census data indicate that while farming in the County is not becoming extinct, there is considerable evidence to the fact that agriculture is in transition in Frederick County.

Frederick County's agricultural industry is heavily influenced by market forces and population expansion from the Washington/ Baltimore metropolitan corridor. Since 1970, Maryland's population has grown by 22 percent. The Washington / Baltimore metropolitan corridor has been the center of most of this population growth. Statewide, an additional 1,152,000 people are projected between 1993 and 2020 (i.e., 23.5 percent growth). Most of the projected population growth will be located in the Washington / Baltimore metropolitan corridor. Large scale in-migration in the metropolitan corridor is resulting in significant changes in the agricultural industry throughout Maryland's metropolitan counties.

Future Trends

The agricultural industry has continued to adapt to market and population forces. A number of factors have helped to generate a perception of impermanence in Frederick County's agricultural industry. The realities of higher land costs to purchase additional crop or pasture land, greater difficulties in obtaining long-term leases, labor shortages, increased wage scales, traffic congestion, loss of nearby agricultural support industries, and the influx of non-agricultural neighboring uses are causes of this industry's transition.

Wildfires and Urban Interface Fire

Overview

A wildfire is an uncontrolled fire spreading through vegetative fuels, such as brush, marshes, grasslands or field lands, exposing and possibly consuming structures. They often begin unnoticed and spread quickly and are usually signaled by dense smoke that fills the area for miles around. Wildfires may also be called forest fires. For the purpose of this analysis, the term wildfire will be used. The causes of these fires include lightning, human carelessness and arson.

An Urban-Wildland Interface fire is a wildfire in a geographical area where structures and other human development meet or intermingle with wildland or vegetative fuels.

Fires can be rated based on their degree of combustion as noted in Table 2.7.

Table 2.7 - Fire Danger Rating Descriptions

Rating	Description
Low	Fuels do not ignite readily from small firebrands although a more intense heat source, such as lightning, may start fires in duff or punky wood. Fires in open cured grasslands may burn freely fro a few hours after rain, but woods fires spread slowly by creeping or smoldering, and burn in irregular fingers. There is little danger of spotting.
Moderate	Fires can start from most accidental causes, but with the exception of lightning, fires in some areas, the number of starts is generally low. Fires in open cured grasslands will burn briskly and rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
High	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High-intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while small.
Very High	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels.

Historic Activity

Data from the Maryland Department of Natural Resources indicates that the County experienced 331 fires between 1994 and 2003. The largest number of fires were experienced in 1999 (80 fires) while there were only 4 incidents in 2003.

Note: This does not include all fires, just the larger ones and comprises about 5 or 6 % of the total wildland fires in the county.

Table 2.8 - Frederick County Fire Incidents

Year	No. Fires
2003	4
2002	31
2001	49
2000	48
1999	80
1998	43
1997	16
1996	12
1995	30
1994	18
Total	**331**

Profile

Wildfires can occur at any time of day and during any month of the year, and the season length and peak months may vary appreciably from year to year. Land use, vegetation, amount of combustible materials present and weather conditions such as

wind, low humidity and lack of precipitation are the chief factors determining the number of fires and acreage burned. Generally, fires are more likely when vegetation is dry from a winter with little snow and/or a spring and summer with sparse rainfall. Wildfires are capable of causing significant injury, death and damage to property. The potential for property damage from fire increases each year as more recreational properties are developed on wooded land and increased numbers of people use these areas. Fires can extensively impact the economy of an affected area, especially the logging, recreation and tourism industries, upon which Frederick County depends. Major direct costs associated with forest fires or wildfires are the salvage and removal of downed timber and debris and the restoration of the burned area. If burned-out woodlands and grasslands are not replanted quickly to prevent widespread soil erosion, then landslides, mudflows and floods could result, compounding the damage.

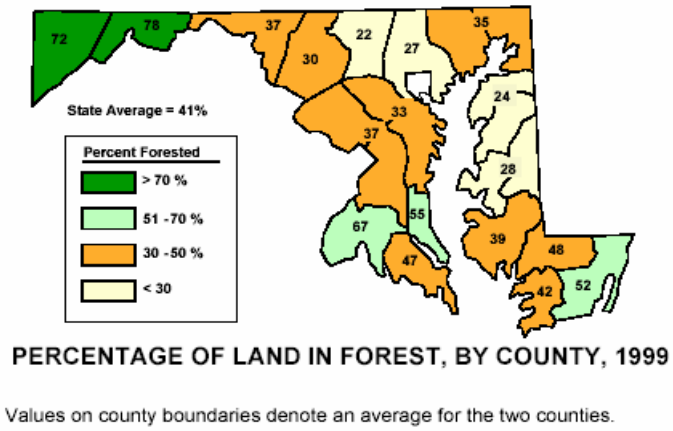


Figure 2.5: Forested Areas in Maryland Counties

The graphic indicates that Frederick County has approximately 30 percent of its land delineated as forested lands.

Geologic Hazards

Earthquakes

An earthquake is a shaking or sometimes violent trembling of the earth that results from the sudden shifting of rock beneath the earth's crust. This sudden shifting releases energy in the form of seismic waves or wave-like movement of the earth's surface. Earthquakes can strike without warning and may range in intensity from slight tremors to great shocks.

Earthquakes are measured by two principal methods: seismographs and human judgment. The seismograph measures the magnitude of an earthquake and interprets the amount of energy released on the Richter scale. An earthquake measuring 6.0 on the Richter scale is ten times more powerful than a 5.0 and one hundred times more powerful than an earthquake measuring 4.0. This is a measure of the absolute size or strength of an earthquake and does not consider the effect at any specific location.

The Modified Mercalli Intensity Scale is an intensity scale expressed in Roman numerals, which reports the amount of shaking and effects at a specific location based on expert judgment. The scale has twelve classes and ranges from I (not felt) to XII (total destruction). Table 2.9 shows a comparison for scales of magnitude and intensity.

Table 2.9: Earthquake Magnitude and Intensity Scales

Magnitude (Richter)	Intensity (Mercalli)	Description
1.0 – 3.0	I	I. Not felt except by a very few under especially favorable conditions.
3.0 – 3.9	II – III	II. Felt only by a few persons at rest, especially on upper floors of buildings. III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people so not recognize it is as earthquake. Standing motorcars may rock slightly. Vibrations similar to the passing or a truck. Duration estimated.
4.0 – 4.9	IV – V	IV. Felt indoors by many outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; wall make cracking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably.
5.0 – 5.9	VI – VII	VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. VII. Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable damage in poorly built or badly designed structures. Some chimneys broken.
6.0 – 6.9	VIII – IX	VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments and walls. Heavy furniture overturned. IX. Damage considerable in specially designed structures well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings foundations shifted.
7.0 and higher	X or higher	X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent. XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly. XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Source: United State Geographical Survey National Earthquake Information Center

Table 2.10: Modified Mercalli Intensity Scale and Peak Ground Acceleration Comparison

MMI	Acceleration (%g) PGA	Perceived Shaking	Potential Damage
I	<0.17	Not Felt	None
II – III	0.17 – 1.4	Weak	None
IV	1.4 – 3.9	Light	None
V	3.9 – 9.2	Moderate	Very Light
VI	9.2 – 18	Strong	Light
VII	18 – 34	Very Strong	Moderate
VIII	34 – 65	Severe	Moderate to Heavy
IX	65 – 124	Violent	Heavy
X – XII	>124	Extreme	Very Heavy

Another way of measuring the potential damage of an earthquake is the peak ground acceleration (PGA). The PGA is measured as a percentage and refers to the maximum percentage of acceleration of the movement of the ground. A higher PGA means a more rapid movement of the ground and a higher probability of structural damage. Table 2.10 provides a comparison between the Modified Mercalli Intensity (MMI) scale and peak ground acceleration.

Source: USGS (Excerpted from FEMA Publication 386-2, "Understanding Your Risks" August 2001

Historic Activity

No earthquake incidents have been recorded in Frederick County since 1960.

Profile

Earthquakes can last from a few seconds to over five minutes and they may also occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris, because the shocks shake, damage or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides or releases of hazardous material, compounding their disastrous effects.

Landslides

Overview

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

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

Slope material that becomes saturated with water may develop a debris flow or mud flow. The resulting slurry of rock and mud may pick up trees, houses, and cars, thus blocking bridges and tributaries causing flooding along its path. Landslides occur in every State and U.S. territory. The Appalachian Mountains, the Rocky Mountains and the Pacific Coastal Ranges and some parts of Alaska and Hawaii have severe landslide problems. Any area composed of very weak or fractured materials resting on a steep slope can and will likely experience landslides.

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

History

No records of past landslides have been found for Frederick County since 1950.

Profile

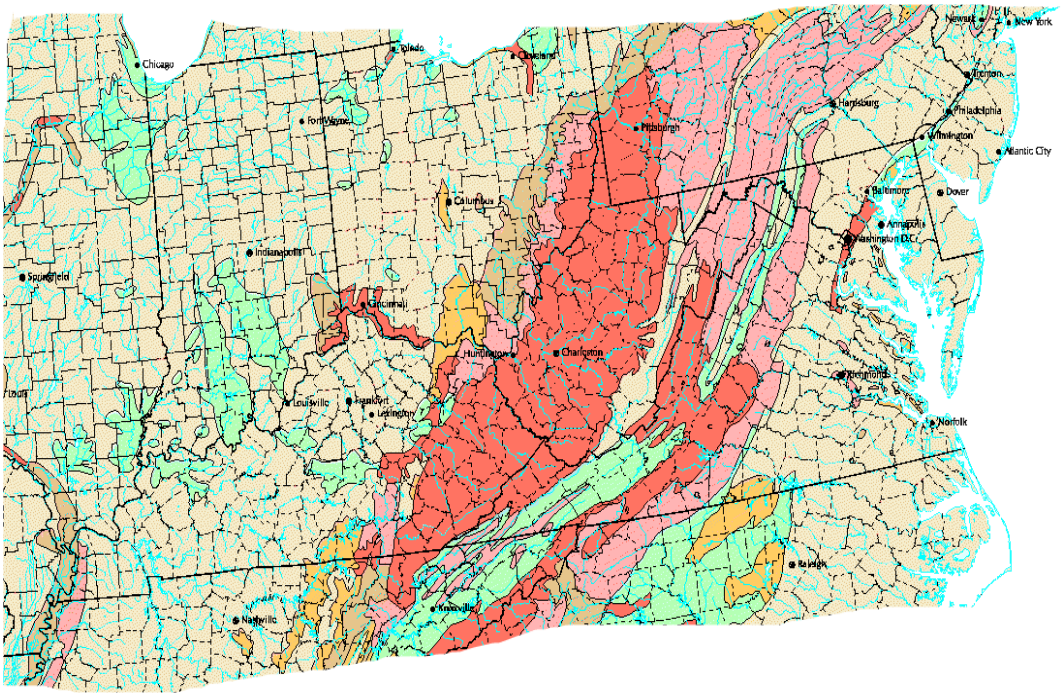
Landslides constitute a major geologic hazard because they are widespread, occurring in all 50 states, and cause $1-2 billion in damages and more than 25 fatalities on average each year. Landslides pose serious threats to highways and structures that support fisheries, tourism, timber harvesting, mining,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

LANDSLIDE INCIDENCE

Low (less than 1.5% of area involved)
Moderate (1.5%-15% of area involved)
High (greater than 15% of area involved)

LANDSLIDE SUSCEPTIBILITY/INCIDENCE

Moderate susceptibility/low incidence
High susceptibility/low incidence
High susceptibility/moderate incidence



Susceptibility not indicated where same or lower than incidence. Susceptibility to landsliding was defined as the probable degree of response of [the areal] rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high precipitation. High, moderate, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. Some generalization was necessary at this scale, and several small areas of high incidence and susceptibility were slightly exaggerated.

Figure 2.6: Landslide Incidence/Susceptibility for the Northeastern United States

Based on the Landslide map from the United States Geological Survey, Frederick County is in an area of moderated susceptibility and low incidence.

Landslides are common throughout the Appalachian region and New England. The greatest eastern hazard is from sliding of clay-rich soils; related damages in urban areas such as Pittsburgh, PA, and Cincinnati, OH, are among the greatest in the U.S. Landslides also occur across the Great Plains and into the mountain areas of the western U.S. in weathered shales and other clay-rich rocks particularly where there are steep slopes, periodic heavy rains, and vegetation loss has occurred after wildfires. Earthquakes and volcanoes also cause landslides; the catastrophic 1980 eruption of Mount St. Helens in Washington State was preceded by the by the development of a large landslide on the north side of the volcano. The Northridge earthquake in 1994 in the San Fernando Valley triggered thousands of landslides in the Santa Susanna Mountains north of the epicenter.

Land Subsidence

Overview

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

Common causes of land subsidence from human activity are pumping water, oil, and gas from underground reservoirs; dissolution of limestone aquifers (sinkholes); collapse of underground mines; drainage of organic soils; and initial wetting of dry soils (hydrocompaction). Land subsidence occurs in nearly every State of the United States.

In Frederick County the zone of influence around a sinkhole is a 1-mile radius for ground water withdrawal.

History

Frederick County has been known to have a number of sink holes. Recently, a study titled *"Stratigraphy-Karst Relationships in the Frederick Valley of Maryland" was conducted by David K. Brezinski and James P. Reger of the Maryland Geological Survey*. The following information has been extracted from this study.

"Karst features are present in strata of Triassic, Ordovician, and Cambrian age in the Frederick Valley of Maryland. The Frederick Valley of Maryland's western Piedmont represents the state's second largest karst terrane. Although the largest is located in eastern Washington County and is known as the Hagerstown Valley or Great Valley, the Frederick Valley has had more incidences of catastrophic collapse and active subsidence than its larger neighbor. The Frederick Valley is a lowland region that stretches from the Potomac River northward to Woodsboro in northern Frederick County, an area of approximately 400 square kilometers. The Maryland Geological Survey, in conjunction with the Maryland State Highway Administration, has been conducting detailed geologic mapping along with karst feature identification. This report is the preliminary results of that study which is currently in progress.

This study recognized and recorded three types of karst features: closed depressions, active sinkholes, and karst springs. By far the most common feature recognized were closed depressions, otherwise known as dolines. Dolines are defined as features that are recognizable

topographic lows towards which the surrounding area is inclined and can be from a few meters to 100 meters in width. The second category of karst features recorded is active sinkholes. These features are differentiated from depressions by the recognition of recent activity, or an open throat. The third category of karst features is springs. Depressions are by far the most common feature recorded, making up nearly 74 percent of all the readings. While active sinkholes comprised nearly 25 percent of the features, springs were a distant third making up only 1.3 percent of all karst features.

Approximately 1,179 karst features have been identified in the southern part of the Frederick Valley (Buckeystown, Point of Rocks and Frederick 7.5 minute quadrangles)."

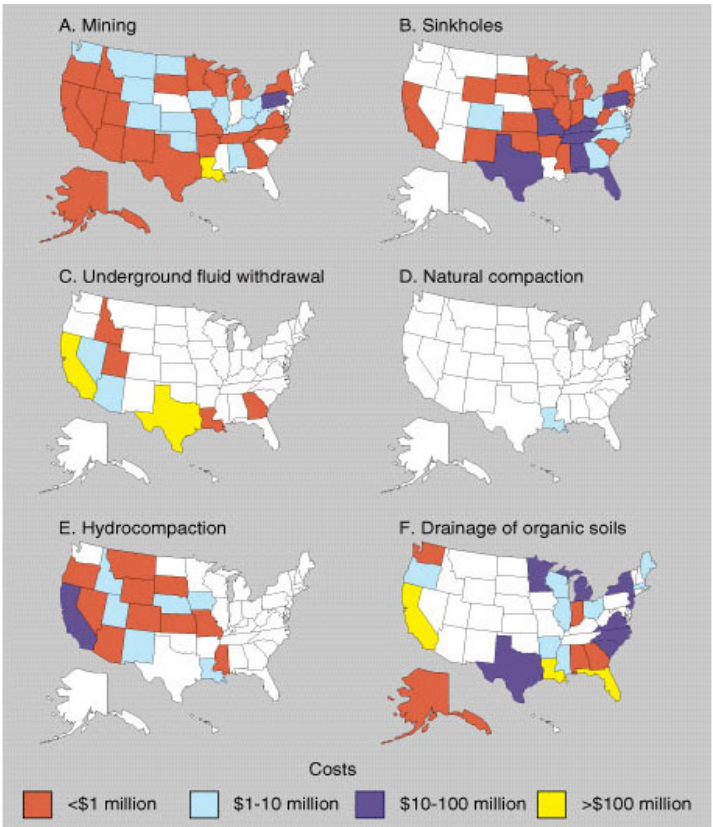


Figure 1. Distribution of subsidence problems in the United States estimated by the National Academy of Sciences (1991). Damage costs are conservative estimates for an unspecified period and are intended to show only relative magnitudes for state-by-state comparisons. The estimates do not reflect annual costs to control or mitigate damage from subsidence.

Figure 2.7: Distribution of Subsidence Problems in the United States

Sinkholes have caused some concern in Frederick County lately. Heavy rains that followed Hurricane Isabel caused a 110-foot long, 35-foot deep sinkhole on Reichs ford Road, knocking out power and putting backpressure on sewer treatment plants. According to the Department of Public Works, 14 sinkholes have opened in Frederick City since June 2003. In on case, a 13-foot deep hole appeared underneath a tanker truck after its driver went into a Sheetz. When he returned, the hole had begun to show, it wound up varying 7-10 feet in diameter.

Another sinkhole formed in a local farmers field in March 2003. Others showed up at the East Gate Shopping Center and in Sagner Park in April and September 2003, respectively. On average, they are 7-8 feet deep and 4-5 feet in diameter.

Profile

Land subsidence is usually not observable because it occurs over a large area. When land subsidence is isolated in a small area, they appear as sinkholes. Land subsidence is major events in California, Texas, and Florida, all of which have experienced hundreds of millions of dollars of damage over the years.

In areas where climate change results in less precipitation and reduced surface-water supplies, communities will pump more ground water. In the southern part of the United States from States on the Gulf Coast and westward including States of New Mexico, Colorado, Arizona, Utah, Nevada and California, major aquifers include compressible clay and silt that can compact when ground-water is pumped.

http://landslides.usgs.gov/html_files/landslides/nationalmap/ecentral.html

Table 2.11 - Summary of Hazard Events 1950 – 2003

Summary of Hazard Events (January 1950 - December 2003)

Hazard Event	Total Events	Injured	Property Damage	Crop Damage
Atmospheric				
Thunderstorms	164	13	4.48 million	$ 561,000
Lightning	25	5	1.79 million	$ -
Tornadoes	23	1	1.76 milliion	$ 50,000
Hurricanes	0	0	0	$ -
Hail	25			$ 10,000
Winterstorms	67	16	8.83 million	$ 20,000
Extreme Heat	27	427	30 million	$ 28,000
Wildfires				
Wildfires	0	0	0	0
Hydrologic				
Flood/flashfloods	54		66.53 million	$ 10,000
Drought	10			93.72 million
Geologic				
Earthquakes	0	0	0	0
Landslide/Land Subsidence	na	na	na	na
Sinkholes/Karst	na	na	na	na
Total	395	462	113.39 million	94.4 million

Summary of Events

Based on Table 2.11, the County has experienced approximately 395 natural hazard events since 1950. These events include atmospheric, hydrologic, wildfire, and geologic hazards. Thunderstorms are the most common occurring hazards in the County, followed by winter storms and floods.

The total property damage to the County by these hazards was almost $ 1 billion and total crop damage was approximately $ 680,000 (excluding drought since figures are regional damage values).

Table 2.12: Frequency of Occurrence

Hazard	Total Events	Years in Record	Frequency/Probability per Year
Atmospheric Hazard			
Thunderstorms	164	54	3.04
Lightning	25	54	0.46
Tornadoes	23	54	0.43
Hurricanes	0	54	0.00
Hailstorm	25	54	0.46
Winterstorms	67	54	1.24
Extreme Heat	27	54	0.50
Wildfire Hazard			
Wildfires	331	10	33.1
Hydrologic Hazard			
Flood/flashfloods	54	54	1.00
Drought	10	54	0.19
Geologic Hazard			
Earthquakes	0	0	0
Landslides/Land subsidence	na	na	na
Sinkholes/Karst	na	54	na

Conclusion

Based on the hazard history and profiles of the aforementioned hazards, the hazard frequency was determined (Table 2.12). The hazard frequency was calculated by dividing the number of events observed by the number of years. For example, 25 hailstorms divided by 54 years indicated that an average of .46 hailstorms occur in Frederick County in any given year.

The natural hazards addressed in this section have been ranked as low, medium, or high priority. The hazards have been prioritized based on several factors including the frequency of occurrence, amount of damage caused, potential for significant damage, and the community's interest in the hazard. Although wildfires had a high probability of occurrence, the Committee classified it as a medium priority hazard. Of the hazards, the high priority hazards such as winterstorms, floods, and sinkholes/karst will be assessed in the following chapter for their vulnerability.

Table 2.13: Hazard Priority

High Priority	Medium Priority	Low Priority
Thunderstorms	Lightning	Extreme Summer Heat
Severe Winter Storms	Hailstorms	Drought
Floods/Flashfloods	Earthquakes	Hurricanes
Tornadoes	Wildfire	Landslides/Land Subsidence
Sinkholes/Karst		

CHAPTER 3 - VULNERABILITY ANALYSIS/LOSS ESTIMATION

Overview

Step 3 – Vulnerability Assessment

A Vulnerability Assessment determines the impact that hazards have on the built environment and its effect on the safety of the residents. The results of the Hazard Identification indicate that some of the hazards warrant a Vulnerability Assessment due to the frequency of occurrence or those hazards that have caused major damage in Frederick County and its municipalities. The Vulnerability Assessment uses the information generated in the hazard identification and hazard profile to identify locations in which residents of Frederick County could suffer the greatest injury or property damage in the event of a disaster. This assessment identifies the effects of hazard events by estimating the relative exposure of people, buildings, and infrastructure to hazardous conditions.

Of the 12 hazards that were identified and profiled, it was determined that the hazards with a ranking of high and medium priorities should be selected for further review since the County is considered to be more vulnerable to these hazards, albeit in varying degrees.

- Flash Floods and Flooding
- Winter Storms
- Sinkholes/Karst
- Tornadoes
- Thunderstorms
- Drought

Step 4 – Loss Estimation

The last step of the risk assessment, namely the loss estimation step, involves estimating losses from hazard events and requires a full range of information and accurate data. The loss estimation process helps answer the question "How will the community's assets be affected by the hazard event?" The most convenient way to express the expected losses is in terms of dollars. These are only rough estimates and are included where available.

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

Note: Areas and total structures that are vulnerable to various hazards have been calculated based on available County data.

County Overview

The geographical size of Frederick County is approximately 666 square miles and contains 32 census tracts. There are over 70,000 households in the County with a total population of 195,277 (2000 Census). There are an estimated 68,064 buildings in the area with a total building replacement value (excluding contents) of $13,062 billion (2002 dollars). Approximately 99 percent of the buildings (and 83% of the building value) are associated with residential housing (Table 3.1), the dollar exposure of which is over $10 billion. Commercial buildings in the County have a total dollar exposure of approximately 1.3 billion.

Table 3.1 – Building Count by Occupancy

Building Count by Occupancy		
Occupancy	# Buildings	% of Total
Residential	67,173	98.7%
Commercial	656	1.0%
Industrial	121	0.2%
Agricultural	1	0.0%
Religious	48	0.1%
Government	50	0.1%
Education	15	0.0%
Total	68,064	100.0%

These buildings have also been categorized by construction type (Table 3.2). While steel and reinforced masonry structures are considered strong and more resistant to the forces of nature, wood and unreinforced masonry structures are more vulnerable to high wind and other hazards. Approximately 70 percent of the county's building stock is wood structures, with a total exposure of $7.7 billion (Table 3.3). Unreinforced masonry buildings constitute 27.5 percent of buildings. The total exposure for masonry buildings in Frederick County (reinforced and unreinforced) is $3.6 billion (Table 3.4). Manufactured housing offers approximately 23 million, in terms of exposure (approximately 600 structures).

Table 3.2 – Building Exposure by Occupancy

Bulilding Exposure by Occupancy		
Occupancy	Exposure	% of Total
Residential	10,828,843,000	83.0%
Commercial	1,363,246,000	10.4%
Industrial	528,036,000	4.0%
Agricultural	29,425,000	0.2%
Religious	132,880,000	1.0%
Government	55,338,000	0.4%
Education	124,625,000	1.0%
Total	13,062,393,000	100.0%

Source: FEMA's HAZUS-MH Hurricane Model (See Appendix for more details)

Table 3.3 – Building Count by Type

Building Count by Type		
Building Type	# Buildings	% of Total
Concrete	795	1.2%
Manufactured Housing	595	0.9%
Precast	40	0.1%
Reinforced Masonry	190	0.3%
Steel	469	0.7%
Unreinforced Masonry	18,725	27.5%
Wood	47,250	69.4%
Total	68,064	100.0%

Note: The tables are developed based on information in HAZUS-MH (level 1). These figures are only for indicative/informative purposes and should not be viewed literally for analytical purposes. For analytical purposes, level 2 data should be used (where specific local information can be keyed in to replace the ones in the national database) for greater accuracy.

HAZUS-MH Levels

Level 1: national level data sets are used for analysis

Level 2: national data may be modified with local data for more site-specific results.

Level 3: users may supply their own techniques to study special conditions such as dam break and tsunami, although engineering and other expertise is typically needed at this level.

Table 3.4– Building Exposure by Type

Building Stock Exposure by Type	
Type	Exposure
Wood	7,743,624,000
Masonry	3,667,502,000
Concrete	476,022,000
Steel	1,152,167,000
Manufactured Homes	23,063,000
Total	13,062,378,000

Critical Facilities

In order to assess the vulnerability of the community, an inventory of Frederick County's structures and critical facilities was performed. Critical facilities are those facilities that warrant special attention in preparing for a disaster and facilities that are vital in maintaining the functioning of the community. Frederick County has prepared an inventory of critical facilities that includes emergency response facilities such as police stations, fire departments, and emergency medical services (EMS) stations; hospitals and nursing homes; schools; local government buildings; and important transportation facilities including airports.

Table 3.5 - Frederick County Critical Facilities

	Police	Fire	Public School	Post Office	Library	Public Facility	Nursing Facility & Care	Other POI	Total
Walkersville	1	1	4	1	1	3	2		**13**
Woodsboro		1	1	1					**3**
Brunswick	1	2	3	1	1	7			**15**
Burkittsville				1		3			**4**
Emmitsburg	1	2	1		1	2	2	2	**11**
Frederick City	2	6	13	1	1	46	97	24	**190**
Middletown	1	1	3	1	1	1		1	**9**
Mt. Airy			1					1	**2**
Myersville		1	1	1					**3**
New Market		1	1	1		1			**4**
Thurmont	1	2	3	1	1	1		2	**11**
Rosemont								1	**1**
Not in towns		14	26	12		21	32		**105**
TOTAL	**7**	**31**	**57**	**21**	**6**	**85**	**133**	**31**	**371**

Table 3.5 indicates a total of 371 facilities in Frederick County and its municipalities that are deemed critical in nature. Of this, 190 facilities are located in Frederick City, and 105 facilities are dispersed in the unincorporated areas of the County. In terms of facility type, there are 133 nursing and health care related facilities in the County. The County has approximately 57 public schools and 85 public buildings. There are over 30 facilities that are classified as '"other points of interest." They include parks, summits, museums and facilities that do not fall into any of the other major categories.

Source: County GIS Data and Maryland State Highway Administration – Points of Interest list for Frederick County.

Table 3.6 - Transportation System Lifeline Inventory

Transportation System Lifeline Inventory			
System	Component	# Locations/ Segments	Replacement Value
Highway	Bridges	152	$ 197,800,000
	Segments	125	$ 1,803,400,000
	Tunnels	0	$ -
Sub Total			$ 2,001,200,000
Railways	Bridges	0	$ -
	Facilities	1	$ 2,200,000
	Segments	75	$ 107,300,000
	Tunnels	0	$ -
Sub Total			$ 109,500,000
Light Rail		0	$ -
Bus		0	$ -
Ferry		0	$ -
Port		0	$ -
Airport	Facilities	8	$ 43,200,000
	Runways	9	$ 276,900,000
Sub Total			$ 320,100,000
Total			$ 2,430,700,000

Lifeline Inventory

Table 3.6 discusses the Transportation System Lifeline Inventory that was derived from the HAZUS-MH database. The replacement value for highways in the County was approximately $2 billion and that of airports was $320 million. The total transportation system lifeline replacement value was estimated at $ 2.4 billion.

HAZUS-MH, categorizes each of the lifelines in the following manner:

- A highway transportation system consists of roadways, bridges, and tunnels.
- A railway transportation system consists of tracks, bridges, tunnels, stations, fuel,

dispatch, and maintenance facilities.

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

Table 3.7 – Utility System Lifeline Inventory

Utility System Lifeline Inventory			
System	Component	# Locations/ Segments	Replacement **Value**
Potable Water	Distribution Lines	NA	$ 73,100,000
	Facilities	2	$ 65,900,000
	Pipelines	0	$ -
Sub Total			$ 139,100,000
Waste Water	Distribution Lines	NA	$ 43,900,000
	Facilities	23	$ 1,516,500,000
	Pipelines	0	$ -
Sub Total			$ 1,560,400,000
Natural Gas	Distribution Lines	0	$ 29,300,000
	Facilities	0	$ -
	Pipelines	0	$ -
Sub Total			$ 29,300,000
Oil Systems	Facilities	8	$ -
	Pipelines	9	$ -
Sub Total			$ -
Electrical Power	Facilities	1	$ 108,900,000
Communication	Facilities	11	$ 1,100,000
Total			$ 1,838,700,000

Table 3.7 discusses the Utility System Lifeline Inventory that was derived from the HAZUS-MH database. The replacement value for potable water system in the County was approximately $139 million and that of airports was $1.5 billion. The total utility system lifeline replacement value was estimated at $ 1.8 billion.

Utility systems addressed in HAZUS-MH methodology include potable water, wastewater, oil, natural gas, electric power, and communication systems.

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

Vulnerability Analysis

Flash Floods

Vulnerability to flash floods is difficult to determine because local terrain, soil conditions, and construction play a role in how much storm water is able to run off, percolate into the soil, or cause flash flooding. Flood vulnerability is described in terms of the community assets that lay in the path of flood waters.

Critical facilities are vulnerable to flash flooding, but their vulnerability is dependent on their specific terrain and soil type and the amount of excess runoff from neighboring areas. Since flash floods frequently occur outside of established floodplains, there is no absolute certainty that future development in a specific location in the County will be subjected to flash floods.

Mitigation Measures

Flash floods have been and will continue to be a significant threat to the economic and social well-being of the more developed areas of Frederick County such as Frederick City, Mount Airy, etc. In particular, the towns that have more population and economic assets are vulnerable to flood damages. Most flash flood events result in direct damage to structures and infrastructure in developed areas, etc. The location and occurrence of flash floods is difficult to predict and is dependent on local conditions of terrain, land use, and percent of impervious cover. As a result, actions should focus on corrective measures for drainage in for all future development plans in these areas.

Data Limitations

First floor elevations and structure replacement values are useful for loss estimation. Replacement value is a necessary component in estimating the dollar amount of losses in a flood and, when combined with a range of flood probabilities from the 100-500 year flood depths, can help in describing the costs and benefits of mitigation actions in monetary terms.

Flooding

Table 3.8 indicates that Riverine flooding in Frederick County is caused by three watersheds from the Lower Monocacy River, Potomac River, and the Catoctin Creek. The following table developed by the Maryland Department of Natural Resources assessed the tree watersheds based on clean water and natural resource goals. It was found that the three watershed areas do not meet the Clean Water or Natural Resource Goals set by the Maryland Department of Natural Resources.

			Unified Watershed Assessment Categorization		
Watershed	Tributary Basin	Total Acreage (non-water)	Priority Category 1	Priority Category 2	Select Category 3
Lower Monocacy River	Upper Potomac	194,397	Yes	No	Yes
Potomac River	Upper Potomac	40,940	No	No	No
Catoctin Creek	Upper Potomac	77,050	Yes	No	No

Source: Department of Natural Resources

Category 1 - does not meet clean water or natural resource goals

Category 2 - Meets clean water or natural resource goals

Category 3 - Need for special protection of natural resources

Table 3.8 – Watershed Assessment

Critical Facilities

The County's critical facilities database was used for locating the facilities that were located in the 100-year floodplain. A total of 8 critical facilities within the County, were in the 100-year floodplain (Table 3.9). The analysis of these facilities revealed that 2 nursing care facilities, 1 museum, 1 water treatment plan, and 1 park were among this list.

Table 3.9 – Critical Facilities in the Floodplain

Of the 8 facilities in the 100-year floodplain, 4 are in the City of Frederick, 2 are in Thurmont, 1 is in Walkersville, and 1 is in Emittsburg. The location of the flood hazard areas in the County is shown on the accompanying floodplain maps at the end of this chapter.

Name	Address	City	Facility Type
FMH Home Oxygen & Durable Me	605 East Church Street	Frederick	Nursing/Care
MedSource Comm. Svcs., Inc.	149 Willowdale Dr., Apt 12	Frederick	Nursing/Care
National Museum of War Medicine		Frederick	Museum
Fort Detrick Water Treatment Plant		Frederick	Water Treatment Plant
Thurmont Town Hall		Thurmont	Town Hall
Thurmont SHA Garage		Thurmont	Parking Garage
Emmitsburg Disposal Plant		Emittsburg	Disposal Plan
Fountain Rock Park	8518 Fountain Rock Spring Road	Walkersville	Park

Based on the Flood Insurance Policies table (Table 3.10) and information from the National Flood Insurance Program (NFIP), there are a total of 100 policies in the County, insured at a total amount of $16 million and approximately $500,000 in premiums. Of these, 64 policies are for properties in the City of Frederick and 15 for the Town of Emmitsburg. The loss statistics indicate that there were approximately 163 loss cases between 1 January 1978 and 30 September 2003. Of these, 127 cases were in the County, resulting in over $ 1.1 million in payment (Table 3.11).

Note: Flood insurance is available to anyone in the County and even those structures outside of the mapped floodplain area. Therefore, in some cases, the number of policies includes policies for structures that are outside the mapped floodplain.

Table 3.10 – Policy Statistics

Policy Statistics as of 12/31/2003			
	Policies	Insurance	Premiums
Brunswick	4	$ 241,100	$ 1,052
Emmittsburg	15	$ 1,559,800	$ 5,153
Frederick	64	$ 11,995,400	$ 461,634
Middletown	1	$ 60,000	$ 513
Thurmont	5	$ 466,300	$ 1,981
Walkersville	11	$ 2,417,500	$ 4,828
Total	100	$ 16,740,100	$ 475,161

Source: Fema.gov/nfip

Repetitive Loss Areas

A repetitive loss structure is defined by FEMA as any structure for which two or more flood insurance claims have been paid for more than $1,000 in a 10-year period. While these properties make up only 1-2 percent of the flood insurance policies currently enforced, they account for 40 percent of the Nation's flood insurance claim payments. A report on repetitive loss structures recently completed by the National Wildlife Federation found that 20 percent of these structures are listed as being outside of the 100-year floodplain. In 1998, FEMA reported that the NFIP's 75,000 repetitive loss properties have already cost $2.8 billion in flood insurance payments and numerous other floodprone properties continue to remain at high risk in the Nation's floodplains. Therefore, there are several programs that encourage communities to identify the causes of their repetitive losses and to mitigate these losses.

Table 3.11– Loss Statistics

Loss Statistics as of 9/31/2003		
	Total Loss	Total Payments
Brunswick	6	$ 22,024
Emittsburg	9	$ 32,271
Frederick	21	$ 94,800
Frederick County	127	$ 1,190,602
Total	163	$ 1,339,698

Source: Fema.gov/nfip

Identifying areas of repetitive losses within a community is a good indicator to use in determining areas of the highest flood damage vulnerability. Although flood damage is not necessarily limited to these areas, repetitive loss data provides location indicators for areas where structures are experiencing recurring and costly flooding damage.

Table 3.12 – Repetitive Loss Structures

City	Zipcode	Type	Use	Source	Zone	LFE	FFE	Est. Floo	Foundation Type	No. Stories	Loss Dates	Sq. Footage	Year Built	Priority
Frederick	217010000	Masonry	Commercial	Caroll Creek	A5	275.8	282.5	11.2	BASEMENT	3	85, 84	3621		
Frederick	217010000	Masonry	Commercial	Unknown	C	286.8	286.8	0.0	SLAB	1	00, 98	1787		LOW
Frederick	217010000	Steel	Commercial	Trib 10 - Monocacy R	A	267.9	0.0	7.1	SLAB	2	79, 79, 78	0		LOW
Frederick	217010000	Stone	Residential	Isreal Creek	A	269.9	277.3	0.0	BASEMENT	2	96, 96	1020	1880	MEDIUM
Frederick	217010000	Wood Frame	Residential	Monocacy River	A	324.0	324.0	0.0	SLAB	2	96, 96	1976	1910	HIGH
Lilypons	217100000	Wood Frame	Commercial	Bennett Creek	A	226.0	234.7	0.0	SLAB	2	96, 88, 85, 84,	0		HIGH
Point of Rocks	217770000	Wood Frame	Residential	Potomac River	A	232.8	232.8	11.2	CRAWLSPACE	2	96, 96	484	1920	HIGH
Point of Rocks	217770000	Wood Frame/Ma	Commercial	Potomac River	A	221.5	221.5	22.5	SLAB ON GRADE	1	96, 96	0		MEDIUM
Point of Rocks	217770000	Wood Frame	Residential	Potomac River	A	0.0	233.2	0.0	BASEMENT	2	96, 96	1372	1882	HIGH
Frederick	217770000					0.0	0.0	0.0		0	96, 96, 85, 84,	0		HIGH
Point of Rocks	217770000					0.0	0.0	0.0		0	96, 96, 85	0		HIGH
Point of Rocks	217770000					0.0	0.0	0.0		0	96, 96	1044	1898	HIGH
Point of Rocks	217770000					0.0	0.0	0.0		0	96, 96	1592	1891	HIGH
Point of Rocks	217770000					0.0	0.0	0.0		0	96, 96	0		HIGH
Point of Rocks	217770000	Wood Frame	Residential	Potomac River	A	0.0	234.7	0.0	BASEMENT	2	96, 96	1608	1870	HIGH
Point of Rocks	217772019	Wood Frame	Residential	Potomac River	A	221.7	221.7	22.3	CRAWLSPACE	2	96, 96	1208	1885	HIGH
Point of Rocks	217772020					0.0	0.0	0.0		0	96, 96, 85	0		HIGH
Point of Rocks	217772020					0.0	0.0	0.0		0	96, 96, 85	1536	1891	HIGH
Point of Rocks	217772021	Wood Frame	Residential	Potomac River	A	229.9	229.9	14.1	CRAWLSPACE	2	96, 96	1064	1897	HIGH
Point of Rocks	217772021	Wood Frame	Commercial	Potomac River	A	0.0	231.3	0.0	BASEMENT	2	96, 96, 85	1215	1904	HIGH
Point of Rocks	217772021					0.0	0.0	0.0		0	96, 96, 85	1292	1883	HIGH
Point of Rocks	217772021					0.0	0.0	0.0		0	96, 96, 85	1216	1891	HIGH
Point of Rocks	217779733					0.0	0.0	0.0		0	96, 96	1568	1889	HIGH
Thurmont	217882632	Wood Frame	Residential	Hunting Creek	A	298.8	298.8	0.0	CRAWLSPACE	2	96, 96	1116	1920	HIGH
Thurmont	217882632	Wood Frame	Residential	Hunting Creek	A	296.1	296.1	0.0	CRAWLSPACE	2	96, 96	576	1955	HIGH

Table 3.12 indicates that Frederick County has 24 repetitive loss structures, 6 in Frederick, 1 in Lilypons, 2 in Thurmont, and 15 in Point of Rocks. Frederick had 3 commercial properties, Lilypons had 1 commercial property, and Thurmont had 2 residential properties. Most of the structures are of wood frame.

Table 3.13 – Building Exposure in the Floodplain

Frederick County	Floodplain	Population	Residential	Commercial	Industrial	Agriculture	Religious	Government	Education
Building Count in Floodplain	100-year		5,853	56	22	1	6	3	0
	500-year		6,692	71	22	1	7	3	0
Building Exposure in Floodplain	100-year	17,350	$947,482.40	$129,022.70	$95,691.10	$3,304.40	$16,675.60	$4,385.20	$4,464.90
(in thousands of $)	500-year	19,640	$1,089,631.90	$161,558.50	$99,428.40	$3,455.10	$19,044.90	$4,767.00	$4,930.30
Content Exposure in Floodplain	100-year	17,350	$473,730.50	$134,609.00	$139,804.40	$3,304.40	$16,675.60	$6,425.30	$4,464.90
(in thousands of $)	500-year	19,640	$544,811.90	$167,733.40	$144,725.20	$3,455.10	$19,044.90	$6,928.20	$4,930.30
Total Exposure in Floodplain	100-year	17,350	$1,421,212.90	$263,631.70	$235,495.50	$6,608.80	$33,351.20	$10,810.50	$8,929.80
(in thousands of $)	500-year	19,640	$1,634,443.80	$329,291.90	$244,153.60	$6,910.20	$38,089.80	$11,695.20	$9,860.60

Based on calculations from the HAZUS Flood Wizard, the following figures were obtained for building exposure and economic losses.

In terms of structural losses, there are approximately 17,350 people in the 100-year floodplain and 19,640 people in the 500-year flood plain. The total residential exposure in the 100-year

floodplain is approximately $1.4 billion and commercial building exposure is approximately $263 million. Government structure exposure in the 100-year floodplain is approximately $10 million.

Table 3.14 – Economic Loss in the Floodplain

Frederick County	Floodplain	Residential	Commercial	Industrial	Agriculture	Religious	Government	Education
Building Loss in Floodplain	100-year	$43,508.20	$20,491.40	$6,571.70	$479.30	$4,829.60	$531.00	$182.50
(in thousands of $)	500-year	$56,386.40	$25,524.60	$8,082.50	$545.10	$5,385.00	$829.70	$195.70
Content Loss in Floodplain	100-year	$82,050.00	$17,430.90	$3,464.30	$414.70	$3,959.70	$276.90	$100.30
(in thousands of $)	500-year	$106,350.60	$21,832.50	$4,249.10	$470.50	$4,557.20	$414.70	$109.50
Total Loss in Floodplain	100-year	$125,558.20	$37,922.30	$10,036.00	$894.00	$8,789.30	$807.90	$282.80
(in thousands of $)	500-year	$162,737.00	$47,357.10	$12,331.60	$1,015.60	$9,942.20	$1,244.40	$305.20

In terms of total economic losses (combined building and content loss) residential structures comprise of a total of $125 million and $ 162 million in the 100-year and 500-year floodplains, respectively and commercial structures comprise a total of $ 37 million and $ 47 million, in the 100-year and 500-year floodplains, respectively.

Data Limitations

In addition to building exposure, first floor elevations are also useful for loss estimation and can better describe the benefits and costs of mitigation actions in monetary terms.

Winter Storms

Current Trends

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

The entire County would be affected by snow, ice and extreme cold. Severe winter storms could result in the loss of utilities, expected increase in traffic accidents, impassable roads, and lost income since normal commuting may be hindered.

Snow and ice can be extremely hazardous. It could reduce visibility and surface accumulation reduces traction and puts strain on powerlines, roofs, and other structures. Severe winter storms have been and will continue to be a significant threat to the economic and social well being of Frederick County. Disruptions of emergency and other essential services and critical facilities are the main threats to the people and property.

Severe storm activity poses a significant threat to unprotected or exposed lifeline systems. Generally, commercial power networks are very susceptible to interruption from lightning strikes, high winds, ice conditions, and hail. Other utilities, including underground pipelines, may be impacted if not protected from exposure.

All critical facilities in the County are vulnerable to the effects of severe winter storms due to the potential disruption of services and transportation systems as well as possible structure failure due to heavy snow loads.

Table 3.15 – Age of Housing Units

Census Tract	Built Before 1940	Built After 1940	Total Structures	% Built Before 1940	MedianYearBuilt	AvgValue
24021750100	601	263	864	69.6%	1939	86,913
24021750200	934	147	1,081	86.4%	1939	190,074
24021750300	576	304	880	65.5%	1939	111,538
24021750400	183	1,555	1,738	10.5%	1969	122,118
24021750501	41	3,947	3,988	1.0%	1984	127,732
24021750502	46	3,038	3,084	1.5%	1986	143,073
24021750600	430	652	1,082	39.7%	1950	256,500
24021750700	84	3,018	3,102	2.7%	1976	131,945
24021750800	342	4,402	4,744	7.2%	1983	143,817
24021750900	356	382	738	48.2%	1948	107,253
24021751000	86	5,093	5,179	1.7%	1990	140,820
24021751200	112	3,298	3,410	3.3%	1985	196,760
24021751300	374	1,731	2,105	17.8%	1971	170,142
24021751400	237	2,546	2,783	8.5%	1976	153,859
24021751500	275	688	963	28.6%	1968	165,021
24021751600	377	591	968	38.9%	1964	175,555
24021751700	501	2,542	3,043	16.5%	1978	164,608
24021751800	194	1,953	2,147	9.0%	1986	184,170
24021751900	122	3,477	3,599	3.4%	1991	197,601
24021752000	190	3,094	3,284	5.8%	1982	203,021
24021752100	70	2,374	2,444	2.9%	1978	200,896
24021752200	232	879	1,111	20.9%	1971	198,603
24021752300	431	2,140	2,571	16.8%	1986	145,534
24021752400	1,108	1,629	2,737	40.5%	1959	122,291
24021752500	493	2,003	2,496	19.8%	1982	187,714
24021752600	504	2,600	3,104	16.2%	1975	190,144
24021752700	143	1,112	1,255	11.4%	1979	189,434
24021752800	461	1,414	1,875	24.6%	1977	163,763
24021752900	325	573	898	36.2%	1958	139,643
24021753000	455	2,289	2,744	16.6%	1977	136,924
24021753100	343	644	987	34.8%	1960	141,627
24021753200	532	718	1,250	42.6%	1953	113,431
TOTAL	11,158	61,096	72,254	15.4%		

Mitigation Measures

Table 3.15 indicates that 15.4 percent of the County's housing units were built prior to 1940. Census 50100, 50200, 50300, 50900, 52400, and 53200 indicate that over 40 percent of their structures were built prior to 1940. These may be well-preserved, older neighborhoods. However, some of the older structures may not be in a condition to weather these storms due to poor building quality, plumbing, etc. and would require adequate measures to ensure that they are brought up to code to face these severe storms.

Forecasting and warning County residents as far in advance as possible would allow time to prepare for winter storms. Stocking adequate quantities of salt and sand expedites and improves road clearing. Public education concerning safe driving and driving only if it is required, and also stocking up on food, water, batteries, and other supplies will prepare people for the storm.

Wildfires

Existing Community Assets

Future wildfires could cause substantial loss of property along with direct and indirect economic effects for residents and community businesses. Currently approximately 30 percent of Frederick County lies in forested areas.

Current Trends

As indicated earlier, in recent years, Frederick County has experienced an increase in population in the urban and rural areas. The Fire Zones map prepared by the Maryland Department of Natural Resources divides the county into 5 distinct zones that identify the fire risk for that area. The risk is based on factors such as fuel type, slope, potential for ignition (human), and land value. Zone 5 is considered the area with the highest risk and Zone 1, that with the lowest risk. No areas in the county have been identified as Zone 1. A large part of the county lies in Zone 2, including Frederick City, Walkersville, and the western part of the county; Zone 3 includes Burkittsville, Middletown, Libertytown, Woodsboro, Emittsburg, Mount Airy, Rosemont, and Brunswick and unincorporated areas in the southeast part of the County; Zone 4 includes the Myersville area and the western part of the county; and a small part of the northwestern portion of Frederick County comprises Zone 5, and is considered the area with the highest risk that pose concerns for future development.

Future Trends

The new comprehensive plan for the County will indicate broader locations where development will occur in the future (future land use). If more development is planned in the more rural or agricultural lands, the occurrence of human-caused fires and the number of people and property at risk due to wildfire will likely increase. Particular attention should be paid while planning for development in Zones 4 and 5. Land supply will not be a deterrent to future population growth in the wildland interface areas. Land supply will not be a deterrent to future population growth in the wildland interface areas.

Mitigation Measures

As people move to reside in the more rural and forested areas, increased development in these areas creates danger for both forests and the population residing there. Mitigation options for wildland fire needs to address not only the management of fuels but also the potential for growing population in wildfire threat areas. These measures may also define the necessary interface between private property needs and natural resource needs, public education, fire brakes, and maintenance of fire roads.

Loss Estimation

Based on data from the Maryland Department of Natural Resources – Forest Service, Frederick County experienced a total of 331 fires between 1994 and 2003, resulting in a total a total of 382 acres burned and a total cost of approximately $70,000 (Table 3.16). This cost does not include the value of the land, only those incurred while fighting the fires.

Table 3.16 - Fire Incidents in Frederick County

Year	No. Fires	Acres Burned	Cost
2003	4	2.9	$354
2002	31	26.4	$18,363
2001	49	51.8	$6,767
2000	48	21.6	$6,950
1999	80	76	$3,880
1998	43	34	$14,135
1997	16	17.7	$2,118
1996	12	18.1	$1,364
1995	30	45	$11,111
1994	18	88.9	$4,551
Total	**331**	**382.4**	**$69,593**

These figures include fires that burned on privately owned and/or county or state-owned property. The statistics represent only those wildland fires to which the Maryland Department of Natural Resources (DNR) Forest Service responded. The DNR State Forest Service responds to about 5% of the fires in the county (the larger fires).

In assessing physical vulnerability, the most important factor is the extent to which structures get damages when they are exposed to fire and heat. Current standard loss estimation tables do not exist for wildfires. The local fire department and structural engineers should help estimate structure and content damage from wildfires.

Most wildfire-related deaths occur as a result of fire suppression activities. However, if roads are damaged or there is insufficient warning time, other injuries and deaths could occur. Since there are no death or injury statistics curves for wildfire, they are estimated based on past wildfire events.

More information about specific properties in or near wooded areas and also total damage values would help in determining the relative vulnerability. In addition, an assessment of the vegetation types in determining specific risk factors. This information should be further researched. Also, data on the value of these facilities was not available at this time and should be gathered to estimate potential losses.

Tornadoes

Current Trends

Tornadoes have occurred in Frederick County in the past and are expected to occur in the future. Tornadoes often result in buildings with missing roofs, uprooted road signs, fallen powerlines and trees, destroyed homes and water towers, and damaged cars. As an example, the tornado that hit the county in August 1999 did extensive damage to trees in Eastview, Walnut Springs, Shookstown, and Fort Detrick. Some trees fell onto cars and houses, and a few homes under construction were damaged. Yellow Springs Road had to be closed for several hours until power and telephone poles blocking the road could be cleared.

Future Trends

The impact of tornadoes primarily depends upon their occurrence in developed areas – tornadoes in undeveloped areas may cause damage only to a few trees and may even go

unreported. As development and population in the County increases, a larger number of structures and people may be subject to tornadoes.

Mitigation Measures

In assessing vulnerability, the most important factor is how likely structures are to fail when subjected to wind loads that exceed their design or to flying debris that penetrates the building. In general, building damages can range from cosmetic to complete structural failure, depending on wind speed and location of the building with respect to the tornado path, and can be analyzed by a structural engineer. Measures to reduce damages from tornadoes would include proper anchoring and strapping of building to their foundations and designing shelters and other critical facilities for appropriate wind speeds.

Loss Estimation

Since there are not any standard loss estimation models and tables for tornadoes, losses are based on exposure by older and that of manufactured homes. In terms of calculating human losses, shelters throughout the community should be assessed for their locations, capacity, and strength in order to ensure they are able to house residents and withstand the design wind speed.

Estimating losses for tornadoes is based on exposure by older structures (built prior to 1940) and that of manufactured homes. As indicated in the Age of Structures (Table 3.15), there are over 11,000 out of a total of 72,000 structures (15%) that were built prior to 1940. Some of these older structures could be particularly more vulnerable to hazard events. There are a total of 595 manufactured homes in Frederick County, with a dollar exposure of approximately $ 23 million (Table 3.17). Manufactured homes are particularly vulnerable to tornadoes and high-wind hazards.

Table 3.17 - Dollar Exposure of Manufactured Homes

Manufactured Homes		
Census Tract	Count	Dollar Exposure
24021750600	2	$ 196,000
24021751000	81	$ 2,743,000
24021751200	4	$ 295,000
24021751300	9	$ 330,000
24021751500	1	$ 162,000
24021751600	44	$ 1,541,000
24021751700	38	$ 1,398,000
24021751800	25	$ 1,049,000
24021751900	32	$ 1,169,000
24021752000	22	$ 753,000
24021752100	16	$ 606,000
24021752200	10	$ 486,000
24021752300	9	$ 488,000
24021752400	31	$ 1,202,000
24021752500	87	$ 3,181,000
24021752600	29	$ 1,105,000
24021752700	4	$ 137,000
24021752800	33	$ 1,286,000
24021752900	21	$ 1,136,000
24021753000	23	$ 860,000
24021753100	55	$ 2,091,000
24021753200	19	$ 855,000
Total	595	$ 23,069,000

In terms of calculating human losses, shelters throughout the community should be assessed for their locations, capacity, and strength in order to ensure they are able to house residents and withstand the design wind speed.

Hurricane Winds

Current Trends

The primary hazard caused by winds is the transport of debris, which can cause casualties and property loss. A less probable hazard involves the dislodging of mobile homes from their structures or vehicles. High winds may also cause damage to poles and lines carrying electric, telephone, and cable television service. As mentioned earlier, older structures built before 1940 could be more susceptible to wind damage.

Although Frederick County is not directly in the part of hurricane by virtue of being located away from the coast, it is still subject to the wind and flooding effects from hurricanes that hit the east coast. Older critical facilities are vulnerable to wind damage due to the age of construction and possible poor condition, especially in the more rural and isolated areas of the County. Since high wind events may affect the entire County, it is important to identify these specific critical facilities and assets that are most vulnerable to the hazard. Evaluation criteria include age of the building (and what building codes may have been in effect at the time of construction), type of construction, and condition of the structure (i.e., how well has the structure been maintained).

Future Trends

As development in the County and population density increases, wind may present an increased threat to the people and structures of the County. It must be ensured that building codes currently in place sufficiently address the excessively high wind velocities occasionally experienced in the county.

Loss Estimation

The HAZUS-MH Hurricane Model from FEMA's loss estimation software was used to determine losses to Frederick County from a hurricane that made landfall on the east coast. Hurricane parameters (wind speed, radius to maximum winds, central pressure, and time) were defined to simulate the effects a category 2 hurricane. Based on this, losses were calculated.

Based on the HAZUS-MH building inventory, the total building exposure value is $13,062,393, of which the total residential building exposure value is $10,828,843 (83%) and that of commercial buildings is $ 1,363,246 (10.4%). In terms of general building stock damage, Frederick County would not incur any damage or destruction in direct building losses (estimated costs to repair or replace the damage caused to the building and its contents) based on the hurricane event itself. Also, there would be no losses due to business interruption (inability to operate a business due to damages sustained by the hurricane). However, there could be damage from the strong winds or inland flooding from the rain that could occur after the hurricane. The HAZUS-MH model does not take these other effects into account.

It should be noted that HAZUS-MH is considered one of many planning tools used by states and local governments. Other tools should be considered in developing the hazard analysis and risk assessment for local communities. In some cases, other tools and methodologies may offer more usefulness than HAZUS in the performance of a measure hazard analysis and risk assessment.

Mitigation Measures

The entire county can be affected by wind hazards. Aged, dilapidated, and poorly constructed buildings, and buildings not constructed to applicable building codes are more susceptible to wind and weather hazards. As mentioned earlier, manufactured housing units are especially susceptible to wind events. Strong winds can rip roofs off houses, overturn manufactured homes, or cause total failure of poorly constructed structures. Gable-ended roofs area also especially vulnerable to strong winds. Special attention should be paid to these structures in terms of strapping and anchoring of foundations.

Drought

Current Trends

Those who rely on surface water (reservoirs and lakes) and subsurface water (groundwater) are usually not adversely affected by a drought. A short-term drought that persists for three to six months may have little impact on these areas, depending on the characteristics of the hydrologic system and water use requirements. Droughts of longer duration affect areas that are dependent on stored surface or subsurface supplies while the impacts of a drought may be less in agricultural areas as rain quickly replenishes soil moisture. Ground water users who are often the last to be affected by drought during its onset, may also be the last to experience a return to normal water levels. The length of a recovery period is a function of the intensity of the drought, its length, and the quantity of precipitation received as the drought ends.

Future Trends

As business and population growth continues in Frederick County, the potential impacts of prolonged drought grow significantly. Continued residential and commercial development in the towns coupled with the need to acquire additional sources of water will result in a diminishing supply of water.

If the County becomes unsuccessful in attracting the majority of its new growth to the more developed areas, new development could encroach into rural areas. This potential conversion of rural land for residential use would be of great concern to the County due to its implications for loss of agricultural and forest land, open space, and rural character.

Mitigation Measures

Identifying the first stages of drought and helping to conserve water will help mitigate drought to an extent. In the future, there is also the potential for limiting population growth and developments dependent on groundwater. Mitigation management for drought is a proactive process. However, most of the process has been at the State level since there is no U.S. water conservation or drought policy.

The Governor's Water Conservation Advisory Committee recommended the actions for the four drought states:
Stage 1: Normal Conditions (green)
Stage 2: Watch (yellow) 5-10% reduction goal and drought conditions evaluated biweekly
Stage 3: Warning (orange) 10-15% reduction goal and drought conditions evaluated weekly
Stage 4: Emergency (red) 15-20% reduction goal and drought conditions evaluated weekly
This information can be reviewed in detail at
http://www.mde.state.md.us/Water/Drought/responding/index.asp

note: Detailed information on Water Conservation Measures in the State of Maryland are included in
http://www.mde.state.md.us/assets/document/water_cons/water_conservation_measures_in_maryland.pdf

Loss Estimation

The 1999 Maryland Hazard Analysis puts Frederick County in a high-risk category for drought. Based on the 1997 Census of Agriculture, 1,304 farms in Frederick County are on 215,927

acres. The average value per farm is $625,965 and the average value per acre is approximately $3,800. The estimated market value of all machinery and equipment on a farm is estimated at $60,000. The County ranked 1st in the state in terms of livestock inventories (cattle, sheep, and milk cows) and hay production; 2nd for barley production, 5th for corn production, and 6th for wheat and soybeans production.

In terms of past trends, the total acreage in farmland decreased (from 222,768 to 215,927) by 3 percent between 1992 and 1997. The average farm size, however, remained unchanged at 166 acres. The number of full-time farms decreased by 12 percent (from 754 to 667) during this period. The total market value of agricultural products sold decreased by 7 percent to $101,660,000 in 1997. The total share for crop sales and livestock sales was 17 and 83 percent, respectively. The market value of agricultural products sold decreased by 4 percent (from $81,127 in 1992 to $77,960 in 1997).

Sinkholes/Karst Topography

Current Trends

Runoff, spills, or pesticides and fertilizers from lawns and farms can leak through the many spaces in the rock, unfiltered by the soil, enter the groundwater system and lead into water resources. As thousands of residents in this region get their water from home wells, these areas are particularly susceptible to pollution almost immediately.

The Frederick Department of Public Works conducted a study of the presence of sinkholes near major transportation routes in Frederick County (refer to Sinkholes maps). Approximately 15 sinkholes were located, that were less than 6 feet deep, throughout the County. Of these, 6 were near/in Frederick City, 2 near Route 15 and 3 near Route 194. Two sinkholes that were over 6 feet deep were found south of Frederick City, one near I-70 and the other, near I-270.

Future Trends

Increased population in the Frederick County region will increase demands on ground-water supplies; this will cause more land subsidence in areas already sinking, and new subsidence in areas where it has not yet occurred. In the past, major subsidence areas have been in agricultural settings where groundwater has been pumped for irrigation. In the future, however, increasing population may result in problems in metropolitan areas where damage from sinking will be significant.

Numerous sinkholes have occurred in close proximity to I-70, resulting in road closures of the Interstate and other major arterial roads. The sinkhole problem is expected to exacerbate since the City of Frederick is tapping underground wells for water. The Mayor and Board of Alderman recently passed a sinkhole liability plan to establish a procedure to deal with potential sinkholes due to well pumping.

Mitigation Measures

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

- Refraining from dumping anything onto a parking lot, storm drain or down a sinkhole;
- Diverting water run-off away from sinkholes;
- Remediating sinkholes that receive runoff, as soon as possible;

- Maintaining vegetation on steep slopes to keep soil in place;
- Identifying the best practices for dispersed storm water management in karst areas; and
- Working with the local health department to select the best septic system for your site and contacting the local health officials if you believe you have a malfunctioning system.

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

Loss Estimation

The estimated losses to the County for sinkholes were not readily available. However, based on information from Frederick's Public Works department, sinkholes along a roadway could cost as much as $6,000 to fix, including materials and labor.

Development Trends Analysis

Based on the current County Comprehensive Plan, Frederick County comprises a total of 425,472 acres. Of this, agricultural and rural uses comprise approximately 64.3 percent. Woodlands comprise approximately 15.4 percent, and open space and parkland covers 5.3 percent of the total area. The remaining 15 percent consists of residential (10.3%), Institutional (2.5), and commercial and industrial (2.2%). As evident, the predominant land use is agriculture. The two regions of the county which contain the highest percentage of land in an agricultural use are the Brunswick and Walkersville Regions, where 80 percent of the land area is devoted to agricultural land uses. The Frederick Region, which is dominated by the City of Frederick, has the lowest percentage of land (47%) in agricultural use.

Since the adoption of the 1990 Countywide Plan, the character of Frederick County has continued to slowly shift toward the development end of the spectrum. For example, in 1988, Agricultural, Woodland, Forestry, and Undeveloped land uses encompassed approximately 351,122 acres or roughly 82.5 percent of the County's total land area. However, these land uses currently constitute only 338,917 acres or approximately 79.6 percent. Conversely, during this same time period, the amount of land used for residential development has risen from 36,825 acres in 1988 to its current total of 43,723 acres.

As development increases, the risk and exposure to hazards increases. In order to mitigation effects of hazards, future land use planning has to take into consideration the approximate locations and impacts of various hazard events by planning for least population concentrations in high-hazard areas.

The county however, does recognize the impacts that adverse development could have on the natural environment or significant historic resources and views this as a priority and designates any growth in such a way that the county's sensitive resources are protected. These resources include: Streams and their buffers; 100-year floodplains; Habitats of threatened and endangered species; Steep slopes; Monocacy Scenic River; Areas of prime agricultural soils outside of community growth areas; Groundwater resources, particularly with regard to well-head protection

areas; Wetlands; Limestone conglomerate/carbonate rock areas; and Historic and archaeological resources.

Mitigation Capability Analysis

Frederick County has a number of resources that it can access to implement hazard mitigation initiatives. These resources include both private and public assets at the local, State, and Federal levels.

A detailed Hazard Mitigation Capabilities Assessment Questionnaire was prepared and distributed to all jurisdictions for input. The Hazard Mitigation Capabilities Assessment Questionnaire was designed to assess the community's ability to reduce future losses from hazards like floods, winter storms, etc. through its various policies and programs. The intent of the capability assessment was to provide an inventory of existing policies, programs, practices and operational responsibilities that have or may have a major role in helping the community in its overall efforts to mitigate hazards. The results of the questionnaire are integral to the development of a mitigation strategy, the backbone of a local hazard mitigation plan currently in development by Frederick County. The questions presented in the questionnaire covered several different agencies within the jurisdictions, particularly the County. These agencies or positions included Planning Department; Department of Public Works; Floodplain Management; Engineering, etc. Table 3.18 summarizes the local government capabilities the County and the municipalities possess that will facilitate implementation of the mitigation strategy and provides a summary of the basic mitigation capabilities.

Table 3.18 – Mitigation Capability Analysis Compilation

MITIGATION CAPABILITY ASSESSMENT MATRIX						
	Brunswick	Rosemont	Thurmont	Walkersville	Frederick City	Frederick County
Comprehensive Plan	Yes	Yes	Yes	Yes	Yes	Yes
- with Hazard Mitigation?	No	No	No	No	No	No
Land Use Plan	Yes	Yes	Yes	Yes	Yes	Yes
Subdivision Regulations	Yes	No	Yes	Yes	Yes	Yes
Zoning Ordinance	Yes	No	Yes	Yes	Yes	Yes
Hazard Mitigation Plan	No	No	No	No	No	No
Floodplain Management Ordinance	Yes	No	Yes	Yes	Yes	Yes
- Administrator?	Yes	No	Yes	Yes	Yes	Yes
CRS Rating	No	No	No	No	No	No
Stormwater Program	No	No	No	Yes	Yes	Yes
Building Code	Yes	Yes	Yes	Yes	Yes	Yes
Building Official.	No	No	Yes	Yes	Yes	Yes
- Inspections?		No	Yes	Yes	Yes	Yes
Local Emergency Operations Plan	No	No	No	No	Yes	Yes
Warning-sirens?	No	No	No	No	No	No
- NOAA W.Radio?	No	No	No	No	No	Yes
Structural Projects	No	No	Yes	No	Yes	Yes
Property Protection	No	No	Yes	Yes	Yes	Yes
Critical Facilities Protection	No	No	Yes	Yes	No	Yes
Natural/Cultural Resources Inventory	No	No	No	No	No	No
Erosion Control	Yes	No	No	Yes	No	Yes
Sediment Control	Yes	No	No	Yes	No	Yes
Public Info Program	No	No	No	No	No	Yes

Two of the most important capabilities that the County and municipalities utilize are the floodplain management ordinances and the building codes. Through administration of the floodplain ordinances, the municipalities can ensure that all new construction or substantial improvements to existing structures located in the 100-year are built with first-floor elevations above the base flood elevation.

Building codes are important in mitigation; codes regionally developed consider the hazards present within that region of the country. Consequently, structures that are built to applicable codes are inherently resistant to many hazards like strong winds, floods, and earthquakes and can help mitigate regional hazards such as drought.

Plan Assessment

As part of the assessment of the Frederick County's mitigation capabilities, a review of enabling statutes, ordinances, planning documents and building codes was conducted. Some portions of these regulations were very strong in relation to mitigation capabilities and others had areas that would enhance the county's mitigation efforts if particular sections were strengthened or revised. As a catch-all, the towns' Zoning Ordinances, Subdivision Regulations and Adequate Public Facilities Ordinances should all address safety issues.

1998 Thurmont Master Plan

Page 13 - Discusses the vision for Thurmont and addresses issues such as small town character, mix of housing types, opportunities for employment, traditional neighborhood design principals. It fails to address development in hazardous areas.

Page 15 – Open space – discusses that open space is relegated to left over spaces around the periphery of the development's floodplain or around stormwater management ponds and do not provide a functional open space for the resident. And that they should be located in the geographic center of a development and be a focal point. These floodplain areas must be designated open spaces and development should be fully discouraged.

Page 21 – Environment – Sensitive Areas
"While most of the land adjoining the creek is developed, there may still be opportunities to provide protective measures. This is a must.
Page 23 – Northern part of Rouzer Run and western portion of High Run do not have 100-year floodplain delineated on FEMA maps

Page 27 – …'to concentrate growth into appropriate areas' – this is too broad and needs to be better defined.

Page 37 discusses problem streets – square corner in downtown, intersection of Frederick Road and Water Street, etc. The issue of moving people quickly through these areas in times of an emergency/evacuation needs to be addressed.

Page 50 – Community Facilities - Policy – discourage development that may have adverse impacts on groundwater. This statement could be further strengthened to include specific hazards.

1996 Comprehensive Plan for the Town of Burkittsville

Nearly 75% of the land within Burkittsville is committed to active agricultural operations completely encompassing the village area.

Page 4 – Goal: Protect Sensitive Areas within Burkittsville
Objectives: Protect the annual (100-year) floodplain along Burkitts Run; Protect the Town's groundwater resources.
Both these are good objectives

Page 5 – Objective – To facilitate adequate and potable water for all Burkittsville households. This is a good objective

Page 11 – Soil Conservation Service considers the Middletown Valley in general and Burkittsville area in particular to contain prime farmland. Land is unsuitable for intensive development since bedrock is so close to surface and that it limits on-site sewage disposal. This should be emphasized in the land use plan.

Page 12 – There is a need to introduce strong guidelines to maintain the historic heritage of Burkittsville – as a historically sensitive area

Annual vs. 100-year? Page 16. 100-year flood could occur even several times a year. The floodplain should be redone.

Page 36 – The Town lacks public water and sewerage services and relies fully on well and septic. During the occurrence of a sinkhole, the wells get contaminated within hours. This issue is of great concern and should be elaborated.

Page 40 – Plan Implementation
Update the Town zoning map and ordinance to be consistent with the comprehensive plan and review Burkittsville's subdivision regulations to ensure that they are consistent with goals and policies contained in the comprehensive plan. This should be elaborated to include: consistent with goals and policies in the comprehensive plan and the county's hazard mitigation plan.

1998 Brunswick Regional Plan (constitutes Rosemont's Comprehensive Plan)

Page 80 - Rosemont is designated as a rural community and no new public facilities are planned and only limited development is allowed. While Rosemont does have water service, none of the Rural Communities are planned for additional water and or sewer service.

This plan does not include any discussion on safety issues.

1992 - New Market Master Plan

Page 6 – Physical Environment – Recommendation
The Town shall adopt and maintain standards for development on and/or near wetlands and floodplains so as to protect these critical resources. This is a good recommendation and could be further elaborated.

Page 15 discusses clustering. This is a good concept and could be elaborated to address discouraging development in high hazard areas.

Page 17 discusses preservation efforts, encouraging and assisting in preservation and rehabilitation of existing housing. This should be done keeping in mind structural solutions that can withstand high winds, tornadoes, etc.

Page 26 states that no development shall be allowed within a 100-year floodplain, historic or annual, and there shall be a 25-foot building setback in areas adjacent to these floodplains – this is a good policy and is the only place where development related to a hazard is touched on.

Page 61 – Community Facilities – the entire individual water supply system for New Market currently comes from private wells. This is of concern, particularly with respect to sinkholes and should be addressed.

Page 97 discusses allowing for a variety of safe, adequate housing opportunities. The Plan provides for limited expansion of the number and types of homes that can be constructed and stresses the importance for preserving the rural historic character of the area. This should be expanded to discourage development in high hazard areas.

1999 – Myersville Comprehensive Plan

Page 2 – Policy – Steep slopes and floodplains shall be protected through review of existing regulations and establishment of minimum standards. This should be further elaborated.

Page 3 discusses preserving the natural beauty of the hillsides and retaining steeply sloped areas and floodplain areas as natural open space and encouraging cluster development to leave unbuildable areas open. This is a good policy and should be enforced.

1998 Emittsburg Comprehensive Plan

Page 6 – Land Use - C. Natural features such as floodplains will be located on the periphery of the community.
Floodplains cannot be moved or shifted. How will this be done? This should focus more on how the community will locate its development out of the floodplain.

Page 6A – Goals and Policies – There is no mention of prohibiting development in high hazard areas.

Page 7 Transportation B – Flat Run Creek will not be crossed by any Town street or extension because of problems with drainage, erosion, cost of bridges, etc. This is a good goal. However, there is no mention of prohibiting development in Flat Run Creek.

Page 9 – Action Areas

a. Proposed community park extending to Tom's creek

b. Page 10 – Continuity of future linear park along the flat Run Creek Corridor. These are good recommendations for open space along the flood prone areas.

Page 12 – Emittsburg Conservation and Development Guidance Standards (1974) Methods of control discusses Natural Resource Areas – preserved through zoning special regulation, easement. Floodplain, marsh, slope areas to be undeveloped through special regulations, easements, zoning. These are good recommendations and that it should be ensured that controls are in place to implement them.

Page 41 – Land use element – The plan does not include any policies to address safety or hazards in the community.

Page 51 – Problem Areas
In time of flood emergency, Creamery Road has provided the only available access to and from US 15 for residents and emergency managers. When Seton Avenue (North and South) and East Main Street were closed to vehicular traffic. It is in the best interest of the Town to retain access to US 15 from Creamery Road in order to provide another travelway to and from the Town during flooding events. This is a good recommendation.

Page 113 – Floodplain – This section discusses that Emittsburg adopted the Maryland Model Floodplain Ordinance in December 1991. A minimum 100 foot setback should be maintained from the edge of the bank to any watercourse floodplain delineated on the Floodway Map or FIRM. This is the only statement in the Plan that has reference to any hazard.

Page 113 – Emittsburg adopted the Maryland Model Floodplain Ordinance in December 1991. This Ordinance states that a minimum 100 foot setback should be marked from the edge of any watercourse, floodplain delineated or the floodway map or FIRM. This is a positive step.

Page 115 – Geology – There is no mention on the karst topography or sinkholes that could develop in this area.

Middletown Comprehensive Plan – 1995

Page3-2 Floodplain and Wetlands
Middletown adopted a State Model Floodplain Ordinance on 13 April 1992. This is a positive step on the Town's part.

Page 3-4 #3. The Town has adopted a wellhead protection policy to protect their water resources. This policy needs to be strengthened through the adoption of a wellhead protection program.

#5 – Additional areas in the Town which are floodplain soils such as along Core Branch. Additional regulations should be enacted to protect this area. This is a good recommendation.

Page 4-8 – There is no mention of avoiding development in high hazard areas.

Comprehensive Development Plan – Woodsboro 1972

Page 31 – Open Space

The annual floodplain must be protected for its value as a water resource and as protection for the developer and home-owner. The floodplains shall remain as open space. This is a good recommendation.

There is no other mention of other land use policies in light of natural hazards.

The plan needs to be updated.

Zoning Ordinance – Town of Woodsboro

Page 1 - Section 1.0 C. To regulate and determine the use and intensity of land. This sentence should be expanded to include 'with respect to natural hazards'.

Page 9 – Section 2.04 The site plan requirements list should be expanded to include information such as proximity to the flood plain, presence of sinkholes, etc.

1994 Brunswick Master Plan

Goals and Objectives – Page 8 – Identify and reserve the most suitable land for future employment and industrial activities. This should be expanded to include 'land outside of high hazard areas'.

Page 9 – Protect steep slopes, floodplain and wetland areas, and stream valleys from begin cleared and developed. This is a good goal to steer development in more suitable areas.

Page 42 – The City will undertake a study to review the adequacy of the channelization of Martins Creek I the downtown area for flood control. This is a good project and it must be ensured that various flood mitigation alternatives are considered prior to deciding on a flood control measure.

Page 42 – The City will encourage the use of development techniques which cluster development on appropriate parts of the site. This is a good recommendation that protects from disturbing extensive areas for development.

CHAPTER 4 – GOALS AND OBJECTIVES

Introduction

This chapter presents a series of goals and objectives to guide Frederick County and its municipalities' toward identifying and selecting mitigation actions to address its vulnerabilities. The mitigation actions address the vulnerabilities discussed in Chapter 3 by identifying measures to help the County avoid, prevent, or otherwise reduce damages from hazards.

While the Hazard Identification and Vulnerability Assessment chapters identified potential hazards and the areas and facilities in the County vulnerable to them, this Chapter will identify broad ideas to address these vulnerabilities and reduce the risk from natural hazards. Chapters 5 will layout a specific mitigation strategy by elaborating the action items, prioritizing the mitigation actions, identifying the implementation strategy of who is responsible for the action, completion, and identifying possible funding sources.

Mitigation Goals and Objectives

In the Hazard Mitigation Planning Committee and Public meetings held in May and June 2004, citizens and local government representatives discussed the findings of the vulnerability assessment and its implications for mitigation strategies. Their main desire was that mitigation objectives maintain the social, economic and environmental fabric of the community. First and foremost, mitigation objectives would protect people, property, local governments, and the local economy from the effects of natural hazards.

Furthermore, the objectives would recognize the necessity of commercial interests. The Hazard Mitigation Planning Committee discussed possible goals during their second committee meeting on 26 May 2004. A list of goals that addressed various hazards was developed by the Consultant, Greenhorne & O'Mara, Inc., based on the risk assessment. The goals were reviewed and revised by the Committee as necessary. The Committee then developed additional goals specific to certain areas of Frederick County. These goals represent Frederick County's vision for reducing damages caused by natural hazards and have been categorized into broad groups.

After the Hazard Mitigation Planning Committee developed the mitigation goals to achieve for the community, they identified specific mitigation objectives to help accomplish the goals. Each of the objectives was then developed into specific actions, discussed in the next chapter of the Plan.

Definitions:

- *Goals are general guidelines that explain what you want to achieve. They are usually broad policy-type statements, long term and represent global visions.*

- *Objectives define strategies or implementation steps to attain the identified goals. Unlike goals, they are specific and measurable.*

PUBLIC AWARENESS

GOAL 1: Promote public understanding, support and involvement in hazard mitigation related activities

Objective 1
Develop a public information and education program for the county and advise citizens on how to protect themselves and their property from natural hazard events.

PLANS AND ORDINANCES

GOAL 2: Promote growth and development in a sustainable fashion

Objective 1
Revise County Comprehensive Plan, sub-area plans, and municipality plans, as appropriate.

Objective 2
Revise existing ordinances (zoning, subdivision, floodplain ordinance) as appropriate.

EVACUATION

GOAL 3: Ensure safe and efficient evacuation routes to and from Frederick County.

Objective 1
Coordinate with State and region to provide safe and efficient evacuation routes.

SHELTERS

GOAL 4: Provide adequate shelters to handle multi-hazards such as floods, tornadoes, winter storms, etc.

Objective 1
Develop a list of designated shelters in various communities and ensure there are an adequate number of shelters throughout the County to house residents during an emergency.

Objective 2
Ensure critical facilities are equipped to handle hazard events.

COMMUNICATION

GOAL 5: Expedite/improve severe weather notification within the community

Objective 1
Ensure the entire county has access to notification impending storms in a timely fashion.

BUILDING CONSTRUCTION

GOAL 6: Reduce exposure of structures to hazards.

Objective 1
Create an awareness of building to safe standards.

MOBILE HOMES

GOAL 7: Ensure safety in mobile home parks

Objective 1
Ensure there is adequate shelter space available for residents in mobile home parks to seek refuge during hazard events.

KARST/SINKHOLES

GOAL 8: Reduce Frederick County's vulnerability to sinkholes

Objective 1
Ensure development is regulated in karst areas.

Objective 2
Address the issue of wellhead protection with respect to sinkholes.

Objective 3
Educate Frederick County residents on karst.

FLOOD

GOAL 9: Investigate structural solutions to flooding problems

Objective 1
Investigate the feasibility of enhancing and/or improving drainage of flood prone lands.

Objective 2
Strengthen building codes and zoning standards where needed.

GOAL 10: Develop measures to protect all buildings (commercial, residential, and industrial) that are in the floodplain

Objective 1
Continue to ensure that the current building codes, floodplain ordinances and standards follow FEMA guidelines and are properly enforced.

Objective 2
Develop flood mitigation strategies for flood prone properties.

WILDFIRES

GOAL 11: Reduce the risk to wildfires in the more rural parts of the county

Objective 1
Introduce and enforce the concept of defensible spaces.

COMMUNITY-SPECIFIC NEEDS

GOAL 12: Identify community-specific needs to reduce risks to various hazards.

Objective 1

Work with the Town of Mount Airy, City of Frederick, Town of Rosemont, Town of Walkersville, Town of Burkittsville, Town of Brunswick, and Town of Thurmont to identify the needs, abilities, and resources to implement various local projects.

CHAPTER 5 – MITIGATION STRATEGY

Introduction

Once the goals and objectives were developed, specific mitigation actions were identified and evaluated to address each goal and objective. This task was performed by the Hazard Mitigation Planning Committee. These actions range from construction projects – retrofitting existing structures to non-construction related projects such as the implementation of educational awareness programs

While some mitigation actions pertain to all hazards, others are specific to hazards such as flooding, karst, etc. Each of the mitigation actions listed below corresponds with its goal and objective. Specific mitigations actions for each municipality in the county have been included at the end of this chapter.

Mitigation actions identified below are presented along with the estimated cost, the office or agency responsible for implementing the action, a timeline, and potential sources of funding. An overall priority is assigned to each action based on its effect on overall risk and property, ease of implementation, political and community support, and potential funding.

Mitigation Projects

PUBLIC AWARENESS

GOAL 1: Promote public understanding, support and involvement in hazard mitigation related activities

Objective 1
Develop a public information and education program for the county to advise citizens on how to protect themselves and their property during natural hazard events.

Project 1
Educate public/businesses that lie in immediate area of critical facilities to report unusual operations with respect to natural hazards. Develop a check sheet that identifies a list of unusual or suspect activities distribute this to residences and businesses that are in close proximity with one or more critical facilities. Include at least 2 or 3 names and contact numbers to immediately report these activities.
Responsible Organizations: Office of Emergency Management
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 1 year

Project 2
Fairs for the elderly are held in various parts of the county. Most municipalities have large fairs that can be used as avenues to distribute information to large groups of people. Use local fairs and carnivals in the county as opportunities to disseminate information to the public and identify specific points of contact in each municipality to take the lead in distributing this information. In the City of Frederick, the Office of Special Events could take the initiative. The Fire Department could have handouts at the annual Frederick County fair held every September and other

carnivals held by the fire department through the summer. The Mount Airy street festival is held every Spring and Fall and is another opportunity to disseminate information to residents in that area.
Responsible Organizations: Office of Emergency Management, Volunteer Fire Company in municipalities, Office of Special Events – Frederick City
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 1 year

Project 3
Develop a brochure for the Town of Rosemont, Town of Burkittsville, and all the rural areas in the county on how to maintain septic systems and measures that could be taken during times they are out of power. A large part of Rosemont relies on well and septic systems. Approximately 50% of Rosemont is on public well. These systems, like most others, are subject to breakdown if not maintained properly. The Frederick County Health Department has published a brochure on septic systems. Routine maintenance procedures, repair centers, and internet sites on related information could be included as part in this brochure.
Responsible Organizations: Town of Rosemont, Town of Burkittsville, Health Department
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 1 year

Project 4
Create a brochure on how to weather a storm. This should contain information on the nearest shelters, evacuation routes, emergency warning information (TV and radio channels) during potential emergency situations, information about flood safety such as the danger of driving through even shallow running water and dangers associated with contaminated flood waters, etc. Other pertinent information would include:

- Location of emergency shelters that may be opened as needed;
- Preparations to wait out a winter storm at home;
- Guidance on the use of portable and standby generators;
- Winter travel and tips for driving in bad weather;
- Fire and carbon monoxide hazards of space heaters;
- Protecting plumbing during a winter storm;
- Coping with winter power failures; and
- Any other do's and don'ts

A small section in the brochure should be tailored to the individual communities with local contact information, etc. Consider local sponsors such as banks and department stores to bear the printing cost. The brochures should be stocked at local grocery stores and gas stations for distribution.
The brochure could also include ideas on how to be a 'good' neighbor.
Responsible Organizations: Office of Emergency Management, municipalities
Estimated Costs: Regular employee pay for content and layout preparation, approximately $2 for printing a trifold brochure
Possible Funding Sources: Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), Pre Disaster Mitigation grant (PDM), Department of Homeland Security grant (DHS)
Timeline for Implementation: 1 year

Project 5
House FEMA information in all branches of the County Library System and the book mobile. Interested property owners can read or check out handbooks or other publications that cover their particular situation. The Public Library should also be home for a number of FEMA publications dealing with various flood and other hazard related topics. In addition to the community library, the county should inventory a number of publications for public review and dissemination at the municipal building.

The following information and manuals could be obtained from FEMA on various topics including flooding, risk management series, etc. and used for reference purposes: http://www.fema.gov/fima/rmsp426.shtm - FEMA 426- Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings

1. http://www.fema.gov/fima/rmsp428.shtm - FEMA 428- Primer to Design Safe School Projects in Case of Terrorist Attackshttp://www.fema.gov/nfip/publicat.shtm - publications
2. http://www.fema.gov/about/faq1.shtm - information on ordering publications and frequently asked questions
3. http://www.fema.gov/nwz97/97050.shtm - This link contains information on publications for people with disabilities, Hispanic population, etc.
4. http://www.fema.gov/hazards/floods/lib234.shtm - Repairing Your Flooded Home

Responsible Organizations: Office of Emergency Management, Frederick County Public Library System
Estimated Costs: No cost incurred
Possible Funding Sources: No funding required
Timeline for Implementation: 1 year

Project 6
Run information clips on the immediate steps to be taken after a storm, right after the hazard event, on Cable Channel 99 and WFMD, WFRE, and KEY 103.1 radio stations.
Responsible Organizations: Office of Emergency Management, Local TV Station, Radio Stations
Estimated Costs: Cost of information placement could vary by station
Possible Funding Sources: General fund
Timeline for Implementation: 1 year

Project 7
Outreach projects are the first step in the process of orienting property owners to property protection measures and assisting them in designing and implementing a project. They are designed to encourage people to seek out more information and take steps to protect themselves and their properties. The Office of Emergency Management should develop and run a public information campaigns with displays, lectures, and other projects. The local libraries could be used as venues for these events.

As such, public outreach projects should include information on property protection measures. Research has also shown that a properly run local information program is more effective than national advertising or publicity campaigns. Therefore, outreach projects should be locally designed and tailored to meet local conditions. Since the west side of Frederick City contains an apartment complex that is predominantly Hispanic and other parts of the city also have pockets of Hispanic population, informational materials should be prepared in English as well as in Spanish.

Educate citizens by teaching Disaster Preparedness at various locations throughout the county. Conduct road shows in schools and other various organizations and identify schools, fire halls, churches, and other non-profit organizations such as the Rotary Club, Kiwanis Club, etc.

throughout the county that could be used as meeting areas and where presentations on awareness, prevention, preparedness, response, and recovery could be conducted. A PowerPoint presentation should be prepared, that would be made available to these organizations on a regular basis. Also, booklets such as 'Are You Ready' by FEMA should be distributed at these presentations with the ultimate objective of providing information to children who will take it to their families. The Office of Emergency Management should conduct a road show in the local schools and use the prepared presentation to educate students.
Responsible Organizations: Office of Emergency Management, Frederick County Schools, Service Clubs, Volunteer Fire Departments - municipalities
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 2-5 years

Project 8
Promote best practices in Frederick County by maintaining an on-going list of activities and learning from those communities that have been successfully accomplished these activities, such as Mount Airy's siren system.
Responsible Organizations: Office of Emergency Management
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 2-5 years

PLANS AND ORDINANCES

Goal 2: Promote growth and development in a sustainable fashion

Objective 1
Revise County Comprehensive Plan, sub-area plans, and municipality plans, as appropriate.

Project 1
City of Frederick's Comprehensive Plan in currently in the process of being completed and adopted later this summer. Integrate this Hazard Mitigation Plan with the City's Comprehensive Plan so that is serves as a 'safety element' to the comprehensive plan. Consider integrating the Hazard Mitigation Plan with the County's Comprehensive Plan as well. Other municipalities should integrate this plan into the local plan as well. This could be done as a Plan Amendment.

Encourage the municipalities and the County to review their comprehensive plans on an annual basis to ensure that designated growth areas are not in high hazard areas identified in this plan. When land use recommendations are developed for the city and surrounding areas, they should be made with reference to the vulnerability maps in the Hazard Mitigation Plan.
Responsible Organizations: Division of Planning, Office of Emergency Management, City of Frederick's Planning Department, municipalities
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 2-5 years

Project 2
Integrate this Hazard Mitigation Plan into the county's 8 regional plans and update as necessary.
Responsible Organizations: Division of Planning, Office of Emergency Management

Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 6-10 years

Project 3
The County's Emergency Management Plan is currently being revised. Ensure the Hazard Mitigation Plan and the Emergency Plan are integrated as well.
Responsible Organizations: Office of Emergency Management, Fire Department, County Sheriff's Office
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 2-5 years

Objective 2
Revise existing ordinances (zoning, subdivision, floodplain ordinance), as appropriate.

Project 1
The Town of Mount Airy has been considering adopting Carroll County's Floodplain Ordinance. Work with the local officials in Mount Airy and encourage the Town to adopt this floodplain ordinance as soon as possible.
Responsible Organizations: Town of Mount Airy, Carroll County Department of Planning
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 2-5 years

Project 2
The Towns of Walkersville and Middleton have adopted Well-head Protection Plans. The State of Maryland has completed a Source Protection Plan for the entire county, including areas in the karst terrain. Work with County Commissioners to expedite the review process – via County Managers Office and encourage the County Attorney to review the ordinance so it may be adopted and implemented.
Responsible Organizations: Office of Emergency Management, Division of Planning, municipalities
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 1 year

Project 3
Revise existing ordinances as appropriate for the towns and the county. Sections that should be improved and areas where attention should be focused have been elaborated in the Mitigation Capability Analysis section at the end of Chapter 3 of this Plan. Consider incorporating these changes during the next plan or ordinance amendment.
Responsible Organizations: Individual municipalities, Department of Planning, Department of Engineering
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 6-10 years

EVACUATION

GOAL 3: Ensure safe and efficient evacuation routes to and from Frederick County.

Objective 1
Coordinate with State and region to provide safe and efficient evacuation routes.

Project 1
Recommendations from all countywide or regional evacuation plans that have been developed for adjacent areas should be integrated into Frederick County's evacuation plan to ascertain smooth transition, traffic flow, etc. A number of studies have been conducted with respect to evacuation. The following studies should be taken into account while developing these evacuation routes. The Baltimore Council of Governments and the Washington D.C. Council of Governments have completed evacuation plans for the region. The Maryland State Highway Administration has a plan on roads in and around Frederick County that may get blocked during an emergency. All major highways such as MD 15, I-70, I-270, and MD 340 and the Frederick County Fairgrounds are areas that would require particular attention.
Responsible Organizations: Office of Emergency Management, Department of Highways and Transportation
Estimated Costs: $ 50,000
Possible Funding Sources: HMGP, DHS
Timeline for Implementation: 2-5 years

Project 2
Update Frederick County's evacuation plan to include issues such as staging areas, feeding plan for displaced persons, bathrooms, signs, temporary housing, decontamination, etc. An integral part of this plan would be introducing the concept of evacuation in stages. As part of this plan, destination points such as schools should be identified for shelters.

The following points should be considered in developing the evacuation plan: experts in emergency planning, transportation planning and traffic engineering should be involved in developing the plan; canned messages should be developed for use with the public and the media; consideration of closed circuit televisions for the county and the State Highway Administration to help aid traffic flow during evacuations.
Responsible Organizations: Office of Emergency Management, Department of Highways and Transportation
Estimated Costs: $30,000
Possible Funding Sources: HMGP, DHS
Timeline for Implementation: 2-5 years

SHELTERS

GOAL 4: Provide adequate shelters to handle multi-hazards such as floods, tornadoes, winter storms, etc.

Objective 1
Develop a list of designated shelters in various communities and ensure there are an adequate number of shelters throughout the county to house residents during an emergency.

Project 1
Identify additional locations that could be equipped and identified as shelters based on the needs and the population centers in the county. Work with the Red Cross to conduct an assessment of existing shelters in the county to determine their condition and adequacy with respect to beds, etc. Develop a database of shelters and their locations and determine which ones would need to be retrofitted, particularly with respect to schools. This should be based on various factors such as wind load certification, etc. The Red Cross and the County's Emergency Management Department should share information about local shelters at least on an annual basis. Information should include the location of each shelter, its capacity, its back-up power availability, and any other relevant information.
Responsible Organizations: Office of Emergency Management, Division of Planning, American Red Cross, Frederick County Public Schools
Estimated Costs: Regular employee pay, professional consulting fees for architect/engineer
Possible Funding Sources: HMGP
Timeline for Implementation: 2-5 years

Objective 2
Ensure critical facilities are equipped to handle hazard events.

Project 1
Identify and prioritize a list of critical facilities that would require generators during times of an emergency. Seek funding sources to help agencies purchase generators.
Responsible Organizations: Office of Emergency Management, municipalities
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 2-5 years

COMMUNICATION

GOAL 6: Expedite/improve severe weather notification within the community

Objective 1
Ensure the entire county has access to notification impending storms in a timely fashion.

Project 1
The County's Police Department should consider introducing a Reverse 9-1-1system that would enhance the quality of service provided by them. Reverse 9-1-1 is an interactive community notification system that enables a recorded telephone message to be sent out to selected areas, blocks or neighborhoods in the event of an emergency. The system is a quick and efficient way of contacting and notifying residents of a potentially serious problem near their homes or businesses. It allows the police department to quickly send out time-critical messages rather than going door-to-door. Messages can be sent to a select jurisdiction or the entire county and includes a convenient TTY/TDD feature capable of sending information to the hearing impaired. The system is sophisticated enough to indicate whether a call was received or whether a message was left on an answering machine. It also can be programmed to keep trying until a call has been successfully received.
Responsible Organizations: Frederick County Sheriffs Office, Office of Emergency Management, Emergency Communications Center, Fire Department

Estimated Costs: To be determined
Possible Funding Sources: HMGP, DHS's Emergency Services Performance Grant (EMPG), PDM
Timeline for Implementation: 2-5 years

Project 2
Develop a county-wide audible alert system. Evaluative alternatives such as sirens, e-911, etc. Identify major developments, municipalities and other populated centers for the installation of these early warning devices. Develop a booklet to educate the public on meanings of warnings, and appropriate action to take before and during a disaster or emergency.
Responsible Organizations: Frederick County Sheriffs Office, Office of Emergency Management, municipalities
Estimated Costs: Varies by type of system – sirens and radios cost approximately $3,000 per piece,, regular employee pay for content and layout preparation of booklet, printing cost per booklet is approximately $2
Possible Funding Sources: Local funds, HMGP, DHS's Emergency Services Performance Grant (EMPG), PDM
Timeline for Implementation: 2-5 years

BUILDING CONSTRUCTION

GOAL 7: Reduce exposure of structures to hazards.

Objective 1
Create an awareness of building to safe standards.

Project 1
Encourage safety in temporary classrooms in schools. Many portable classrooms have been built with an aluminum roof, a thin trailer aluminum exterior, small windows, a residential grade door, doorframe and lockset, wood underlayment, studs and walls, and minimum lighting and ventilation. Non-combustible classrooms should be considered in Frederick County Schools. These consist of doublewide classrooms built on a rigid steel frame, with lightweight concrete floors with fiberglass reinforcement offering the feel of site built construction. The new non-combustible sits on the ground and eliminates the need for the costly steps, decks and ramps. This not only minimizes installation costs, but also eliminates a potential mold problem. Refer to http://www.mbinet.org/web/magazine/studyin5_01.html for additional details on non-combustible classrooms.
Responsible Organizations: Office of Emergency Management, Frederick County Schools
Estimated Costs: To be determined
Possible Funding Sources: HMGP
Timeline for Implementation: 6-10 Years

Project 2
Identify large abandoned structures that are in a state of disrepair and consider demolition of these structures. A good example of this is the old water tank in Mount Airy on North Main Street next to the elementary school, which is to be demolished shortly. Ensure that the integrity of historic properties is maintained.

Responsible Organizations: Office of Emergency Management, Division of Planning, Fire Department
Estimated Costs: Varies by structure
Possible Funding Sources: HMGP, PDM
Timeline for Implementation: 2-5 years

Project 3
Conduct structural assessments and engineering inspections of critical facilities and determine their useful life and replacement requirements while assessing each facility's ability to sustain damage from both flood and wind events and recommend specific retrofitting measures for each building as appropriate to better protect them from flooding and high winds.
Responsible Organizations: Office of Risk Management
Estimated Costs: Engineering consulting fees
Possible Funding Sources: HMGP, FMA
Timeline for Implementation: 6-10 years

MOBILE HOMES

GOAL 8: Ensure safety in mobile home parks

Objective 1
Ensure there is adequate shelter space available for residents in mobile home parks to seek refuge during hazard events.

Project 1
Consider planning for a storm safe structure/shelter in or in close proximity each mobile home park. Investigate the availability of shelter space at the following locations: Ruritan and Jefferson Fire Halls for the 2 trailer parks on MD 180 and large buildings at the MD 340/MD180 Interchange such as Prospect Hall, 7th day Adventist Church, and the assisted living home; and the Shields Trailer Park on Route 355.

The extreme forces of a tornado require that a shelter envelope be designed to resist high wind pressures and the impact of windborne debris. The walls, roof, and doors to the shelter should be designed, at a minimum, to resist 250 mph (3-second gust) wind speeds and the impact of windborne debris (15-pound wood 2 x 4) traveling at 100 mph. The architect and the structural engineer should ensure that the connections between the shelter foundation and walls and between the walls and roof are adequate to resist the design loads specified by FEMA 361 Design and Construction Guidance for Community Shelters. FEMA 361 includes requirements for shelter size based on the number and type of expected shelter occupants. The shelter should include toilets, storage space, a mechanical room and circulation area in addition to the actual space that houses the occupants
Responsible Organizations: Office of Emergency Management, Division of Planning, Division of Engineering
Estimated Costs: Varies by shelter
Possible Funding Sources: HMGP
Timeline for Implementation: 6-10 years

KARST/SINKHOLES

GOAL 9: Reduce Frederick County's vulnerability to sinkholes

Objective 1
Ensure development is regulated in karst areas.

Project 1
Establish building standards and regulations in areas where there is evidence of water-soluble bedrock (limestone, dolomite, marble, gypsum). While regulation is not meant to discourage development, it ensures that the proper steps are taken to minimize the potential for future problems. Regulation could include requiring special foundations for residential and commercial structures and requiring special design for utility and storm-water facilities. Establish stringent requirements and check by geologists, prior to any new construction.
Responsible Organizations: Department of Permits and Inspections, Office of Emergency Management, Soil Conservation District
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 2-5 years

Project 2
Establish specific development regulations and storm water management plans in karst areas to minimize future problems.
Responsible Organizations: Department of Permits and Development Review
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 6-10 years

Project 3
Encourage homeowners and developers to pay particular attention to the foundation issue and geotechnical engineering during construction by providing them informational material.
Responsible Organizations: Department of Permits and Inspections
Estimated Costs: Regular employee pay for content and layout preparation, approximately $2 for printing a trifold brochure
Possible Funding Sources: Hazard Mitigation Grant Program (HMGP),
Timeline for Implementation: 2-5 years

Objective 2
Address the issue of wellhead protection with respect to sinkholes.

Project 1
Since moving water is a major triggering mechanism, the County's Public Works Department should ensure that water main and connections, storm sewers and sewage lines are checked regularly for leaks. This will minimize potential subsidence problems as well as ground water contamination.
Responsible Organizations: Division of Public Works, Public Works Departments in municipalities

Estimated Costs: Regular employee pay and/or engineering consulting fees
Possible Funding Sources: HMGP
Timeline for Implementation: 2-5 years

Objective 3
Educate Frederick County residents on karst.

Project 1
Make available the karst topography brochure for sinkholes titled 'A Users Guide to Karst and Sinkholes in Western Maryland' that has been developed by the Western Maryland Resource Conservation and Development Council.
Responsible Organizations: Office of Emergency Management
Estimated Costs: Regular employee pay for content and layout preparation, approximately $2 for printing a trifold brochure
Possible Funding Sources: Hazard Mitigation Grant Program (HMGP),
Timeline for Implementation: 1 year

Project 2
Encourage residents to find out what is beneath the land surface prior to purchase of property. Information could be found in the library, at the county, or at state and federal agencies on the geology of the area. The Soil Conservation District and /or Natural Resources Conservation Service at 92 Thomas Johnson Drive, Suite 230, Frederick MD 21702, phone 301-695-2803 serves as a local resource center for information. Other State and regional agencies include the Maryland Geological Survey (MGS) and the Western Maryland Resource Conservation & Development Council (RC&D).
Responsible Organizations: Division of Planning, Board of Realtors
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 1 year

FLOOD

GOAL 10: Investigate structural and/or other solutions to flooding problems

Objective 1
Investigate the feasibility of enhancing and/or improving drainage of flood prone lands.

Project 1
Flooding on low-lying areas such as Route 550 at Israel Creek and Route 355 at Bennett's Creek are major areas of concern. These low-lying areas that have shallow flooding that typically occurs following snowmelt or high volume rainfalls often cause a significant amount of damage. Assess these areas to determine the best mitigation solution such as improving the storm drain system, elevating the roadway, etc.
Responsible Organizations: Office of Emergency Management, Division of Public Works, Maryland State Highway Administration
Estimated Costs: To be determined
Possible Funding Sources: FMA, HMGP
Timeline for Implementation: 6-10 years

Project 2
A thorough inspection of each of the identified critical facilities in the 100-year floodplain should be conducted by a registered engineer or architect. The inspection will enable the engineer or architect to identify potential structural weaknesses and other factors that could affect its ability to withstand a major wind or flood event and adequately protect its contents. Alternatives such as elevation, relocation, floodproofing, retrofitting should be considered to determine the best flood control measure. For each critical facility, a technical report should be completed to provide information on the first floor and base flood elevations. Mitigation measures and a detailed cost/benefit analysis should be conducted for each facility. This type of inspection would cost approximately $2,000-$3,000. Upon completion of a thorough assessment, the County could complete an application for Federal mitigation funds to fund a retrofitting project. A project application form would need to be completed for the project and submitted to the State Hazard Mitigation Officer (at the Maryland Emergency Services Agency).
Responsible Organizations: Office of Emergency Management, Department of Public Services, Division of Planning, municipalities
Estimated Costs: will vary by facility
Possible Funding Sources: USACE's Floodplain Services Program, Pre-disaster Mitigation Assistance Funds administered by MEMA, Hazard Mitigation grant Program Technical Assistance Funds administered by MEMA, Flood Mitigation Assistance Program Technical Assistance Funds, Small Flood Control Projects, Watershed Protection and Flood Prevention Program, Watershed Surveys and Planning.
Timeline for Implementation: 6-10 years

Objective 2
Strengthen the county's stand with respect to flood programs.

Project 1
Consider the benefits of enrolling Frederick County in the Community Rating System (CRS). The CRS Program of the NFIP was established to encourage communities to do more than the minimum when it comes to administering their individual floodplain programs. All activities that the County undertakes that they wish to be considered above the minimum are documented and submitted for verification. Points are awarded for the various activities. For each set of 500 points earned, flood insurance premiums are lowered by 5% throughout the community. Once the CRS application is completed, it should be reviewed by the Insurance Services Organization (the contractor that administers the CRS Program for FEMA) for accuracy and completeness.
Responsible Organizations: Office of Emergency Management, Division of Planning
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 6-10 years

GOAL 11: Develop measures to protect all buildings (commercial, residential, and industrial) that are in the floodplain

Objective 1
Continue to ensure that the current building codes, floodplain ordinances and standards follow FEMA guidelines and are properly enforced.

Project 1

Although no changes are required to be made to the floodplain services ordinances at this time, the State of Maryland recommends that the following changes be considered, to strengthen the ordinance, based on lessons learned from Isabel. The recommended changes to the State Model Floodplain Ordinance are outlined below. Municipalities are encouraged to adopt the State Model or should determine how to best fit these changes into their ordinance.

An increase in the freeboard requirement can be implemented simply by modifying the Flood Protection Elevation definition. Currently it is 1 foot of freeboard, but changing it to 2 or 3 feet will implement a higher elevation requirement. Also, it is recommended that "repetitive loss" be added to the definitions. This will allow extension of the Increased Cost of Compliance (ICC) coverage in flood insurance policies that pays up to $30,000 in additional coverage to bring repetitive loss as well as substantially damaged properties into compliance with the floodplain ordinance. The community must be willing to treat repetitive loss properties the same as new and substantially improved structures to qualify. If this is adopted, they must require that repetitive loss properties meet all code requirements as new structures, but they will be making ICC payments available to these structures.
Point of contact: John Joyce, State National Floodplain Coordinator, MDE. Email: John Joyce [jjoyce@mde.state.md.us]
Responsible Organizations: Office of Emergency Management, municipalities
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 6-10 years

Objective 2
Develop flood mitigation strategies for flood prone properties.

Project 1
Ensure that high-risk, pre-FIRM residential structures do not get repeatedly flooded by using retrofitting techniques to reduce the flood risk to the properties by developing a "flood inventory" of all repetitive loss structures.

The Maryland Department of the Environment will provide the names and addresses of repetitively flooded properties (those having two or more claims of $1,000 or more within any 10-year period of time). However, FEMA only has records of those properties having flood insurance. The County will therefore need to rely upon their own records to determine repetitively flooded properties that do not carry flood insurance.

Consider procuring the services of a consulting engineer/surveyor to determine and inventory the following on these repetitive loss structures: first floor elevation, basement elevation, lowest opening, lowest adjacent ground grade, type of construction, use, and condition.

- Continue to maintain acquisition plans or mitigation strategies for repetitively flooded properties.
- In residences that lose their basements due to elevating the home above the floodplain, include the construction of a "safe room" in the retrofitted structure.

Responsible Organizations: Division of Planning, Office of Emergency Management
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 1 year

Project 2
Once the parcel layer is complete, develop a structure layer on GIS that shows the actual structures (not only properties) in the 100-year floodplain for the County and the City of Frederick. This should be done in conjunction with the parcel layer.
Responsible Organizations: Division of Planning, Office of Emergency Management
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 2-5 years

WILDFIRES

Goal 12
Reduce the risk to wildfires in the more rural parts of the county

Objective 1
Introduce and enforce the concept of defensible spaces.

Project 1
There are a number of logging roads throughout the county that serve as good fire breaks. These roads are overgrown and as a result, not being used for the purposes they were intended. Identify these roads and maintain them on a regular basis so that they can be used as natural breaks.
Responsible Organizations: Department of Highways and Transportation, Department of Natural Resources
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 2-5 years

Project 2
Develop a flier to introduce residents to the concept of defensible space practices in urban interface areas, which emphasizes that trees areas new homes be thinned or cut down to create a buffer zone or standoff distance of approximately 50 feet to reduce the potential for damage from wildfire.
Responsible Organizations: Office of Emergency Management, Division of Fire and Rescue Services
Estimated Costs: Regular employee pay for content and layout preparation, approximately $2 for printing a trifold brochure
Possible Funding Sources: Hazard Mitigation Grant Program (HMGP), Pre Disaster Mitigation grant (PDM), Fire Management Assistance Grant
Timeline for Implementation: 1 year

Project 3
Develop a concerted educational campaign targeted to high risk areas that focuses on the nature of the risk, how to reduce the risk and what to do in the event of a fire. Components of the educational program will include risk awareness, defensible space/housekeeping, neighborhood evacuation procedures, ignition control, burn permits, and reporting procedures.
Responsible Organizations: Office of Emergency Management, Division of Fire and Rescue Services, Department of Natural Resources
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required

Timeline for Implementation: 2-5 years

COMMUNITY-SPECIFIC NEEDS

Goal 13
Identify community-specific needs to reduce risks to various hazards

Objective 1
Work with the Town of Mount Airy, City of Frederick, Town of Rosemont, Town of Walkersville, Town of Burkittsville, and Town of Brunswick to identify the needs, abilities, and resources to implement various local projects.

Town of Mount Airy

Project 1
Install/replace emergency back-up generators at all critical facilities
Responsible Organizations: Town of Mount Airy Communications & Technology Committee, Department of Water and Sewer
Estimated Costs:
Possible Funding Sources: Hazard Mitigation Grant Program (HMGP), Pre Disaster Mitigation grant (PDM), Department of Homeland Security grant (DHS)
Timeline for Implementation: 2-5 years

Project 2
Prepare and implement an emergency response plan for the Town of Mount Airy.
Responsible Organizations: Town of Mount Airy Communications & Technology Committee, Office of Emergency Management
Estimated Costs: Regular employee pay and/or consultant fees
Possible Funding Sources: Department of Homeland Security's Emergency Services Performance Grant (EMPG)
Timeline for Implementation: 2-5 years

Project 3
Install a SCADA system to monitor all critical public works facilities. This is a type of computer monitoring system for water and wastewater system operations. From a desk and/or lap top computer all pumps, flows, chemical feeds, power usage, security door contacts, fire detectors, etc. could be monitored.
Responsible Organizations: Town of Mount Airy Communications & Technology Committee, Division of Public Works, Department of Water and Sewer
Estimated Costs: To be determined
Possible Funding Sources: Department of Homeland Security's Emergency Services Performance Grant (EMPG)
Timeline for Implementation: 1 year

City of Frederick

Project 1
Complete the Carroll Creek Levee. The completion of the project will protect an additional 48 properties.
Responsible Organizations: City of Frederick – Planning, Engineering, Public Works, Maryland Department of the Environment, Maryland Historical Trust, Federal agencies
Estimated Costs: $40 per linear foot for 2' levee; $75 per linear foot for 4' levee; $125 per linear foot for 6' levee
Possible Funding Sources: HMGP, FMA
Timeline for Implementation: 6-10 years

Project 2
Protect the Independent Hose Company on Baughman's Lane by either raising the road or creating a levee. A 100-year flood could block access to the only firehouse west of downtown.
Responsible Organizations: City of Frederick - Planning, Engineering, Public Works
Estimated Costs: $40 per linear foot for 2' levee; $75 per linear foot for 4' levee; $125 per linear foot for 6' levee
Possible Funding Sources: HMGP, FMA
Timeline for Implementation: 6-10 years

Project 3
Retrofit drainage where major roads frequently flood:
- West Patrick Street opposite West Frederick Middle School (MD Route 144-major arterial road).
- Gas House Pike near confluence of Carroll Creek and Monocacy River (construction of new Monocacy Boulevard might relieve burden). This has been planned but not built.
- Waverly Drive (Frederick Towne Mall, major City mall subject to flooding by Rock Creek.).

Responsible Organizations: City of Frederick – Public Works, Engineering, Planning
Estimated Costs: City engineer to do preliminary analysis to determine costs at each location
Possible Funding Sources: HMGP, FMA
Timeline for Implementation: 6-10 years

Project 4
Develop a wellhead protection ordinance (all wellheads are in the 100-year floodplain).
Responsible Organizations: City of Frederick – Public Works, Engineering, Water and Sewer, Legal
Estimated Costs: Regular employee pay and/or consultant fees
Possible Funding Sources: HMGP, FMA
Timeline for Implementation: 1 year

Project 5
Develop a GIS map of all City sinkholes. Require that sinkhole topography be included in all site plans in affected areas.
Responsible Organizations: City of Frederick – Engineering, Planning
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 1 year

Project 6
Middletown, Walkersville, Frederick should get together and urge the county to adopt sinkhole ordinance.
Responsible Organizations: Town of Middletown, Town of Walkersville, City of Frederick – Engineering, Public Works, Legal, Mayor's Office
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 6-10 years

Project 7
Establish a regular maintenance inspection and preventive program for sinkholes on/near city streets.
Responsible Organizations: City of Frederick – Streets and Grounds
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 1 year

Town of Rosemont

Project 1
Develop measures to assist those who rely on well water, during the drought season.
Responsible Organizations: Town of Rosemont
Estimated Costs: To be determined
Possible Funding Sources: HMGP, FMA
Timeline for Implementation: 2-5 years

Project 2
Provide the Rosemont Police Building with a generator.
Responsible Organizations: Town of Rosemont
Estimated Costs:
Possible Funding Sources: Department of Homeland Security's Emergency Services Performance Grant (EMPG)
Timeline for Implementation: 1 year

Town of Walkersville

Project 1
Purchase a generator for the Town Hall.
Responsible Organizations: Town of Walkersville
Estimated Costs:
Possible Funding Sources: Department of Homeland Security's Emergency Services Performance Grant (EMPG)
Timeline for Implementation:

Project 2
Update the sinkhole ordinance to address sinkholes on private property.
Responsible Organizations: Town of Walkersville, Division of Permits and Inspections
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required

Timeline for Implementation: 2-5 years

Project 3
Update procedures for mapping sinkholes to GIS.
Responsible Organizations: Town of Walkersville, Office of Emergency Management
Estimated Costs: Regular employee pay
Possible Funding Sources: No funding required
Timeline for Implementation: 1 year

Town of Burkittsville

Project 1
Develop an additional fire pond at east end of the Town.
Responsible Organizations: Town of Burkittsville
Estimated Costs: To be determined
Possible Funding Sources: HMGP
Timeline for Implementation: 6-10 years

Town of Brunswick

Project 1
Consider providing battery-operated radios, flashlights, etc. to residents, free-of-charge.
Responsible Organizations: Town of Brunswick, Office of Emergency Management
Estimated Costs: Regular employee pay
Possible Funding Sources: General fund
Timeline for Implementation: 1 year

Project 2
Provide generators at the Brunswick Water Treatment Plant, Police Department building and the Fire Department Building.
Responsible Organizations: Town of Brunswick, Office of Emergency Management
Estimated Costs:
Possible Funding Sources: Department of Homeland Security's Emergency Services Performance Grant (EMPG)
Timeline for Implementation: 2-5 years

Town of Thurmont

Project 1
Obtain generators of various sizes for wastewater treatment and for water treatment.
Responsible Organizations: Town of Thurmont, Office of Emergency Management
Estimated Costs:
Possible Funding Sources: Department of Homeland Security's Emergency Services
Timeline for Implementation: 1 year

Project 2
Coordinate with local fire and rescue services to develop a community emergency response plan.
Responsible Organizations: Town of Thurmont, Office of Emergency Management
Estimated Costs: Regular employee pay

Possible Funding Sources: No funding required
Timeline for Implementation: 2-5 years

CHAPTER 6 – ACTION PLAN

Introduction

This Plan document is intended to serve as Frederick County's road map for evaluating hazards, identifying resources and capabilities, selecting appropriate actions, and developing and implementing mitigation measures to eliminate or reduce future damage from those hazards in order to protect the health, safety, and welfare of the residents in the community.

The action plan contains the list of mitigation actions; each action contains information on the responsible agencies, estimated costs, possible funding sources, and timeline for implementation. The action plan outlines the steps necessary to implement the mitigation strategies. There may be differences in the amount of information and analysis, or the number of proposed initiatives for each jurisdiction or the county. This may be a result of the varying characteristics and available data with each jurisdiction.

The action plan also identifies procedures for keeping the plan current and updating it at least once every 5 years, as prescribed by the Disaster Mitigation Act of 2000.

The Planning Committee met on 21 July 2004 to prioritize these actions for the county and its municipalities. Each Committee member ranked hazard mitigation actions for their respective jurisdictions as well as for the county.

The mitigation actions discussed at the previous committee meeting were listed on large poster sheets for the Committee to review. Each team member was then given 8 voting dots to place next to any of the mitigation actions they felt were important to their community or to the county as a whole. The dots were then tallied and the mitigation activities were then listed in order of priority, (those with the highest number of points ranked first) according to the number of voting dots each received. The actions were then classified into three main categories based on the tallies: those actions that received 3 tallies and above were ranked as high priority actions; those that received 1 and 2 tallies were ranked as medium priority actions; and those that did not receive any tallies were ranked as low priority actions.

Prior to casting their votes, the Committee members took the following considerations into account:

1. Plan goals and objectives: how does the mitigation action address the goals and objectives of the plan?
2. Equity: does this action benefit most, if not all the communities within the county? Is there an equitable distribution of actions by municipality?
3. Countywide impacts: how does it affect Frederick County as a whole?
4. Ease of implementation: Can this action be easily implemented first? Does the county or town have the capability (funding, regulatory authority, staff) in place now to implement the action?
5. Multi-objective actions: Does this action achieve multiple community goals?
6. Time: Can this action be quickly accomplished compared to those that would take a long time to obtain the necessary approvals or funding?

7. Post-disaster mitigation: Is this action more feasible in a post-disaster setting? Would the extent of damages, political will, and access to State and federal mitigation funds dramatically alter the feasibility of implementation?

Monitoring, Evaluating and Updating the Plan

Monitoring, evaluating, and updating the Plan are critical to maintaining its relevance. Effective implementation of mitigation activities paves the way for continued momentum in the planning process and gives direction for the future. This section identifies who will be responsible for monitoring, evaluating, and updating the Plan, and what those responsibilities entail. This section also lays out the method and schedule of these and describes how the public will be involved on a continuing basis.

Hazard Mitigation Planning Committee

A permanent entity needs to be responsible for maintaining the Plan and for monitoring, evaluating, and updating it. This plan recommends retaining the Hazard Mitigation Planning Committee (with representation from all participating municipalities). The Committee will represent citizen, municipal, business, educational, volunteer and County interests through a balanced membership. A mitigation coordinator from the County's Office of Emergency Management would lead the committee.

The Hazard Mitigation Committee will oversee the progress made on the implementation of the identified action items and update the Plan, as needed, to reflect changing conditions. The Committee will therefore serve as the focal point for coordinating countywide mitigation efforts. The Committee will meet annually to address all its responsibilities. It will serve in an advisory capacity to the Frederick County Office of Emergency Management.

The Committee will monitor the mitigation activities by reviewing reports form the agencies identified for implementation of the different mitigation actions. The Committee will request that the responsible agency or organization submit a semi-annual report, which provides adequate information to assess the status of mitigation actions. The Committee would then provide their feedback to the individual agencies.

Evaluation of the plan should include not only checking on whether or not mitigation actions are implemented, but also assessing their degree of effectiveness. This would be done through a review of the qualitative and quantitative benefits (or avoided losses) of the mitigation activities. These would then be compared to the goals and objectives that the Plan was intended to achieve. The Committee would also evaluate mitigation actions to see if they need to be modified or discontinued in light of new developments. The Committee would document progress annually.

The Plan would be updated every 5 years, as required by the DMA 2000, or following a disaster. The Plan will be updated by the County's Office of Emergency Management. The updated Plan would account for any new developments in the County or special circumstances (post-disaster). Issues that come up during monitoring and evaluation, which require changes in mitigation strategies and actions should be incorporated in the Plan at this stage.

Public Involvement

The Planning Committee should involve the public during the evaluation and update of the Plan through annual public education activities, public workshops, and public hearings. A public meeting will be held to obtain public input for plan evaluation. The meeting will be facilitated by the Frederick County's Office of Emergency Management. The public will be notified through a newspaper advertisement. It is recommended that the County's website serve as a means of communication by providing information about mitigation initiatives.

Updating the Plan

Throughout the hazard analysis and vulnerability assessment, descriptions of missing or inadequate data indicate some areas in which the County and municipalities could improve their ability to identify vulnerable structures. As the County and municipal governments work to increase their overall technical capacity and implement their comprehensive planning goals, they should also attempt to improve their ability to identify assets vulnerable to hazards.

Conclusion

In summary, Frederick County and its municipalities can begin their mitigation process by gearing their resources to implement the following initiatives that ranked high in the priority listing of initiatives:

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Prioritization Schedule Frederick County Hazard Mitigation Plan		
Table 6.2		
Mitigation Action	**Page No.**	**Score**
High Priority		
Educate citizens by teaching Disaster Preparedness at various locations throughout the county. Conduct road shows in schools and other various organizations.	66	5
Adopt the Source Protection Plan that has been developed for the entire county, including areas in the karst terrain as soon as possible.	68	5
Encourage safety in temporary classrooms in schools.	71	4
Provide generators at the Brunswick Water Treatment Plant, Police Department building and the Fire Department Building.	81	4
Establish building standards and regulations in areas where there is evidence of water-soluble bedrock.	73	3
Establish specific building standards and regulations and storm water management plans in karst areas.	73	3
The County's Sheriff's Office should consider introducing a Reverse 9-1-1system that would enhance the quality of service provided by them.	70	3
Develop a county-wide audible alert system. Educate the public on meanings of warnings and appropriate actions to take before, during and after an emergency.	71	3
Medium Priority		
Once the parcel layer is complete, develop a structure layer on GIS that shows the actual structures in the 100-year floodplain.	77	2
Develop a check sheet that identifies a list of unusual or suspect activities in and around critical facilities and distribute this to residences and businesses.	64	2
Work with the local officials in Mount Airy and encourage the Town of Mount Airy to adopt this floodplain ordinance as soon as possible.	79	2
Complete the Carroll Creek Levee.	79	2
Protect the Independent Hose Company on Baughman's Lane by either raising the road or creating a levee.	79	2
Retrofit drainage where major roads frequently flood: • West Patrick Street opposite West Frederick Middle School (MD Route 144-major arterial road). • Gas House Pike near confluence of Carroll Creek and Monocacy River (construction of new Monocacy Boulevard might relieve burden). This has been planned but not built. • Waverly Drive (Frederick Towne Mall, major City mall subject to flooding by Rock Creek)	79	2
Develop a wellhead protection ordinance for the City of Frederick.	79	2
Develop an additional fire pond at east end of the Town of Burkittsville.	81	2
Consider providing battery-operated radios, flashlights, etc. to residents in the Town of Brunswick, free-of-charge.	81	2
House FEMA information in all branches of the county library system. Inventory a number of publications for public review and dissemination at the municipal building.	66	1
Promote best practices in Frederick County by maintaining an on-going list of activities and learning from other successful communities.	67	1
Ensure that the Hazard Mitigation Plan and the Frederick County Emergency Plan are integrated.	60	1

Install/replace emergency back-up generators at all critical facilities in Mount Airy.	78	1
Update the sinkhole ordinance for the Town of Walkersville to address sinkholes on private property.	80	1
Low Priority		
Use local carnivals and fairs held throughout the county as opportunities to disseminate information to the public.		
Develop a brochure for the Rosemont, Burkittsville, and other rural parts on the county on how to maintain septic systems and measures that could be taken during times they are out of power.	65	
Create a brochure on how to weather a storm.	65	
Run information clips on immediate steps to be taken after a storm, right after the hazard event.	65	
Integrate this Hazard Mitigation Plan with the municipalities' and County's Comprehensive Plans so that is serves as a 'safety element' to these comprehensive plans and ensure that designated growth areas are not in high hazard areas identified in this Plan.	67	
Integrate this Hazard Mitigation Plan into the county's 8 regional plans and update as necessary.	68	
Revise existing ordinances as appropriate for the towns and the county.	68	
Integrate recommendations from all county-wide or regional evacuation plans that have been developed for adjacent areas, into Frederick County's evacuation plan to ascertain smooth transition, traffic flow, etc.	69	
Update Frederick County's Evacuation Plan to include issues such as staging areas, feeding plan for displaced persons, bathrooms, signs, temporary housing, decontamination, etc.	69	
Identify additional locations that could be equipped and serve as shelters. Work with the Red Cross to conduct an assessment of existing shelters in the county to determine their condition and adequacy. Develop a database of shelters and their locations and determine ones that need to be retrofitted.	70	
Identify and prioritize a list of critical facilities that would require generators during times of an emergency.	70	
Identify large abandoned structures that are in a state of disrepair and consider demolition of these structures.	71	
Conduct structural assessments and engineering inspections of critical facilities and determine their useful life and replacement requirements. Recommend specific retrofitting measures for each building as appropriate.	72	
Consider planning for a storm safe structure/shelter in or in close proximity each mobile home park.	72	
Encourage homeowners and developers to pay particular attention to foundation issues and geotechnical engineering during construction.	73	
Ensure that water main and connections, storm sewers and sewage lines are checked regularly for leaks.	73	
Make available the brochure on Karst Topography.	74	
Conduct a thorough inspection of each of the identified critical facilities in the 100-year floodplain by a registered engineer or architect.	75	
Encourage residents to find out what is beneath the land surface prior to purchase of property.	75 75	
Consider the benefits of enrolling Frederick County in the Community Rating System (CRS).	75	
Encourage municipalities to adopt the Sate Model Floodplain Ordinance or determine how to best fit these changes into their ordinance.	75	
Develop a "flood inventory" of all repetitive loss structures in the county.	76	
Identify logging roads and maintain them on a regular basis so that they can be used as natural breaks.	77	
Introduce residents to the concept of defensible space practices and stand-off distances in urban interface areas.	77	
Develop a concerted educational campaign targeted to high risk areas that focuses on the nature of the risk, how to reduce the risk and what to do in the event of a fire.	77	
Prepare and implement an emergency response plan for the Town of Mount Airy.	77	
Install a SCADA system to monitor all critical public works facilities in Mount Airy.	78	
Develop a GIS map of all sinkholes in Frederick County. Require that sinkhole topography be included in all site plans in affected areas.	79	
Middletown, Walkersville, Frederick should get together and urge the county to adopt sinkhole ordinance.	79	
Establish a regular maintenance inspection and preventive program for sinkholes on/near city streets in Frederick City.	79	
Develop measures to assist those who rely on well water, during the drought season in Rosemont.	80	
Provide the Rosemont Police Building with a generator.	80	

Purchase a generator for the Walkersville Town Hall.	80	
Update procedures for mapping sinkholes to GIS in the Town of Walkersville.	80	
Obtain generators of various sizes for wastewater treatment and for water treatment in Thurmont.	81	
Coordinate with local fire and rescue services to develop a community emergency response plan for Thurmont.	81	