CITY OF CHESAPEAKE

NATURAL HAZARDS MITIGATION

Prepared by:

The City of Chesapeake, Virginia

and Dewberry & Davis LLC, Fairfax, Virginia

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SECTION I — EXECUTIVE SUMMARY

The City of Chesapeake is vulnerable to many types of natural hazards — including hurricanes, nor'easters, floods, tornadoes, winter storms, earthquakes and wildfires — and has experienced the effects of each of these at some point in its history.

For the most part, the last 50 years have been relatively quiet in terms of disasters throughout southeastern Virginia. However, the last few decades of exponential growth within the City of Chesapeake has placed more development than ever in harm's way, increasing the potential for severe economic and social consequences if a major disaster or other catastrophic event were to occur today. Such an event could have the potential to cost the city's government, residents, and businesses millions of dollars in damages to public buildings and infrastructure, lost tax revenues, unemployment, homelessness, and emotional and physical suffering for many years to come.

A multi-hazard mitigation plan has been prepared for the City of Chesapeake in accordance with the requirements of the Disaster Mitigation Act of 2000. Having the mitigation plan in place will help the city to:

- Better understand local hazards and risks;
- Build support for mitigation activities;
- Develop more effective community hazard-reduction policies and integrate mitigation concepts into other community processes;
- Incorporate mitigation into post-disaster recovery activities; and
- Obtain disaster-related grants in the aftermath of a disaster.

Hazard Identification and Risk Assessment

Prioritizing the potential hazards that can impact the City of Chesapeake was based on the probability that a potential hazard will affect the city and the potential impacts on the

city should a given disaster strike. Values were assigned to each hazard type, based on the hazard's highest potential hazard level. These hazard level categories represent the likelihood of a hazard event, which could significantly affect the city. These categories are based on the classifications used in the city's original Hazard Vulnerability Assessment (HVA) document and are ***High, Medium-High, Medium,*** and ***Low***. In order to focus on the most significant hazards, only those assigned a level of highly likely or critical have been included for analysis in the risk assessment. Table 1 summarizes the results of this analysis, which is explained more fully in Section V of this plan.

TABLE 1 – HAZARD IDENTIFICATION RESULTS

HAZARD TYPE	HAZARD LEVEL
Flood	High
Wind Events	High
Drought	Medium-High

The Mitigation Strategy

During the presentation of findings for the hazard identification and risk assessment workshop, the Mitigation Advisory Committee (MAC) was asked to provide comments and suggestions on actions and policies, which could lessen the city's vulnerability to the identified hazards. The MAC supported the following preliminary comments below:

- Top priorities for the city were public safety, public education, and reduction of potential economic impacts of disasters.
- Alternatives should consider the impacts on the community as a whole.
- Alternatives must not conflict with other city programs.

- Community Rating System and the floodplain ordinance update, policies and activities should be a priority.
- Past experiences from disasters should be built upon.
- The success of past mitigation projects should be considered in developing alternatives.
- Outreach and other efforts should be attempted to FEMA-designated Repetitive Loss Properties.
- The city's Project Impact program was an effective public outreach tool and should be built upon.
- Recent disasters have been less damaging to structures but more significant in terms of lost road access, time, and inconvenience.

The following overarching community goal and six specific goals were developed by the MAC to guide the city's future hazard mitigation activities.

OVERARCHING COMMUNITY GOAL: "To develop and maintain a disaster resistant community that is less vulnerable to the economic and physical devastation associated with natural hazard events."

GOAL 1: Enhance the safety of residents and businesses by protecting new and existing development from the effects of hazards.

GOAL 2: Protect new and existing public and private infrastructure and facilities from the effects of hazards.

GOAL 3: Increase the city's floodplain management activities and participation in the National Flood Insurance Program.

GOAL 4: Ensure hazard awareness and risk reduction principles are institutionalized into the city's daily activities, processes, and functions by incorporating it into policy documents and initiatives.

GOAL 5: Enhance community-wide understanding and awareness of community hazards.

GOAL 6: Publicize mitigation activities to reduce the city's vulnerability to the identified hazards.

The MAC then used STAPLE/E Criteria (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) to select and prioritize the most appropriate mitigation actions for the City of Chesapeake. This methodology required that social, technical, administrative, political, legal, economic, and environmental considerations be taken into account when reviewing potential projects and policies. This process was used to help ensure that the most equitable and feasible actions would be undertaken based on Chesapeake's capabilities. These actions are laid out with an implementation strategy and timeframes in Section VII of this plan.

Conclusion

The plan allows the City of Chesapeake to be the ***first*** community in the Commonwealth of Virginia to adopt a local hazard mitigation plan. The plan symbolizes

the City of Chesapeake's continued commitment and dedication to enhance the safety of its residents and businesses by taking action before a disaster strikes. While the city cannot prevent natural hazard events from occurring, it can minimize the disruption and devastation that so often accompanies these disasters.

SECTION II — INTRODUCTION

Mitigation

Mitigation is commonly defined as sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects. Hazard mitigation focuses attention and resources on community policies and actions that will produce successive benefits over time. A mitigation plan states the aspirations and specific courses of action a community intends to follow to reduce vulnerability and exposure to future hazard events. These plans are formulated through a systematic process centered on the participation of citizens, businesses, public officials and other community stakeholders.

A local mitigation plan is the physical representation of a jurisdiction's commitment to reduce risks from natural hazards. Local officials can refer to the plan in their day-to-day activities and decisions regarding regulations and ordinances, granting permits, and in funding capital improvements and other community initiatives. Additionally, these local plans will serve as the basis for states to prioritize future grant funding as it becomes available.

It is hoped that the city's hazard mitigation plan will be a tool for all community stakeholders to use by increasing public awareness about local hazards and risks, while at the same time providing information about options and resources

available to reduce those risks. Teaching the public about potential hazards will help the community protect itself against the effects of the hazards, and will enable informed decision making on where to live, purchase property, or locate their businesses.

The Local Mitigation Planning Impetus

On October 30, 2000, the President signed into law the Disaster Mitigation Act of 2000 (DMA 2000), which established a national disaster hazard mitigation grant program that would help to reduce loss of life and property, human suffering, economic disruption, and disaster assistance costs resulting from natural disasters.

DMA 2000 amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act and has added a new section, §322 Mitigation Planning. Section 322 requires local governments to prepare and adopt jurisdiction-wide hazard mitigation plans for disasters declared after November 1, 2003, as a condition of receiving Hazard Mitigation Grant Program (HMGP) project grants and other forms of non-emergency disaster assistance. Local governments must review and if necessary, update the mitigation plan every five years from the original date of the plan to continue program eligibility.

Interim Final Rule Planning Criteria

As part of the process of implementing DMA 2000, The Federal Emergency Management Agency (FEMA) prepared an Interim Final Rule (the Rule) to define the mitigation planning criteria for States and communities. Published in the Federal Register on February 26, 2002, at 44 CFR Part 201, the Rule serves as the governing document for DMA 2000 planning implementation.

Organization of the Plan

This planning document has been organized in a format that follows the process enumerated in the Rule. The next section,

Section III – Planning Process describes the City of Chesapeake's stakeholder involvement and defines the processes followed throughout the creation of this plan.

Section IV – Community Profile provides a physical and demographic profile of the city, looking at things such as geography, hydrography, development, people, and land uses within the city.

Section V – Risk Assessment evaluates the natural hazards likely to affect the City of Chesapeake, and quantifies whom, what, where, and how the city may be vulnerable to future hazard events.

Section VI – Capability Analysis analyzes the city's policies, programs, plans, resources, and capability to reduce exposure to hazards in the community.

Section VII – Mitigation Strategy addresses the city's issues and concerns for hazards by establishing a framework for loss-reduction activities and policies. The strategy includes a community vision, goals, objectives, and a range of actions to achieve the goals.

Section VIII – Plan Maintenance Procedures specifies how the city will monitor, evaluate, and update the plan, including a process for continuing stakeholder involvement once the plan is completed.

Section IX – Appendices is the last section of the plan, and includes supplemental reference materials and more detailed calculations and methodologies used in the planning process. The Appendices also include commonly used mitigation terms and an acronym list.

SECTION III — PLANNING PROCESS

In late 1999, the Federal Emergency Management Agency and the Virginia Department of Emergency Management selected the City of Chesapeake to be a participating community in the Project Impact Program. The program was a nationwide initiative dedicated to help make communities become disaster-resistant through a local partnership of government officials, citizens, private sector companies, professional and civic associations, learning institutions, volunteer and community organizations, and the media. Representatives from each of these community stakeholder groups formed a Project Impact Steering Committee to develop disaster prevention and preparedness programs to reduce the impact of natural and manmade disasters.

The City of Chesapeake's Project Impact goals were based on the principles of hazard awareness and disaster prevention. These goals included:

- Ensure that the city has sustainable communities and businesses resistant to the human and economic costs of disasters;
- Maintain and enhance the economic stability, public health, and safety to the communities of the city;
- Ensure that the city's cultural richness and environmental quality are not jeopardized by the occurrence of a disaster; and
- Recognize the potential impact of natural or manmade hazards on public and private buildings and facilities, and the utility and transportation systems that serve them.

From 2000 to 2002, the Steering Committee held regular meetings and continually worked on the city's Hazard Vulnerability Assessment (HVA). The Steering Committee coordinated and consulted with other entities and stakeholders to identify and delineate natural and manmade hazards within the city and to assess the risks and vulnerability of public and private buildings, facilities, utilities, communications, transportation systems, and other vulnerable infrastructure.

CITY OF CHESAPEAKE PROJECT IMPACT STEERING COMMITTEE PARTICIPATION	
MEETING DATES	**Summary Discussions**
09/28/00	Establishment of a Mitigation Planning Workgroup and the development of roles and responsibilities.
10/26/00	Ed Wrightson and Carl Dozier offer to co-chair Mitigation Planning Workgroup to develop the City's mitigation plan. Begin to generate a list of potential work group members.
12/07/00	Identification of parameters for the Hazard Vulnerability Analysis (HVA). Begin to set timeline for HVA (Final Draft June 2001).
01/23/01	Discussion of Chesapeake's known natural and manmade hazards. Assignment of specific hazards for workgroup members to research.
02/16/01	Discussion of Geographical Information System (GIS) data: demographics, floodplain delineations, HAZMAT locations, critical facilities, etc. Group evaluation of New Hanover County, NC risk assessment CD.
03/08/01	Distribution of HVA summaries and critical facilities and other public and private facilities. Scheduling of ride-a-long hazard location/ orientation field trips with the City Battalion Chiefs to discuss hazard locations. Discussion of HVA document format.
03/29/01	Review of NOAA's TP40 Precipitation Data Tool, discussion of preliminary weather analysis report, additional GIS layers, and HVA's previously completed for Public Works and Public Utilities.
04/26/01	All needed data has been identified and collected and is ready for analysis. Discussion of benefits of developing a comprehensive hazard mitigation plan. Draft HVA is scheduled to be presented and discussed on May 14, 2001.
05/31/01	Workgroup meeting to review the preliminary HVA document and provide recommendations. Still waiting on digitized FIRM's, due in late June, 2001 and the receipt of the new Census 2000 data.(FIRM's digitization completed by City of Chesapeake)
06/08/01	Meeting to review recommendations and discuss format recommendations.
08 /30/01	The workgroup continues to gather information and incorporate new information into the HVA. First draft is expected to be completed at the end of September and will be distributed in the near future to City Fire Department Command personnel for review and comment.

02/05/02	HVA status meeting to discuss the planning sector breakdown into nine geographic locations and the current ranking of hazards.
04/25/02	GIS is in the final stages of creating hazard maps, which will be incorporated into the draft HVA. In order to increase citizen participation as work begins on the mitigation plan, additional citizens will be contacted. Discussion possibly using citizen surveys at the Chesapeake Jubilee and upcoming Planning Commission meeting in June.
08/22/02	Draft HVA was discussed and distributed for review and comment.
10/31/02	Meeting to answer questions and discuss workgroup comments for the draft HVA. Once the final draft is completed, the workgroup will begin the next step of planning process. Will be re-reviewing the DMA 2000 planning requirements before the next meeting.

In February 2003, the city contracted with Dewberry & Davis LLC to build upon their completed HVA and Project Impact efforts and work with the community to develop a hazard mitigation plan. The city worked with the consultants throughout the planning process to ensure that potential stakeholders participated in the process and would have opportunities for input in the draft and final phases of the plan.

The Mitigation Advisory Committee

A Mitigation Advisory Committee (MAC) made up of public representatives, private citizens, businesses, and organizations was brought together to work with the Dewberry team and provide input at key stages of the process. Efforts to involve city departments and community organizations that might have a role in the implementation of the mitigation actions or policies included invitations to attend meetings and serve on the MAC, e-mails of minutes and updates, strategy development workshops, and teleconferences, and opportunities for input and comment on all draft deliverables.

The City of Chesapeake would like to thank and acknowledge the following persons who served on the MAC for their representative departments and organizations throughout the planning process:

Frankie Carroll	**Planning Commission**
Heath Covey	**Communications Department**
Carl Dozier	**Chesapeake Public Schools**
Lee Dydiw	**Planning Department**
Rodney Foster	**City of Chesapeake Private Citizen**
Joan Fowler	**Economic Development Department**
Eric Freiburger	**Private Businesses (NOVA Chemicals Inc.)**
Steve Gilbert	**School Administration**
Sam Gulisano	**Fire Department**
Yolanda Jefferson	**Redevelopment and Housing Department**
John Knowles	**Planning Department**
Pat Knowles	**Director of Chesapeake Division- Chamber of Commerce**
Allyson Kuriger	**Consultant (Dewberry)**
Eric Martin	**Public Works Department**
Louise McCarthy	**City of Chesapeake Private Citizen**
Elaine Meil	**Virginia Department of Emergency Management**
Mary Moneypenny	**City Attorney's Office**
John Oliphant	**Board of Directors Member- Chamber of Commerce**
Joey Rothgery	**American Red Cross**
Dana Sanford	**City Attorney's Office**
Sam Sawan	**Public Works Department**
Karen Shaffer	**Planning Department**
Bob Smalley	**Building Inspections**

Earl Sorey	**Public Works Department**
Ray Stout	**Private Businesses (Chesapeake Management Services)**
Ted Van Kirk	**Consultant (Dewberry)**
Hui-Shan Walker	**Emergency Management Office**

CITY OF CHESAPEAKE MITIGATION ADVISORY COMMITTEE PARTICIPATION	
MEETING DATES	**Summary Discussions**
02/14/03	Meeting to discuss scope, schedule, potential MAC members and stakeholders, and additional public outreach initiatives for citizen involvement.
03/06/03	MAC kickoff meeting – discussion of project status, overview of hazards and mitigation planning, next steps.
04/07/03	HVA (Revised by Dewberry) presentation and strategy development workshop.
	Email distribution of goals and objectives for evaluation and ranking to the MAC.
	Interviews with MAC members that may have a role in the implementation of the plan for additional input and information regarding community capabilities, etc.
05/07/03	MAC Teleconference to discuss short, medium, and long-range actions.
	Email distribution of final draft strategy for MAC review and approval.
06/23/03	Draft plan distributed to the MAC, State, and FEMA for preliminary review and comment.
09/05/03	Final MAC meeting to discuss the draft plan comments.
09/23/03	City Council work session
10/14/03	City Council plan adoption/ public hearing

Public Participation and Citizen Input

As shown in Table 5 below, several opportunities were provided to the public for input and participation throughout the planning process. One open public

meeting was held on July 31, 2003, to allow the general public an opportunity to meet with the planning consultants and MAC members, ask questions, and provide comments and input on the draft mitigation plan. A special open forum was held immediately preceding the public meeting for members of the business community that had concerns about the potential impact of the plan on their livelihoods. One person attended the open forum for the business community and no one attended the open public meeting. Following the meeting, draft copies of the plan were on public display at the Planning Department for review.

CITY OF CHESAPEAKE METHODS AND DATES	
DATES	**Summary of Methods**
03/23-03/29	Public Notice of Upcoming Mitigation Planning Process Posted on City Website
03/23-03/29	1st Interview to Discuss Planning Process on Chesapeake This Week
04/01-04/30	News Release of Mitigation Plan Posted on City Website
05/16- CURRENT	Request for Citizen Input and Participation Hazards Flyer Posted In Public Libraries
07/10-07/27	Public Notice of Public Meeting for the Draft Mitigation Plan – Draft Plans Available for Review at the City's Fire Department.
07/23-07/25	2nd Interview to Discuss the Plan Status on Chesapeake This Week
07/31	Special Meeting With the Business Community/ Chamber of Commerce to Address Issues and Answer Questions (5:30pm -6:30pm) / Open Public Meeting (7:00pm – 8:30pm)
07/31-08/07	Draft Plan Available for Public Viewing at the City's Planning Department
08/07	Public Comments Due for the Draft Mitigation Plan
10/14/03	Public hearing for adoption of the mitigation plan.

Throughout the planning process, several citizens called the city's Fire Department to learn more about the plan and the planning process. One comment was received (verbally) from the attendee of the open forum for the business community. This comment was in regard to the potential "codifying" of

the plan, which the attendee feared could have the potential to impose additional regulations that could affect the business community.

RESOLUTION ADOPTING A NATURAL HAZARDS MITIGATION PLAN FOR THE CITY OF CHESAPEAKE, VIRGINIA.

WHEREAS, the Disaster Mitigation Act of 2000, as amended, requires that local governments develop and adopt natural hazard mitigation plans in order to receive certain federal assistance, and

WHEREAS, a Disaster Mitigation Advisory Committee ("MAC") comprised of Chesapeake citizens, members of the business community and non-profit organizations working in Chesapeake, and City staff was convened in order to study the City's risks from and vulnerabilities to natural hazards, and to make recommendations on mitigating the effects of such hazards on the City; and

WHEREAS, a request for proposals was issued to hire an experienced consulting firm to work with the MAC to develop a comprehensive natural hazard mitigation plan for the City; and

WHEREAS, the efforts of the MAC members and the City's consulting firm have resulted in the development of a Natural Hazards Mitigation Plan for the City.

NOW THEREFORE, BE IT RESOLVED by the Council of the City of Chesapeake, Virginia that the Natural Hazards Mitigation Plan dated October 14, 2003 is hereby approved and adopted for the City of Chesapeake, Virginia. A copy of the plan is attached to this resolution.

ADOPTED by the Council of the City of Chesapeake, Virginia this ____ day of _____, 2003.

APPROVED:

_____

Mayor

ATTEST:

_____

Clerk of the Council

ORDINANCE AMENDING CHAPTER 2 OF THE CHESAPEAKE CITY CODE, ARTICLE V THEREOF, ENTITLED "BOARDS, COMMITTEES AND COMMISSIONS," TO ESTABLISH THE NATURAL EVENT MITIGATION ADVISORY COMMITTEE FOR THE CITY OF CHESAPEAKE.

BE IT ORDAINED by the Council of the City of Chesapeake, Virginia that Chapter 2 of the Chesapeake City Code, Article V thereof, entitled "Board, Committees, and Commissions" is hereby amended and reordained as follows:

Chapter 2. ADMINISTRATION

ARTICLE V. BOARDS, COMMITTEES AND COMMISSIONS

DIVISION 25. NATURAL EVENT MITIGATION ADVISORY COMMITTEE

Section 2-620.39. Creation; composition; appointment; compensation.

(a) There is hereby established an advisory committee to be known as the "Natural Event Mitigation Advisory Committee."

(b) The committee shall derive its authority from, and be administered by, city council.

(c) The committee shall consist of seventeen members who shall serve on the committee without compensation. The membership shall consist of the following:

(1) Five legal residents of the city;

(2) Two representatives of the city's business community;

(3) One representative of a non-profit organization providing services in the city;

(4) The city director of economic development, or designee;

(5) The city director of facilities management, or designee;

(6) The city fire chief, or designee;

(7) The city director of inspections, or designee;

(8) The city neighborhood services coordinator, or designee;

(9) The city director of planning, or designee;

(10) The city director of public communications, or designee;

(11) The city director of public utilities, or designee; and

(12) The city director of public works, or designee.

(d) All members of the committee, other than city employees hereby designated to serve in their official capacities, shall be appointed by city council. Such members shall be appointed by city council for terms of three years; provided, however, that of those first appointed, five members shall be appointed for three year terms and three members shall be appointed for two year terms. All vacancies on the committee shall be filled by the city council for the unexpired portion of the term.

Section 2-620.40. Removal of members.

Any member of the committee may be removed at the pleasure of the city council.

Section 2-620.41. Presiding officer; quorum.

(a) The committee shall elect annually a presiding officer and shall make rules and forms for the procedures consistent with the laws of the City of Chesapeake and of the Commonwealth of Virginia.

(b) Notwithstanding any other provision of this Code to the contrary, a quorum shall consist of a majority of the members of the committee who are not city staff members serving in their official capacities.

Section 2-620.42. Duties and purpose.

(a) The committee shall monitor the efficiency and effectiveness of various natural hazard mitigation strategies and will make recommendations to city council for additional improvements. The committee shall have no authority to obligate or expend any city funds without the express authorization of city council.

(b) The committee shall review each year's local natural hazard events and impacts, community activities that may help or hinder mitigation capabilities, and the progress of mitigation activities. Results of this review shall be presented to the city council and Virginia department of emergency management on or before June 1 of each year for the previous year.

(c) The committee shall undertake a comprehensive review and evaluation of the city's natural hazards mitigation plan every five years. Any revisions to the plan shall be presented to city council for consideration. Once adopted by city council, the plan shall be sent to the Virginia department of emergency management and the federal emergency management agency.

ADOPTED by the Council of the City of Chesapeake, Virginia this _____ day of _____, 2003.

APPROVED:

_____

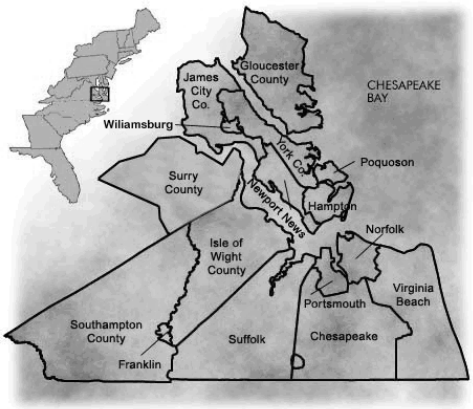
Mayor

ATTEST:

_____

Clerk of the Council

SECTION IV — COMMUNITY PROFILE



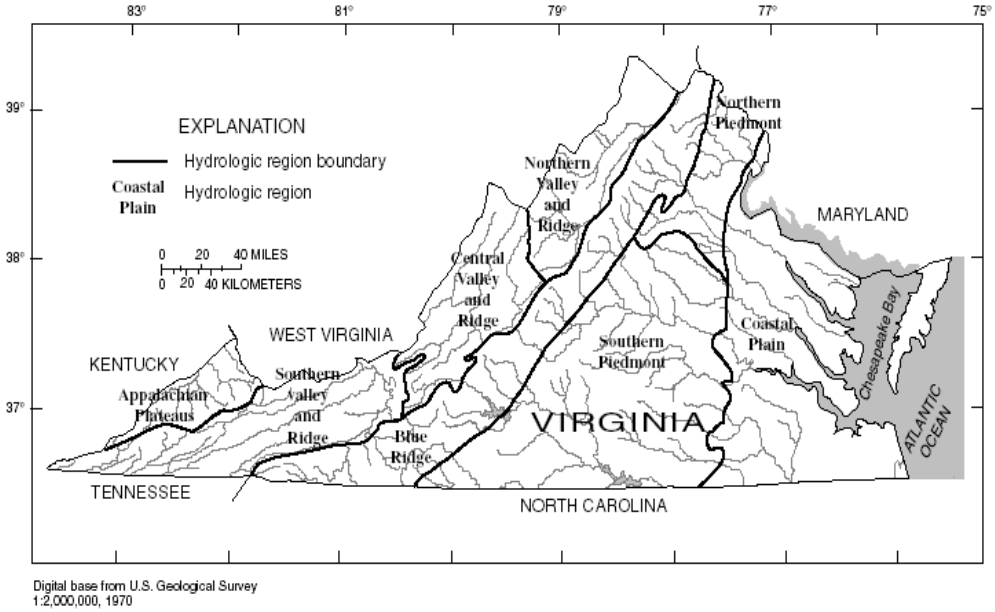
Geography

Located in the southeastern quadrant of Virginia, the City of Chesapeake is bordered to the north by the Cities of Portsmouth and Norfolk, to the south by Currituck and Camden Counties in North Carolina, to the east by the City of Virginia Beach, and to the west by the City of Suffolk. Averaging 353 square miles of land area within its jurisdictional boundaries, Chesapeake is the second largest city in land area in Virginia, and the 13th largest city in the United States. According to the city's Economic Development Department, Chesapeake lies within a 750-mile radius of 2/3 of the nation's population and industrial activity.

The City of Chesapeake is part of the Hampton Roads region, which includes the Cities of Virginia Beach, Hampton, Newport News, Williamsburg, Poquoson, Norfolk, Portsmouth, and Suffolk, and the Counties of York, Matthews, James City, Isle of Wight, and Gloucester in Virginia, and Currituck County in North Carolina. The 2000 Census estimated that 1.6 million residents live in Hampton Roads, and ranked the region as the 31st largest Metropolitan Statistical Area (MSA) in the country.

The Hampton Roads communities are located within the Atlantic Coastal Plains Province, which is characterized by its low, flat relief. The City's elevation is nearly level with the highest elevation point being 25 feet above sea level. The City of Chesapeake overall averages about 12.2 feet above sea level. Excluding the Great Dismal Swamp, approximately one-third of the City of Chesapeake's land area consists of wetlands.

The Atlantic Coastal Plain is the easternmost of Virginia's physiographic zones. The zone extends from New Jersey to Florida, and includes all of Virginia east of the Fall Line, which is the point at which east-flowing rivers cross from the hard, igneous, and metamorphic rocks of the Southern Piedmont to the relatively soft, unconsolidated strata of the Coastal Plain (USGS 2001).



Hydrologic Regions of Virginia
USGS Fact Sheet 023-01, 02/01

Hydrology

The Eastern Branch, Western Branch, and Southern Branch of the Elizabeth River are located within the City of Chesapeake. The Eastern Branch is located towards the northeast portion of the city, while the Western Branch is located in the northwest. The Southern Branch is the main stem of the Elizabeth River, and is located towards the southwest and southeasterly portions of the city. The Indian River, which is a major drainage way for the city, is a tributary of the Eastern Branch. The Southern Branch is part of the Intracoastal Waterway system, connected by its Deep Creek tributary, which runs southwest to the Dismal Swamp Canal, and at the North Landing River via the Chesapeake and Albemarle Canal.

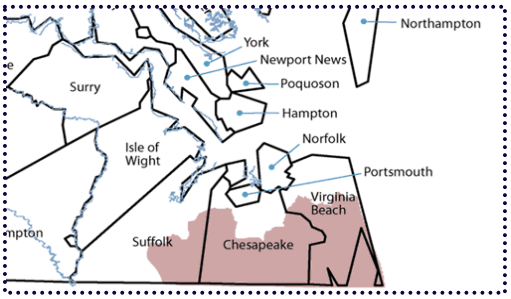
The North Landing River is also a part of the Intracoastal Waterway, and serves as the easternmost boundary for the city. Other significant bodies of water within the city's jurisdictional boundaries include the Northwest River and Lake Drummond.

Watersheds

Two watersheds are located within the City of Chesapeake — the James River Watershed and the Albemarle Sound Coastal Watershed. The James River

Watershed encompasses approximately 10,432 square miles (6.5 million acres), and its headwaters are located in Bath and Highland Counties. The James River, which is a part of the Chesapeake Bay Basin, empties into the Chesapeake Bay at Hampton Roads.

James River Watershed



Albemarle Sound Coastal Watershed

The Albemarle Sound Coastal Watershed is a part of the Pasquotank River Basin, and encompasses about 3,900 square miles. In Virginia, the watershed is comprised of four distinct sub-watersheds — the Great Dismal Swamp, North Landing River, Northwest River, and Back Bay. These waters flow into the Albemarle and Pamlico Sounds in southeastern North Carolina.

Climate

The summer, fall, spring, and winter temperatures are typically mild, averaging 76.5°, 61.9°, 57.2°, and 41.3°, respectively. Average rainfall is approximately 45 inches per year, and the region usually receives only trace amounts of snowfall annually (Southeast Regional Climate Center, 2002). Table 6 below summarizes climate data for the region recorded at Norfolk Airport between August 1, 1948, and December 31, 2000.

TABLE 6 — CLIMATE SUMMARY TABLE

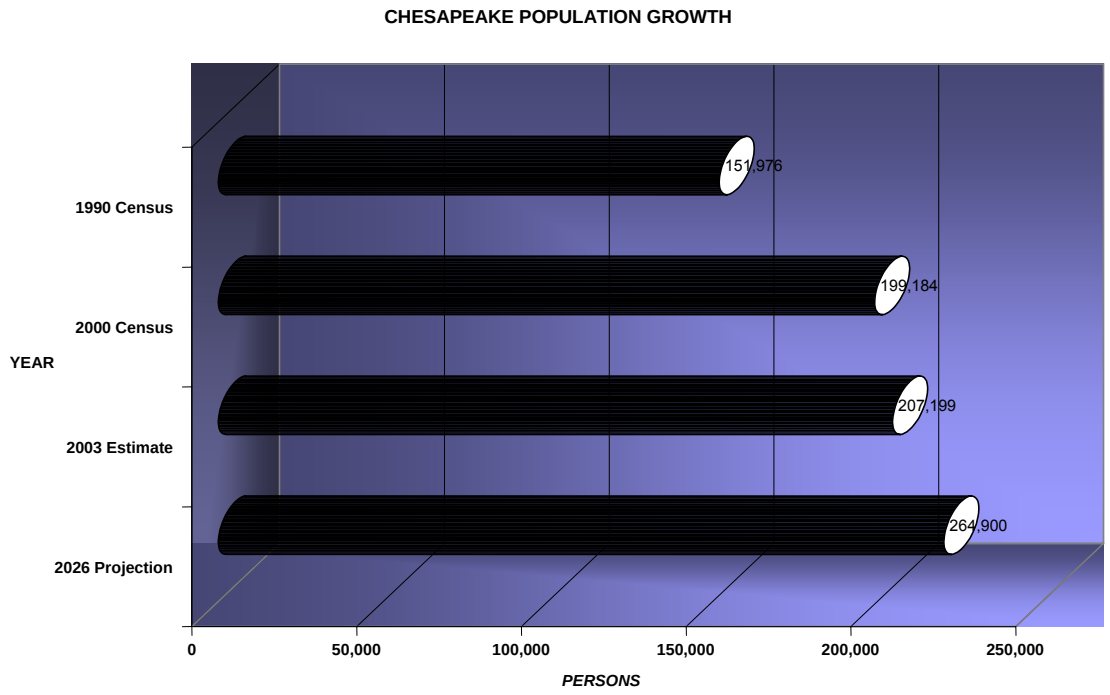
AVERAGES	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
AVG. MAX. TEMP. (F)	48.8	50.9	58.0	68.0	75.8	83.5	87.4	85.5	80.0	70.1	61.2	52.2
AVG. MIN. TEMP. (F)	32.4	33.5	39.7	48.1	57.4	65.8	70.8	69.7	64.3	53.2	43.4	35.4
AVG. TOTAL PRECIP. (IN)	3.71	3.32	3.80	3.09	3.56	3.60	5.33	5.38	4.04	3.28	2.94	3.08
AVG. TOTAL SNOWFALL (IN)	3.0	2.9	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
AVG. REL. HUMIDITY (%)	59	57	54	51	56	57	59	62	61	59	57	59

Population and Demographics

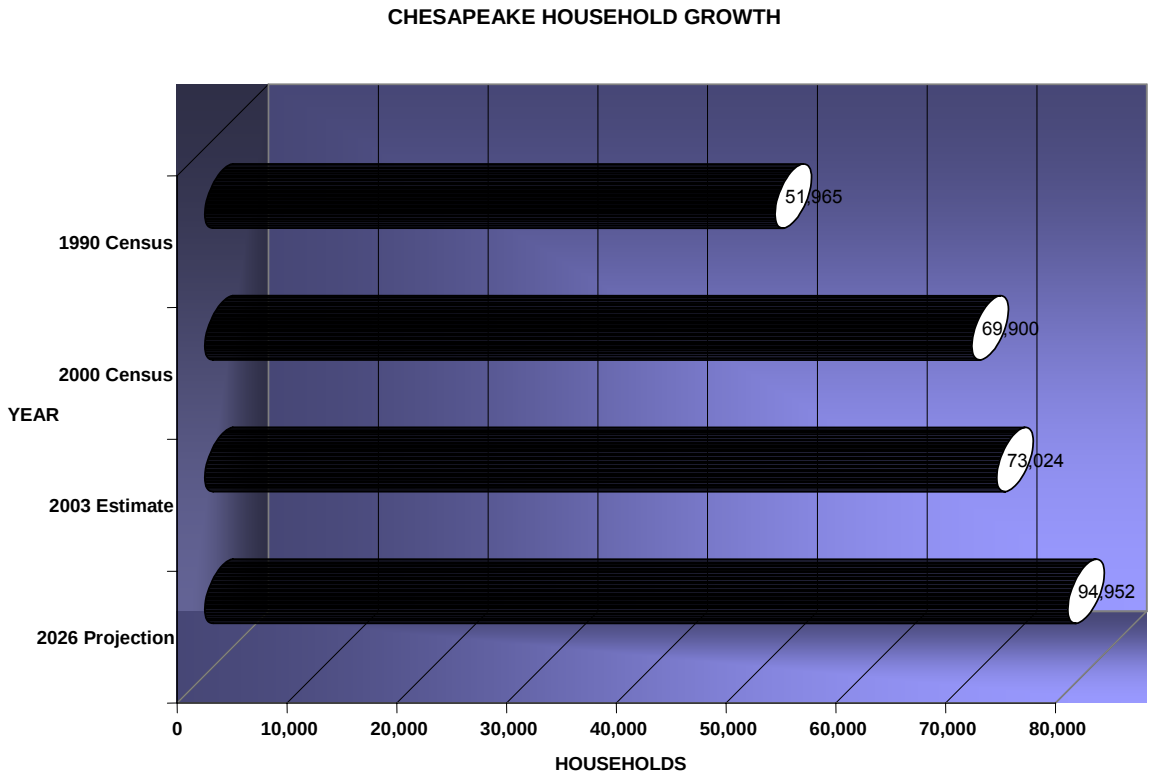
The 2000 Census estimated the City of Chesapeake's total population to be 199,184 persons. Slightly over half of the population is female (102,456) at 51.4%, and 48.6% are male (96,728). The median age is 34.7 years old, and almost 2/3 of the total population (71.2%) is 18 years old or older. Almost 17% of the total population are 55 years and older.

Chesapeake has experienced an exponential population growth trend in the last few decades, increasing over 31% between 1990 and 2000. The Hampton-Roads Planning District Commission (HRPDC) predicts that the city's population

will grow another 33% to 264,900 persons by the year 2026 (HRPDC, 2002).



Between 1990 and 2000, the number of households in Chesapeake grew almost 35%, from 51,965 to 69,900. By 2026, the HRPDC estimates that the number will increase to 94,950 households.



Based on the 2000 Census, 66.9% (133,193) of the city's population is White, 28.5% (56,823) are Black or African American, and approximately 4.6% are other races. Most of the city's population speaks only English as a language, averaging 94.4% (174,633) of the total population. Approximately 5.6% (10,392) of the total population speak a language other than English.

The median family income is $56,302, while the median household income is $50,743. The average per-capita income is $20,949. Slightly more than 23% of the population use social security benefits as a primary or supplemental source to their income. An additional 20.9% utilize some form of retirement income. Only 2.2% claim public assistance as their income. Approximately 7.3% of individuals live below poverty level, and 6.1% of families live below poverty level.

Housing

According to the 2000 Census, the City of Chesapeake has 72,672 housing units within its jurisdictional boundaries. Of those units, 96.2 % (69,900) are occupied and 3.8% (2,772) are vacant. The city has a significantly higher number of

owner-occupied versus renter-occupied housing units, at 74.9 % (52,335), and 25.1% (17,565), respectively.

There are 98 apartment complexes throughout the City of Chesapeake, with an estimated population of over 10,000 tenants. Chesapeake has five public housing complexes. Institutionalized populations and non-institutionalized populations living in group quarters are 2.1% (4,114) of the total population, which accounts for a relatively small percentage of the community overall.

The average household size in the city is 2.79 persons, while the average family size is 3.17 persons. Owner-occupied and renter-occupied units have similar numbers at 2.87 and 2.56 persons, respectively.

Labor and Industry

The City of Chesapeake was created in 1963 with the merger of Norfolk County and the City of South Norfolk. Still a relatively young city, Chesapeake has a significant stake in fostering economic expansion throughout the community. In 2001, 15 new businesses opened facilities in Chesapeake and 21 existing businesses expanded their operations. The city's Economic Development Department estimates that these 36 firms alone invested over $56 million in new capital investment, and hired an additional 945 new employees to their payrolls (Department of Economic Development, 2002).

In 2002, Chesapeake had 110,698 persons in the civilian labor force, which is approximately 6.8% of the metro region's total civilian labor force (778,889), and 21% of Virginia's statewide total (3,735,394). The city's unemployment rate remains relatively low at 3.3%, which is below the metro region's 4.2% and the Commonwealth's 4.1% rates (HRPDC 2002).

Manufacturing, Service, and Support Centers

The City of Chesapeake has developed an Enterprise Zone, which encompasses over 1,900 acres targeted for revitalization. The city has offered special tax incentives and some regulatory reprieve to businesses locating within this area, which has helped to stimulate economic growth within the city. The city's abundant land, proximity to major transportation routes, and economic incentives, like the Enterprise Zone, has created an attractive environment for both foreign and domestic firms. Over 165 manufacturers employing approximately 8,700 people are located in Chesapeake. A few of the major businesses are listed below.

Major Manufacturing Employers:

- American GFM Corporation
- Flow Serve, Inc.
- Mitsubishi Chemical America, Inc.
- NOVA Chemicals, Inc.
- Plasser American Corp.
- Sumitomo Machinery Corp. of America
- Exxon Mobile Corporation

Major Service and Support Centers:

- Canon Information Technology Systems
- Verizon Communications
- U.S. Coast Guard Finance Center
- Panasonic Customer Call Service
- Pitney Bowes
- First Data Resources
- Sentara Healthcare Materials Management Division
- QVC of Chesapeake
- Household Finance Inc.
- Dendrite International
- Chubb and Son Insurance Group
- Harris Publishing

Approximately 1,000 acres of industrial property and two business parks are included within part of the city's district known as Foreign Trade Zone Number 20. These zones are outside U.S. customs territory, which means firms can legally import merchandise into these districts without paying tariffs. The zone has been very successful in attracting new foreign businesses, and the city now has more than 60 foreign-owned companies from 16 different countries.

Military Facilities and Related Maritime Industries

The city's waterfront properties and proximity to major military facilities has attracted other industries such as the maritime and shipbuilding-related industries, and oil and petroleum industries. The City of Chesapeake borders the Norfolk Naval Base, which is known as the largest naval base facility in the world.

The greater Hampton Roads Region includes other major military facilities such as Langley Air Force Base, Fort Monroe, Fort Eustis, Little Creek Amphibious Base, Camp Pendleton, NAS Oceana, and a myriad of other small bases. Fentress Landing Field is located in Chesapeake, which is a Naval Auxiliary Field utilized as a training facility for training naval aviators on carrier flight operations.

Chesapeake is also home to the U.S. Navy Northwest Radio Station, which is a high-security intelligence base that monitors radio and other communications traffic from around the world. Major units include the Fleet Surveillance Support Command, the Naval Satellite Communications Facility, the Coast Guard Communications Master Station Atlantic, the Marine Corps Security Force Training Company, the Electronic Warfare Operational Programming Facility, and the NATO Satellite Communications Facility.

Agriculture

The city has close to 300 farms that produce annual sales totaling $37 million. The largest source of their sales is in the nursery and greenhouse businesses, and the city is Virginia's number one producer. Chesapeake also ranks among Virginia's top ten communities in terms of production of agronomic crops such as soybeans, corn, and wheat. Other agricultural products include alfalfa, potatoes, honey, and dairy products.

Industrial and Commercial

The city has two regional malls, 50 strip shopping centers, and other smaller retail centers. Additionally, the city has numerous industrial and commercial parks, which are listed below.

Private Industrial and Commercial Parks:

- Cavalier Business Center
- Crossways at Greenbrier
- Gateway Industrial Center
- Greenbrier Business Park
- Greenbrier International Park
- Greenbrier Commerce Park
- Greenbrier Industrial Park
- Gateway Commerce Park
- Battlefield Corporate Center
- Dominion Commerce Park

- Liberty Executive Center

Municipally Controlled Parks:

- Campostella Industrial Park
- Cavalier Industrial Park
- Chesapeake Air Commerce Park
- Oakbrooke Business & Technology Center

Schools

With an enrollment of over 39,000 students, Chesapeake Public Schools is the sixth largest school system in the Commonwealth. Chesapeake has 28 primary and elementary schools, 10 middle schools, and 6 high schools, and over 1,600 acres of school campus. The schools operate the largest transportation system in the city with more than 400 buses; last year the school bus fleet traveled over four million miles, transporting more than 28,000 students to and from school each day. The school system is also the city's largest employer with more than 5,400 employees.

Additionally, Chesapeake has five special program centers; an alternative school, a center for science and technology, a gifted and talented school, a special education center, and an adult education center. Tidewater Community College operates a campus within Chesapeake with an annual enrollment of 34,000 students.

Infrastructure

Transportation

The city has eight major highways and roads within its jurisdictional boundaries. These are I-64, I-264, I-464, I-664, US Route 58, US Route 17, Route 168, and Route 168 Bypass. Route 168 is a relatively new four-lane highway that links I-64 to North Carolina and the Outer Banks region, which is a major tourist destination throughout the year. US Route 58 links Hampton Roads with I-95 and I-85, which is the primary north-south interstate highway, and US Route 13 connects the city to Virginia's Eastern Shore via the Chesapeake Bay Bridge Tunnel.

Both residents and travelers are dependent on the 87 bridges that traverse the city. Table 7 highlights a few of the major bridges and overpasses in the city.

TABLE 7 —MAJOR BRIDGES AND OVERPASSES

NAME	Approximate Location and/ or Owner
C&P RAILROAD BRIDGE	Located over the Albemarle & Chesapeake Canal
CENTERVILLE TURNPIKE DRAWBRIDGE	Located on Centerville Turnpike North of Mount Pleasant Road
DEEP CREEK BRIDGE	Located on Cedar Road East of George Washington Hwy.
HENRY GILMERTON BRIDGE	Located on Military Highway West of Bainbridge Blvd.
GREAT BRIDGE DRAWBRIDGE	Located on Battlefield Blvd. in Great Bridge
HIGH RISE BRIDGE I-64	Located on Route 64 East of Route 17
HIGH RISE BRIDGE ROUTE 168 BYPASS	Located on 168 Bypass crossing the Atlantic Intracoastal Waterway
HODGES FERRY BRIDGE	Portsmouth Boulevard (City of Chesapeake)
INDIAN RIVER OVERPASS HWY 407	Between Oaklette and Lilac Avenue
JORDAN BRIDGE	Located on Poindexter Street (West of 464)
NORTH LANDING DRAWBRIDGE	Located on Route 165 at Virginia Beach City Line
NORFOLK/SOUTHERN RAILROAD BRIDGE	Located near Burton's Point and Gilligan Creek (Norfolk/Southern Railroad)
STEEL BRIDGE OVER THE SOUTHERN BRANCH	Located on Dominion Boulevard North of Cedar Road

Working Waterfronts

Water-related infrastructure is prevalent throughout the city's waterways for commercial, industrial, and recreational uses. Located approximately 20 miles inland from the Atlantic Ocean, the city has over 120 miles of commercial waterfront land, including over 12 miles of deep draft channels. According to the City of Chesapeake 2003 Legislative Program Document, the city has more miles of deep-water canals than any other city in the country. The city is currently responsible for the maintenance, repair, and replacement of 56 fixed bridges, 4 drawbridges, and 10 overpasses. The city has four marinas — the Centerville Waterway Marina, the Atlantic Yacht Basin, Chesapeake Yachts, and the Elizabeth River Boat Landing and Park. A portion of the Atlantic Intracoastal Waterway cuts through the city, which is a series of federally maintained inland navigation channels that extend from Norfolk, Virginia to Miami, Florida. The Intracoastal Waterway was authorized by the Rivers and Harbors Act of 1938, and was developed and is still maintained by the U.S. Army Corps of Engineers.

Aviation Facilities

The Hampton Roads region's primary airport is the Norfolk International Airport located in the City of Norfolk. Chesapeake has two private airports, which are the Chesapeake Regional Airport and the Hampton Roads Airport, and one Federal landing field, which is the Fentress Naval Auxiliary Landing Field.

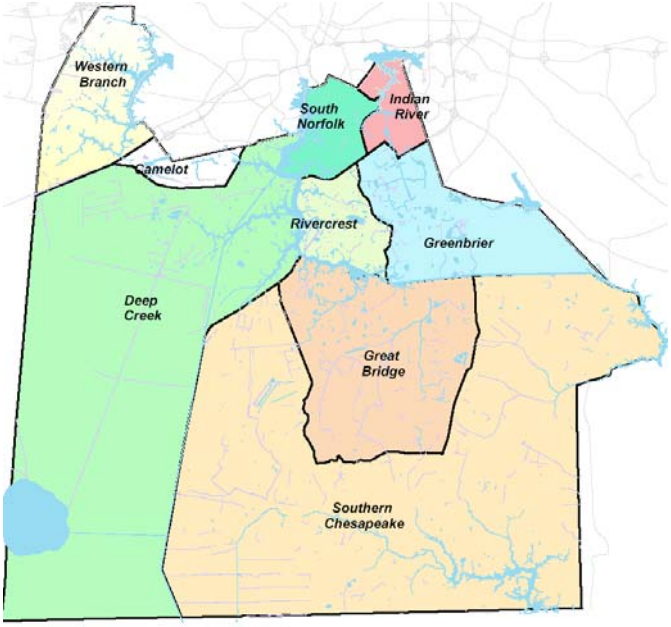
Rail

Rail operations have long been a part of Chesapeake's history, both for public and private uses. Rail lines within the City include CSX Railway Western Branch, Norfolk Southern, Commonwealth Railroad, the Chesapeake and Albemarle Railroad, and the Norfolk/ Portsmouth Beltline.

Description of Planning Sectors

Of the city's estimated 229,640 total acres of land, less than one quarter (55,000 acres) of the land is zoned for residential uses. Of that amount, over 4,700 acres of undeveloped property remains available throughout the city for residential development.

The city is divided into nine planning areas that are illustrated below; these are Camelot, Deep Creek, Great Bridge, Greenbrier, Indian River, Rivercrest, Southern Chesapeake, South Norfolk, and Western Branch.



City of Chesapeake Planning Sector Map

Development within the northern planning areas of South Norfolk, Indian River Camelot, and the northeast corner of Deep Creek are urban in nature and are densely populated. Western Branch, Rivercrest, Greenbrier, and the northernmost parts of Great Bridge are suburban in nature

Table 8 summarizes land use by planning area in Chesapeake:

TABLE 8 — LAND USE BY

PLANNING AREA	LAND USE TOTALS				
	Residential	Commercial	Industrial	Agricultural	Other
CAMELOT	48%	4.7%	47%	-	0.3%
DEEP CREEK	10.3%	4.2%	5.1%	13%	67.4%
GREAT BRIDGE	42%	3%	3%	48%	4%
GREENBRIER	24%	6.6%	4%	47.6%	17.8%
INDIAN RIVER	74%	10%	2%	3%	11%
RIVERCREST	49%	9%	27%	4%	11%
SOUTH NORFOLK	46%	8%	45%	-	1%
SOUTHERN CHESAPEAKE	3.6%	4.6%	0.4%	91.4%	-
WESTERN BRANCH	63.1%	7.5%	2.3%	23.2%	3.9%

SOURCE: CITY OF CHESAPEAKE HAZARD VULNERABILITY ASSESSMENT

Table 9 summarizes population distributions by planning area in Chesapeake:

TABLE 9 — POPULATION DISTRIBUTION BY PLANNING AREA

PLANNING AREA	PERCENT OF POPULATION
CAMELOT	3.8%
DEEP CREEK	12.1%
GREAT BRIDGE	22.4%
GREENBRIER	11.6%
INDIAN RIVER	9.7%
SOUTH NORFOLK	11.3%
WESTERN BRANCH	14.5%
RIVERCREST	8.6%
SOUTH CHESAPEAKE	6.0%

SOURCE: CITY OF CHESAPEAKE HAZARD VULNERABILITY ASSESSMENT

The Western Branch and Great Bridge planning areas contain the city's highest populations — 14.5% and 22.4%% of the total population, respectively. Most of the newer residential development is occurring within the Great Bridge, Deep Creek, and Western Branch areas.

Land Use Trends

The City of Chesapeake is currently updating the city's Comprehensive Plan. This plan will establish a vision and goals to guide the city's development over the next 20 years. The plan will include a text policy document, a land use plan, and a transportation plan. The city is currently in its third of three phases of the plan. The three phases of the plan are:

- **Phase One** – The first phase was an assessment during which existing conditions and issues were evaluated. The result is a vision statement and goals to be used throughout the plan development process. Phase One has been completed.
- **Phase Two** – The second phase focused on the creation and selection of a 2050 development pattern. A series of three alternative development concepts were developed in order to provide choices for the City's growth. Each alternative assumed a similar growth rate for the next 50 years (approximately 1% per year). The alternatives and

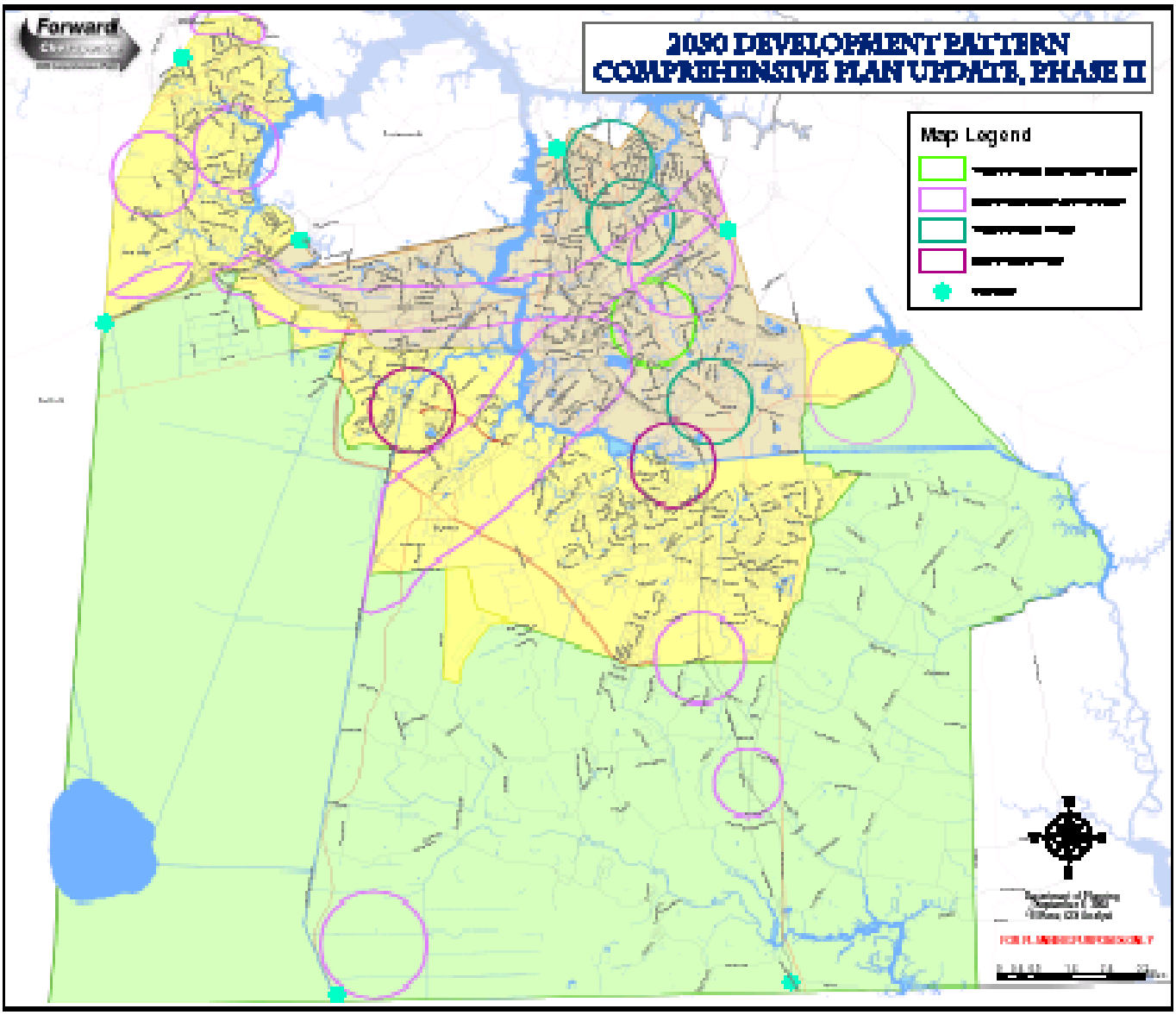
preferred development pattern is described in more detail below. Phase Two has been completed.

- **Phase Three** – The third phase will focus on the development of action plan to achieve the preferred development pattern. The action plan will include a land use plan, transportation plan and policy document. Phase 3 is currently underway.

The three development alternative concepts that were developed are:

- Alternative A – The dispersed concept
- Alternative B – The compact concept
- Alternative C – The nodal concept

The three development alternative concepts were analyzed to determine the impacts of each alternative on transportation and community facilities. It was determined that all three alternatives could be accommodated and none were eliminated from further consideration. The three alternatives were then presented to the public and a Plan Advisory Team comprised of 32 citizens. The Plan Advisory Team determined that the preferred alternative should be a hybrid that contained elements of the three alternative development patterns. This hybrid, the 2050 Development Pattern, was refined by the Planning Commission and accepted by City Council on September 4, 2003.



Key features of the 2050 Development Pattern include the following:

- The denser, compact development pattern lies in the sections of the City north of the Albemarle-Chesapeake Canal and Interstate 64.
- A dispersed development pattern is south of the compact area and extends for approximately 4 miles.
- The remaining areas of the city display a rural development pattern.

- There are 17 nodes that occur along major transportation routes. The nodes are either a major activity center or a village. The major activity centers and villages are either auto-oriented or transit-oriented.
- Gateways located at major entryways into the city are identified to provided services to travelers as well as announce one's arrival into Chesapeake.

The 2050 Development Pattern proposes new activity centers be developed in previously undeveloped areas and floodplain areas along Dominion Boulevard, Battlefield Boulevard, and George Washington Highway. The development pattern also proposes redevelopment in some of the city's oldest areas, which could provide for opportunities to buy out or retrofit existing buildings vulnerable for flooding. By including mass-transit centers and nodal development, the amount of new impervious surfaces will be reduced.

The 2050 Development Pattern encourages new growth within the City of Chesapeake. All of the new development and redevelopment will be built to conform to the current code, but measures should be taken to ensure that the existing codes and floodplain ordinances will be enforced.

SECTION V — RISK ASSESSMENT

A risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from hazards (FEMA, 2001). The natural hazard risk assessment for the City of Chesapeake was performed in two main steps — a hazard analysis and a vulnerability assessment. A hazard analysis identifies and describes the types of hazards the city is vulnerable to and involves the creation of a profile for the most threatening or likely hazards. This profile evaluates the location, extent, magnitude, probabilities, and likelihood of occurrence of the hazards. While there are many different natural hazards that could potentially affect the City of Chesapeake, some hazards are more likely to cause significant impacts and damages than others are. This analysis will attempt to quantify these potential impacts and identify the hazards that pose the greatest possible risk. Once these hazards have been identified, further analysis will be conducted to profile these potential hazard events and quantify Chesapeake's vulnerability.

The second step in the risk assessment process is the vulnerability assessment, which estimates the extent of injury and damages that may result from a hazard event of a given intensity within the city. Vulnerability is defined as the degree of exposure or susceptibility of people, property, or other community attributes to the effects of hazard events. This assessment includes inventorying infrastructure and critical community facilities, and estimating potential dollar losses to vulnerable structures.

The vulnerability assessment also examines the impact of hazards on the city's existing and future land uses, development trends, and demographics within the identified hazard areas. Current conditions were evaluated in terms of what is already developed, and in terms of people, property types, and values. The city's comprehensive plan, zoning ordinance, capital improvement plan, and other plans were used as indicators of potential future risks to undeveloped properties, services, and infrastructure. New development and areas targeted for redevelopment often present the best opportunities for incorporating new methods of development or retrofitting development so that it will be able to withstand the effects of hazards.

Critical facilities are community assets that are the most important or vital to emergency management functions (such as response and recovery activities), or for the daily continuity of government services (now and in the aftermath of a natural disaster). These include:

- Essential facilities for the health and welfare of the whole population (e.g., hospitals, police and fire stations; emergency operations centers, evacuation shelters, and schools).
- Lifeline utility systems (e.g., potable water, wastewater, oil, natural gas, electric power and communication systems).

The City of Chesapeake owns and services The Water Treatment, Water Distribution, and Waste Water Collection Infrastructure under the Public Utilities Department. The stormwater infrastructure is owned and serviced by the City of Chesapeake under the Public Works Department.

Virginia Power provides the electricity, and Virginia Natural Gas and Columbia Gas of Virginia provide the natural gas. Verizon provides local telecommunications services. A local municipal system provides sewage collection, and the Hampton Roads Sanitation District provides sewage treatment. The Southeastern Regional Public Service Authority provides the solid waste disposal service. The provision of these community services is vital

to the continuity of the city's normal functions. The city's critical infrastructure is listed below.

Critical Infrastructure:

- Emergency Operations Center
- Chesapeake Energy Center
- Surry Power Station
- Gaston Hydro Station
- Bowers Hill Substation
- Fentress Substation
- Hickory Substation
- Deep Creek Substation
- Gilmerton Substation
- Yadkin Substation
- Ruritan Substation
- Berkley Substation
- Campostella Substation
- South Norfolk Substation
- Weaver Fertilizer Industrial Substation
- Cofield Substation
- Hodges Ferry Substation
- Cradock Substation
- Portlock Substation
- Thrasher Substation
- Dozier Corner Substation
- Virginia Natural Gas
- Columbia Gas of Virginia
- A & B Propane
- Northwest River Treatment Plant

The city's essential facilities and their locations are listed in Table 10 below.

TABLE 10 — ESSENTIAL FACILITIES

NAME/DESCRIPTION	LOCATION
POLICE AND SHERIFF'S OFFICES	
PRECINCT # 1, GREAT BRIDGE	**304 Albemarle Dr**
PRECINCT # 2, SOUTH NORFOLK	**1209 20th St**
PRECINCT # 3, DEEP CREEK	**949 N. George Washington**

TABLE 10 — ESSENTIAL FACILITIES

NAME/DESCRIPTION	LOCATION
PRECINCT # 4, WESTERN BRANCH	4764 Station House Rd
PRECINCT # 5, GREENBRIER	212 Research Dr, Suite 104
PUBLIC SAFETY DESK	304 Albemarle Dr
SHERIFF'S OFFICE	401 Albemarle Dr
FIRE STATIONS	
FIRE STATION 1 SOUTH NORFOLK	1201 20th Street
FIRE STATION 2 PORTLOCK	1205 Freeman Ave.
FIRE STATION 3 WASHINGTON BOROUGH	1826 Rokeby Ave.
FIRE STATION 4 RED OAK COLONY	104 Lenore Trail
FIRE STATION 5 GREAT BRIDGE	451 Hanbury Road
FIRE STATION 6 FENTRESS	1109 Whittamore Rd
FIRE STATION 7 ST BRIDE'S	3329 S. Battle Filed Blvd
FIRE STATION 8 DEEP CREEK	209 George Washington Hwy
FIRE STATION 9 BRENTWOOD	1420 Sherbrooke Rd
FIRE STATION 10 BOWER'S HILL	1629 Homestead Rd
FIRE STATION 11 DOCK LANDING	2040 Dock Landing Rd
FIRE STATION 12 WESTERN BRANCH	4421 Taylor Rd
FIRE STATION 13 CORNLAND	2900 Benefit Rd
FIRE STATION 14 GREENBRIER	1101 N. Eden Way
FIRE STATION 15 BELLS MILL	1345 Bells Mill Rd
EMERGENCY MANAGEMENT CENTER	304 Albemarle Drive
EMERGENCY OPERATION CENTER #1	304 Albemarle Drive
CALL CENTER # 1	304 Albemarle Drive
MEDICAL FACILITIES	
CHESAPEAKE GENERAL HOSPITAL	736 N. Battlefield Blvd
CHILDREN'S HEALTH SYSTEMS INC.	733 Volvo Parkway
URGENT CARE FACILITIES	
CHESAPEAKE HEALTH CLINIC	490 Liberty St
CITY OF CHESAPEAKE FREE CLINIC	1204 20th Street
CHESAPEAKE CARE	2145 S. Military Hwy
PATIENT FIRST	705 N. Battlefield Blvd
BON SECOUR	2845 Cedar Rd
PATIENT FIRST	1239 Cedar Rd
CITY OWNED TRAILERS	Various locations
DETENTION FACILITIES	
CHESAPEAKE CITY JAIL ADULT CORRECTIONS	401 Albemarle Dr.

TABLE 10 — ESSENTIAL FACILITIES

NAME/DESCRIPTION	LOCATION
(MAXIMUM SECURITY)	
ST. BRIDES CORRECTIONAL CENTER ADULT CORRECTIONS (MEDIUM SECURITY)	701 Sanderson Rd
INDIAN CREEK CORRECTIONAL CENTER (MEDIUM SECURITY)	801 Sanderson Rd
TIDEWATER DETENTION HOME (MAXIMUM SECURITY)	420 Albemarle Dr
RESIDENTIAL FACILITIES – SPECIAL NEEDS	
SOUTHEASTERN VA TRAINING CENTER (MEDIUM SECURITY)	2100 Steppingstone Square
RESIDENTIAL FACILITIES – SENIOR DISABLED INDEPENDENT LIVING	
CAMBRIDGE CROSSING SECTION – 1	1937 Robert Hall Blvd
CAMBRIDGE CROSSING SECTION – 2	1925 Robert Hall Blvd
CAMBRIDGE CROSSING SECTION – 3	1921 Robert Hall Blvd
CAMBRIDGE SQUARE	704 Gainsborough Ct
CHURCHLAND COURTYARD	3504 Executive Center Dr
KEMET HOUSE	2139 W. Broadmoor Ave
EMMANUEL ADULT HOME	2035 Spadina Ave
OTHER PUBLIC FACILITIES	
INFORMATION TECHNOLOGY	300 Shea Drive
LIBRARIES & RESEARCH SERVICES	298 Cedar Road
PUBLIC UTILITIES	Northwest River Water Treatment Plant
PUBLIC WORKS	306 Cedar Road
SCHOOL ADMINISTRATION	312 Cedar Road
CITY HALL	306 Cedar Road
ANIMAL CONTROL	3807 Cooke Blvd
ELEVATED STORAGE TANKS	Kempsville Rd. and Battlefield Blvd.
ELEVATED STORAGE TANK	1217 Laurel Ave
ELEVATED STORAGE TANK	Bainbridge Blvd and Military Hwy
ELEVATED STORAGE TANK	4892 Station House Rd
ELEVATED STORAGE TANK	3824 Cook Blvd
PUBLIC WORKS OPERATIONS CENTER	925 Executive Blvd.
WATER DISTRIBUTION INFRASTRUCTURE	Citywide
WASTEWATER COLLECTION INFRASTRUCTURE	Citywide

The historical data collected includes accounts of all hazard types. However, some have occurred more frequently than others with a wide range of impacts. By analyzing the historical frequency of each hazard, along with the associated impacts, the hazards that pose the most significant risks to the City of Chesapeake can be identified. This analysis will allow the city to focus its hazard mitigation plans on those hazards that are most likely to cause significant impacts to the community.

Prioritizing the potential hazards that can threaten Chesapeake will be based on two separate factors — the probabilities that a potential hazard will affect the city and the potential impacts on the city should a hazard event occur. The probability for each hazard was based on the history of events in the City of Chesapeake, as well as any other relevant available data related to the probability for the Tidewater area. The hazard's total impact is determined by three factors — (1) the extent of the potentially affected geographic area, (2) the primary impacts of the hazard event, and (3) any related secondary impacts. While primary impacts are a direct result of the hazard, secondary impacts can only arise subsequent to a primary impact. For example, a primary impact of a flood event may be road closures due to submerged pavement. A possible secondary impact in these circumstances would be restricted access of emergency vehicles to citizens in a portion of the community due to the road closure.

In order to quantify these hazard factors, a preference scale was utilized to arrive at a hazard level for each of the hazard types considered for the City of Chesapeake. A detailed description of the preference scale with all calculations and formulas, as well as a Hazard Identification worksheet, is provided in Appendix A. The hazards are broken down into four distinct categories that represent the likelihood of a hazard event of that type significantly affecting the City of Chesapeake — Highly, Medium-High, Medium, and Low. Table 11 summarizes the results of this analysis.

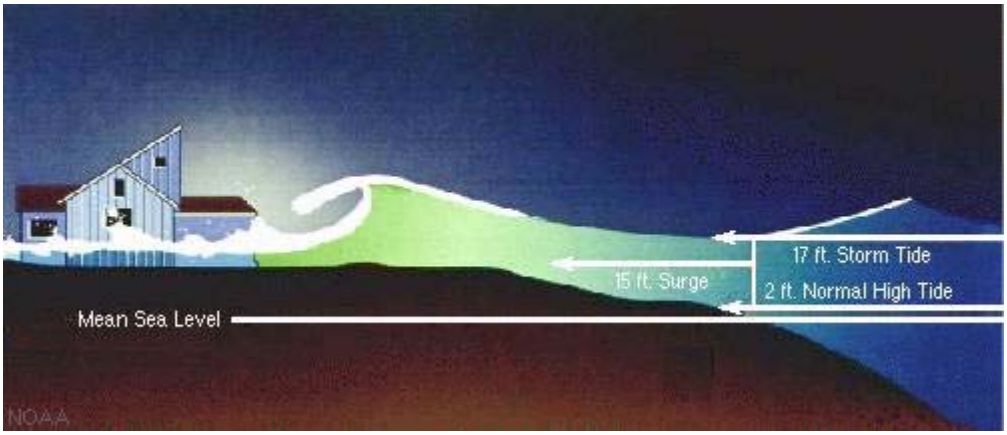
TABLE 11 — HAZARD IDENTIFICATION RESULTS

HAZARD TYPE	Hazard Level
FLOOD	High
WIND EVENTS	High
DROUGHT	Medium-High

The hazard identification results independently confirm the results of City of Chesapeake's Hazard Vulnerability and Risk Assessment (HVA): which classified wildfires, winter storms, earthquakes, land cave-ins, and tsunamis as non-critical hazards. In addition, the Mitigation Advisory Committee (MAC) has reviewed these non-critical natural hazards and determined that they do not pose a substantial risk to the City of Chesapeake. Therefore, in order to focus on the most significant hazards, only those hazards assigned a level of High or Medium-High will be addressed in this document. The High hazards of flood and wind events will be addressed on the pages that follow, and will include detailed vulnerability assessments. At the end of this section, the Medium-High hazard of drought will be discussed, but will not include a detailed vulnerability assessment.

Floods

One of the most significant hazards that the City of Chesapeake is vulnerable to is flooding. A majority of the flooding that affects the city is tidal flooding, which primarily occurs in conjunction with coastal storms such as hurricanes or nor'easters. The high winds associated with these events can actually push water towards the shore, increasing tide heights. This increase is known as storm surge and is calculated in addition to the normally occurring tide.



The illustration above shows storm surge, which is water that is pushed toward the shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level 15 feet or more. In addition, wind driven waves occur in addition to the storm tide. This rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides and a full moon. According to the National Oceanic & Atmospheric Administration (NOAA), much of the United States' densely populated Atlantic and Gulf Coast coastlines lie less than 10 feet above mean sea level, resulting in a potentially tremendous danger from storm tides. Depending on the intensity of the event in the City of Chesapeake, storm surge levels can range from 4 or 5 feet for a Category 1 hurricane to more than 18 feet for a Category 5 hurricane. It is important to note that since these levels are added to the normally occurring tide levels, the most significant flooding is during a high tide. The duration of these events is approximately 12 to 14 hours.

In addition to tidal flooding, the City of Chesapeake is also subject to inland or riverine flooding. This type of flooding occurs when runoff generated from heavy rains exceed the capacity of streams, channels, or drainage infrastructure. These flooding events can also be caused by rain associated with a hurricane or

tropical storm and can produce extreme amounts of rainfall in a relatively short period of time. Although coastal flooding is more commonly associated with tropical events, more people have died in the United States due to inland flooding in the last 30 years than due to storm surge.

Hazard History

The City of Chesapeake has a lengthy history of both tidal and inland flooding. One of the most significant and recent events was Hurricane Floyd, which occurred on September 16, 1999. This event brought over 10 inches of rain to the city; this rainfall occurred just two weeks after Tropical Storm Dennis had saturated the area with 6.2 inches of rain. Hurricane Floyd caused the Dismal Swamp to overflow its banks creating flooding along the Northwest River.

Other historic flooding events in the city include the “Ash Wednesday” Storm of March 6 - 7, 1962. This nor’easter caused significant flooding along the entire mid-Atlantic coast and produced tide levels as high as 9 feet above mean water level. Complete lists of flooding events are summarized in Table 12 on the following pages.

TABLE 12 — HISTORICAL FLOODING AND WIND EVENTS

OCCURRENCE	LOCATION	MAGNITUDE	DETAILS
Aug 23, 1806			Great Coastal Hurricane helped complete formation of Willoughby Spit in Norfolk, Virginia.
Sep 3, 1821			One of the most violent hurricanes on record.
Aug 23 , 1933		Category 1 Hurricane; Wind speeds of 70-90 mph	Flooding. Tidal surges at Sewell's Point; 9.0 ft surges in Norfolk; 9.3 ft surges in Portsmouth; tide reached 8.6 feet at Lynnhaven Inlet and 8.0 feet in Lynnhaven Bay/East Bridge/Elizabeth River and 3.8 feet at Back Bay.
Sep 16, 1933		Category 1 Hurricane; Wind speeds of 70-90 mph	Caused flooding.
Sep 14, 1944		Wind speeds 134 mph and gusts 150 mph at Cape Henry; inland wind speeds of 70-90 mph were recorded	
Aug 14, 1953		Category 1 Hurricane; Wind speeds of 60-80 mph	Hurricane Barbara - 5"-8" of rain reported; one death.
Oct 15, 1954	Norfolk, Hampton	Category 1 Hurricane; Wind speeds of 78 mph at Norfolk and 130 mph at Hampton	Hurricane Hazel - caused flooding when local rivers breached their banks.
Aug 12, 1955		Winds 47 mph and gusts 55 mph	Tropical Storm Connie.
Sep 19, 1955	Southeast of Norfolk	Winds 47 mph and gusts 58 mph	Tropical Storm Ione.
Sep 30, 1959	Norfolk	Category 3 Hurricane	Hurricane Gracie did not directly hit SE VA, but dumped 6.79 inches of rain at Norfolk Airport in 24 hours; spawned 3 F3 tornadoes.
Sep 12, 1960	Norfolk, Cape Henry, Chesapeake Light Ship	Category 2 Hurricane; Wind speeds of 73 mph at Norfolk Airport, 80 mph at Cape Henry, and 138 mph at Chesapeake Light Ship	Hurricane Donna - 3 deaths; spawned one F2 tornado.
Mar 6, 1962			Ash Wednesday Storm – nor'easter produced hurricane force winds and tides as high as 9 feet above mean water level.
Aug 31, 1964	Tidewater		11.40" rainfall caused severe flooding.
Jun 13, 1966	Hampton Roads	Winds 46 mph, gusts 55 mph	4-6 ft storm surge along the Outer Banks of North Carolina.
Aug 27, 1971	Norfolk	Wind speeds of 52 mph at Norfolk Airport and 71 mph at NAS, Norfolk	Tropical Storm Doria – spawned tornado.
Sep 5, 1979	Newport News, Hampton		Tropical Storm David - spawned 8 tornadoes (2 in Virginia), 1 in Newport News ($2 million damages) and 1 in Hampton ($0.5 million damages).

TABLE 12 — HISTORICAL FLOODING AND WIND EVENTS

Sep 27 1985	Cape Henry, South Island	Category 1-2 Hurricane; Wind speeds of 46 mph at Cape Henry, 67 mph gusts at Airport, 94-104 mph gusts at South Island CBBT	Hurricane Gloria - 5.65 inches rainfall; highest tide 5.3 feet above Mean Low Water (MLW); $5.5 million in damage in Virginia; power loss caused all but one radio station to go off air.
Aug 17 1986	Virginia Beach	Wind speed of 40 mph, with gusts of 63 mph at Airport, 94-104 mph at South Island CBBT, and 54-82 mph at Cape Henry.	Tropical Storm Charley - Highest tide 5.5 feet above MLLW. Approximately $1 million in damages in Virginia.
Jul 12 1996	Suffolk, Newport News, Norfolk	Category 2 Hurricane; Wind speeds of 35 mph with gusts of 48 mph at Norfolk Airport	Hurricane Bertha - spawned tornadoes in Northumberland, Smithfield, Gloucester, and Hampton. Total damage several million dollars. Nine people injured; spawned 5 F0-F1 tornadoes.
Sep 6 1996	South-Central VA	Winds 35 mph, gusts 50 mph in Chesapeake	Hurricane Fran – 12,000 residents lost power; no injuries or property losses reported.
Aug 27 1998	Norfolk, South Island	Category 2-3 Hurricane; Wind speeds 46 mph, gusts 64 mph at Norfolk Airport and 90-104 mph at CBBT.	Hurricane Bonnie - 4"-7" rain; 245,000 customers lost power, some for up to a week; highest tide 6.0 feet above MLW; 12-15 ft swells; spawned tornado; Chesapeake declared federal disaster area, eligible for $2,275,297 in federal aid; child killed by fallen tree; 12 storm-related injuries reported; property damaged.
Aug 30 1999	Hampton		Tropical Storm Dennis - spawned F2 tornado in Hampton; substantial rain and flooding.
Sep 15 1999	SE VA	Category 2 Hurricane; Wind speed of 31 mph with gusts of 46 mph; speeds between 69 and 84 mph measured at Chesapeake lighthouse.	Hurricane Floyd - 10"-20" of rain produced 500-year flood for Franklin, VA; 5-6 foot surges along VA coast; WFO Wakefield inaccessible for 36 hours; Chesapeake declared federal disaster area; widespread power outages; flooding contaminated Portsmouth City water supply (Chesapeake's water supplier).
Oct 14 1999	Tidewater area	Wind gusts of 30-40 mph	Tropical Storm Irene - dropped up to 10 inches of rain: flooding 6" to 4' deep observed.

Hazard Profile

Flooding can occur along all waterways in the City of Chesapeake including the branches of the Elizabeth River, the Indian River: the Northwest River, and the North Landing River. Localized riverine flooding can occur in areas of the city not adjacent to a major body of water.

Areas identified as vulnerable to flooding are depicted on FEMA's Flood Insurance Rate Maps (FIRMs), which were developed through the National Flood Insurance Program (NFIP), and on the hurricane surge maps, which were developed through the National Hurricane Center (NHC) SLOSH Model.

The FEMA flood zones represent the areas susceptible to the 1% annual flood, or 100-year flood, and the 0.2% annual flood, or 500-year flood. These areas are commonly referred to as the 100-year flood; this flood has at least a 1% chance of occurring in any given year, and at least a 26% chance of occurring over the life of a typical 30-year mortgage. The area of the city included in the 100-year floodplain and the 500-year floodplain are represented on the maps contained in the Appendix of this document as Zone A/AE and Zone X respectively. Note that the floodplain maps were taken directly from the FIRMs: which were digitized by the City of Chesapeake's GIS department.

The city's existing HVA also contains surge maps representing the hurricane inundation zones for Category 2, Category 3, and Category 4 hurricanes. These areas are determined by estimating the storm surge heights of potential hurricanes by considering a variety of factors including the storm's size, forward speed, wind speed, and track. By determining surge heights, and comparing these data with community elevations, the SLOSH model can delineate the areas of the community that are subject to inundation during a particular storm.

Locally Identified Flood Areas

In order to determine more specific local areas subject to flooding, a meeting of city officials from a variety of different departments — including engineering, public works, planning, fire department, public housing, and public utilities — was held on March 6, 2003. The areas along the Southern Branch of the Elizabeth River, including the areas of Deep Creek, Camelot, and South Norfolk, were identified as the most flood prone areas of the City in the opinion of city officials. In addition, Table 13 lists the specific flood prone areas. The locations of these areas within the City of Chesapeake are identified on the attached figure at the end of this section.

TABLE 13 — LOCAL AREAS OF FLOODING

Planning Area	Name	Description	Source
South Norfolk & Indian River	Money Point	Industrial area which receives frequent tidal flooding	Tidal/Storm water
	Berkley Avenue	Frequently flooding due to insufficient outfall capacity	Storm water
	Border Road	Public housing facility at this location receives frequent flooding.	Storm water

TABLE 13 — LOCAL AREAS OF FLOODING

	Norfolk Highlands	Older area that was developed in the 40's and 50's where historic flooding has occurred.	Storm water
	Sunny Brook Apartments	Apartment complex off Bainbridge Blvd. has experience historic flooding.	Storm water
	Queen City	Public Housing Complex in this area has received historic flooding.	Storm water
Greenbrier & Rivercrest	Bainbridge Blvd.	Industrial Area that frequently is cut off by flooding. Fire Station in the area also experiences flooding.	Tidal/Storm water
	Crestwood	Area has received historic flooding. Ongoing outfall project in this area should reduce flooding.	Storm water
	Campostella Walk	Historic flooding has occurred in this area. An outfall project has been identified to address flooding in this area.	Storm water
	Fernwood Farms Road	This area has experienced historic flooding of roadways and garages. Very few structures in the area are at a low elevation, although this is a frequently impacted area.	Storm water
	Stumpy Lake	Outfall crosses over road causing flooding.	Storm water
	River walk	Residential Area effected by tidal Flooding	Tidal
Great Bridge & Southern Chesapeake	Bells Mill Road	Residential neighborhood is cut off by flooding. May have a high concentration of special needs populations.	Storm water
	Inland Colony	Historic flooding has occurred to elevations of 4' or 5' receive most frequent flooding	Storm water
	Caroon Farms	Caroon Farms has experienced historic flooding. Maintenance has been identified as a potential problem.	Storm water
	Washington Area	Forest Lake and Scenic Parkway area. Area was built before drainage system/improvements.	Storm water
	Dominion Blvd	On west end steel bridge area, low -subject to be overtopped	Tidal
Deep Creek & Camelot	Millville	Residential area where historic flooding has occurred	Tidal
	Mill Creek	Newer residential area (80's & 90's) located west of George Washington Highway that experienced historic flooding.	Storm water
	George Washington Highway/S Military Highway	Areas surrounding this intersection have received flooding in the past	Storm water
	Elmsmore Road	Residential has experienced historic flooding	Storm water
	Route 17Camelot	Areas of Route 17 have experienced historic flooding. An elderly housing complex in the area may have experienced flooding including water in the facility basement.	Storm water
	Yadkin Road	Container Storage area that has received damage due to flooding in the past.	Storm water
	Sun Ray area	Sparsely settled Rural area that has received flooding in the past.	Storm water
Western Branch	Only small isolated flooding areas in the Western Branch area		

Additional areas that have been identified as a flood risk include Route 17 along the boundary of the Dismal Swamp, and the areas adjacent to the Intracoastal Waterway. If flooding were to occur in this area, Route 17 (a major transportation route in the city) could be undermined or blocked with floodwaters

or debris. The areas adjacent to the Intracoastal Waterway are also subject to significant flooding if an event were to occur, with the potential for local roadways being blocked and structures being inundated with floodwaters. In addition to these flood prone areas, the City of Chesapeake's existing HVA also listed some flood prone roadways. Table 14 contains a list of these roadways taken directly from the HVA and organized by planning sector. It should be noted that depending on the flood characteristics, additional roadways may be subject to flooding other than those provided in the following list.

TABLE 14 — ROADWAYS SUBJECT TO FLOODING BY SECTOR

SECTOR	ROADWAY
Deep Creek	Route 17 along the Dismal Swamp
	Route 17 near Deep Creek Locks, points south
	Mill Creek and Cooks Mill Road
	Shipyard Road area of Millville Road
	Rockwood Road and Burson Road
	SunRay Road and Homestead Road
Great Bridge	Cedar and Sawyer Mill
	Bells Mill and Cedar Road
	Bells Mill and Deep Water Drive
	Bells Mill and Seabrook Lane
	100 Block of Battlefield Boulevard North
	I-64 at the Highrise Bridge - either side of the bridge
	Bells Mill and Seabrook Point
Southern Chesapeake	Route 68 at the waterway near Northwest River
	Ditch Road in Southern Chesapeake
	Route 17 and Douglas Road
	Route 17 and Cornland Road
	South Battlefield Boulevard Water Treatment Plant
	Route 17 and Ballahack Road area
	Route 17 and #10 Lane
	St. Julian Creek area
	Bunch Walnuts Road - 3200 Block
	Lake Drummond Causeway to Ballahack Road
River Crest	Route 168 Bypass at Oak Grove/North Battlefield Exit
	Dominion North (revised Route 17) to Steel Bridge
	Bainbridge Boulevard from Military Highway to Dominion Boulevard
South Norfolk	Bethel Road from Berkley to Border
	Cayce Drive from Bethel to Amick
	Pringle Drive from Bethel to Amick
	Liberty Street from Fitchett to Nelson
	Nelson Street from Portland to Liberty
	Liberty Street at Commerce

TABLE 14 — ROADWAYS SUBJECT TO FLOODING BY SECTOR

SECTOR	ROADWAY
	Poindexter at 1200 Block
South Norfolk (continued)	Poindexter at Bainbridge
	Chesapeake Avenue at Stuben Avenue
	Chesapeake Drive at 2100 Block
	Rodgers Street at Stuben
	Haywood Avenue at Stuben
	Ardmore Avenue at 2100 Block
	Rowland Avenue in South Norfolk
	Freeman Avenue and Bainbridge Boulevard in South Norfolk
	Freeman Avenue East of I-464
	Great Bridge Boulevard in South Norfolk
	Bainbridge and Military
	North Battlefield by Swing Bridge
	I-464 between Freeman Avenue Exit and Poindexter Street Exit
Indian River	Tatemstown from Haring to Wingfield
Western Branch	Lake Shore Road and Charlton Road
	Route 58 at I-264, I-664, I-64 Interchange
	I-664 at I-264, I-664, I-64, and Route 58 up to Portsmouth Boulevard Exit
	I-264 at I-264, I-664, I-64 and Route 58 Interchange

The National Flood Insurance Program

In 1968, the U.S. Congress created the National Flood Insurance Program (NFIP). Their intent was to reduce future flood damages and to provide protection for property owners from potential losses through federally subsidized flood insurance. All properties located within a participating community are eligible to purchase flood insurance, whether or not their property is located within a flood zone. Over $1 billion worth of flood insurance policies are currently in force within the city. As of 2002, there were 6,968 flood insurance policies within the City of Chesapeake.

Flood insurance was designed to provide an alternative to disaster assistance to reduce the rising costs of repairing damage to buildings and their contents caused by flooding. In fact, Federal Emergency Management Agency (FEMA) estimates that every three dollars paid in flood insurance claims saves one dollar in disaster assistance payments. Additionally, flood damages are reduced by nearly $1 billion each year through the combination of communities implementing

sound floodplain management requirements and property owners purchasing and maintaining flood insurance policies.

Flood Insurance Rate Maps

The Federal Emergency Management Agency (FEMA) is the Federal entity responsible for producing Flood Insurance Rate Maps (FIRM), which show areas subject to flooding. The flood risk information presented on the FIRM is based on historic, meteorological, hydrologic, and hydraulic data, as well as open-space conditions, flood-control works, and development within the study area.

Information found on a flood map includes:

- Common physical features, such as major highways, secondary roads, lakes, railroads, streams, and other waterways,
- Special Flood Hazard Areas (SFHA),
- Base flood elevation (BFE) depths,
- Flood insurance risk zones, and
- Areas subject to inundation by the 500-year flood.

FIRM maps provide the above information in order to:

- Identify Special Flood Hazard Areas (SFHA's),
- Identify the location of a specific property in relation to the SFHA's,
- Identify the base (100-year) flood elevation at a specific site,
- Identify the magnitude of flood hazards n a specific area, and
- Locate regulatory floodways.

FIRM maps are used for a variety of different things. Private citizens, insurance agents, and the real estate industry use FIRM maps to locate buildings, properties, and corresponding flood insurance risk zones. Community officials use the maps to administer and enforce floodplain management regulations. Lending institutions and Federal agencies use the maps to locate properties, buildings, and determine whether flood insurance is required when making loans or providing grants for the purchase or construction of buildings. FEMA estimates that buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance.

FIRM maps are the mapped product of engineering studies called Flood Insurance Study Reports (FIS). Using the information gathered in these studies, Special Flood Hazard Areas, or areas subject to inundation that have a 1% or greater chance of being equaled or exceeded in any given year are mapped. SFHA's are commonly referred to as the 100-year flood zone or base flood. SFHA's are the regulatory standard used by Federal agencies and the Commonwealth of Virginia in the administration of floodplain management programs and by the NFIP as the basis for flood insurance requirements nationwide. The 100-year flood zone has a 26% chance of occurring during any given 30-year period (the length of most mortgages).

According to FEMA, approximately 41.93 square miles of the city is located in the floodplain. In 1980, an estimated 970 structures were located within these floodplain areas. In 2002, approximately 1,782 structures were located in the floodplain. While it is not clear how FEMA developed these figures, our estimates (shown in Table 16 on the following page) reflect a dramatic difference. According to these new estimates, approximately 13,328 structures are located in the floodplain.

FEMA- Designated Repetitive Loss Properties

A repetitive loss property is a property that is insured under the National Flood Insurance Program (NFIP) that has filed two or more claims in excess of $1,000 each within a 10-year period. Nationwide, repetitive loss properties constitute 2% of all NFIP insured properties, but are responsible for 40% of all NFIP claims.

Chesapeake's repetitive losses rank higher than the national average, at approximately 6% of all policies, but responsible for 59% of all NFIP claims. Within the City of Chesapeake, over 476 claims were paid for total losses of $1,478,876. Chesapeake has 42 repetitive loss properties that have filed 127 claims totaling $875,474. These properties have a total assessed value of $6,317,600. The locations of these properties are indicated on the Flood Zone Maps and are listed by planning area in Table 15 below.

It is important to note, however, that of the total repetitive loss structures, six were built post-FIRM, which means that these structures were built to the city's required floodplain ordinance. Mitigation for repetitive loss properties is a high priority for FEMA, and the areas where these properties are located typically represent the most flood prone areas of a community.

TABLE 15 —REPETITIVE LOSS PROPERTIES BY PLANNING AREA

Planning Area	Number of Properties	Total Assessed Value
Deep Creek and Camelot	7	$1,206,500
Great Bridge and Southern Chesapeake	14	$2,114,400
Greenbrier and River Crest	13	$1,732,300
South Norfolk and Indian River	4	$494,400
Western Branch	4	$770,000
Totals	**42**	**$6,317,600**

The types of insured structures, the policies and insurance in force, the paid losses, and the total paid losses are summarized in Table 16.

TABLE 16 — FLOOD INSURANCE POLICY SUMMARY AS OF 2002

Structure Type	Policies In Force	Insurance In Force	Number of Paid Losses	Total Paid Losses
1-4 Family	6,444	$964,178,000	447	$1,122,256
Other Residential	365	$28,951,700	0	$0
Other Structures	159	$52,426,100	21	$274,613
Small Business	0	$0	8	$83,007
Total	6,968	$1,045,555,8000	476	$1,478,876

SLOSH Maps

SLOSH (Sea, Lake and Overland Surges from Hurricanes) is a computerized model run by the National Hurricane Center (NHC) to estimate storm surge heights and winds resulting from historical, hypothetical, or predicted hurricanes by taking into account:

- Pressure
- Size
- Forward speed
- Track
- Winds

This data for a particular area is produced in a graphical output into maps, which display color-coded storm surge heights. The calculations are applied to a specific locale's shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads and other physical features.

The SLOSH model is estimated to be accurate within plus or minus 20 percent. For example, if the model calculates a peak 10 foot storm surge for the event,

you can expect the observed peak to range from 8 to 12 feet. The model accounts for astronomical tides (which can add significantly to the water height) by specifying an initial tide level, but does not include rainfall amounts, riverflow, or wind-driven waves. However, this information is combined with the model results in the final analysis of at-risk-areas.

The point of a hurricane's landfall is crucial to determining which areas will be inundated by the storm surge. Where the hurricane forecast track is inaccurate, SLOSH model results will be inaccurate. The SLOSH model, therefore, is best used for defining the potential maximum surge for a location.

Existing Warning Systems

In 1996, the National Weather Service installed computers that track how much rain has fallen in various locations across any given region. These figures can provide forecasters with better understanding of how much water will be flowing down our rivers and streams, thus increasing the Watch and Warning times. The City of Chesapeake is engaged in installing rain gauges and lake level gauges to assist in monitoring when rainfall or water height reaches dangerous levels. In addition, the NOAA Weather radio is used extensively throughout the city. These radios have been freely distributed to all Fire Stations, Public Schools and assisted living facilities.

Vulnerable Structures

Within the City of Chesapeake a number of facilities and structures are at risk of being effected by floodwaters. For each planning area, the number of these structures and the total assessed value has been computed, and the locations of the structures are located on the Planning Area Maps. These facilities are located in either the 100-year or 500-year floodplain and are susceptible to impacts of flood waters during large storm events. Table 17 (on the following page), compiled using the city's existing GIS data, summarizes the number, type, and approximate total value of these structures. Also included in Table 17 is the approximate number of people living in the floodplain in each sector. (It should be noted that this table has been developed for planning purposes and the exact location of each structure relative to the floodplain must be verified in the field.)

TABLE 17 — PLANNING AREA ANALYSIS - FLOOD AREAS

PLANNING AREA	TYPE OF COMPLEX	# OF UNITS in Flood Zone	APPROXIMATE VALUE in the Flood Zone	# OF PEOPLE in Flood Zone	# OF PEOPLE in Planning Area
Camelot	Places of Worship	2	$662,100		
	Warehouses	1	$271,300		
	Day Care Centers	3	$224,100		
	Agricultural Properties	2	$405,600		
	Mobile Home Parks	1	$4,163,500		
	Residential Properties	348	$21,329,700		
Deep Creek	Places of Worship	21	$4,082,500		
	Warehouses	2	$235,000		
	Sara Title 3 Facilities	2	$5,965,500		
	Day Care Centers	4	$593,500		
	Construction Companies	1	$118,200		
	Fire Stations	1	$485,000		
	Agricultural Properties	43	$11,819,000		
	Apartment Complexes	2	$4,789,400		
	Mobile Home Parks	2	$1,225,500		
	Residential Properties	3,552	$326,643,800		
	TOTALS	3,630	$355,957,400	5,509	23,800
Great Bridge	Places of Worship	9	$6,100,800		
	Warehouses	2	$1,926,400		
	Senior Centers	1	$1,557,800		
	Fire Stations	1	$1,631,100		
	Schools	2	$28,359,200		
	Sara Title 3 Facilities	5	$5,283,700		
	Day Care Centers	8	$2,914,000		
	Community Centers*	1	$3,553,300		
	Construction Companies	2	$1,491,800		
	Apartment Complexes	3	$1,776,700		
	Agricultural Properties	11	$4,600,700		
	Residential Properties	2,189	$309,525,100		
Southern Chesapeake	Places of Worship	2	$370,200		
	Agricultural Properties	174	$46,211,400		
	Residential Properties	822	$126,431,100		
	TOTALS	998	$173,012,700	1,095	11,987
Greenbrier	Places of Worship	3	$439,800		
	Warehouses	2	$1,892,300		

TABLE 17 — PLANNING AREA ANALYSIS - FLOOD AREAS

PLANNING AREA	TYPE OF COMPLEX	# OF UNITS in Flood Zone	APPROXIMATE VALUE in the Flood Zone	# OF PEOPLE in Flood Zone	# OF PEOPLE in Planning Area
	Sara Title 3 Facilities	1	$4,096,800		
Greenbrier (Continued)	Agricultural Properties	13	$3,475,400		
	Residential Properties	171	$31,455,300		
Rivercrest	Places of Worship	3	$502,800		
	Warehouses	5	$4,723,100		
	Schools	2	$10,708,400		
	Sara Title 3 Facilities	5	$2,150,500		
	Day Care Centers	2	$862,500		
	Community Centers	1	$3,553,300		
	Construction Companies	2	$4,317,000		
	Apartment Complexes	6	$22,185,700		
	Agricultural Properties	3	$2,746,400		
	Mobile Home Parks	2	$1,351,200		
	Residential Properties	2,761	$374,801,300		
	TOTALS	2,792	$427,902,200	6,858	17,019
South Norfolk	Places of Worship	4	$1,304,300		
	Warehouses	12	$8,729,800		
	Schools	2	$7,515,400		
	Sara Title 3 Facilities	13	$16,045,200		
	Day Care Centers	2	$1,081,600		
	Construction Companies	3	$3,048,100		
	Fire Stations	1	$1,393,000		
	Medical Offices	2	$65,000		
	Apartment Complexes	18	$26,489,000		
	Residential Properties	773	$27,726,900		
Indian River	Apartment Complexes	1	$31,330,900		
	Residential Properties	625	$82,487,400		
	TOTALS	626	$113,818,300	1,015	19,444
Western Branch	Places of Worship	1	$579,800		
	Agricultural Properties	29	$11,954,000		
	Residential Properties	1,641	$277,258,500		
	COMMUNITY TOTALS	13,328	$1,891,017,700	24,769	199,089

PLANNING AREA	TYPE OF COMPLEX	NO. OF UNITS in Flood Zone	APPROXIMATE VALUE in the Flood Zone	NO. OF PEOPLE in Flood Zone	NO. OF PEOPLE in Planning Area
Southern Chesapeake	Places of Worship	2	$370,200		
	Agricultural Properties	174	$46,211,400		
	Residential Properties	822	$126,431,100		
	TOTALS	998	$173,012,700	1,095	11,987
Greenbrier	Places of Worship	3	$439,800		
	Warehouses	2	$1,892,300		
	Sara Title 3 Facilities	1	$4,096,800		
	Agricultural Properties	13	$3,475,400		
	Residential Properties	171	$31,455,300		
	TOTALS	190	$41,359,600	408	23,864
Rivercrest	Places of Worship	3	$502,800		
	Warehouses	5	$4,723,100		
	Schools	2	$10,708,400		
	Sara Title 3 Facilities	5	$2,150,500		
	Day Care Centers	2	$862,500		
	Community Centers	1	$3,553,300		
	Construction Companies	2	$4,317,000		
	Apartment Complexes	6	$22,185,700		
	Agricultural Properties	3	$2,746,400		
	Mobile Home Parks	2	$1,351,200		
	Residential Properties	2,761	$374,801,300		
	TOTALS	2,792	$427,902,200	6,858	17,019
South Norfolk	Places of Worship	4	$1,304,300		
	Warehouses	12	$8,729,800		
	Schools	2	$7,515,400		
	Sara Title 3 Facilities	13	$16,045,200		
	Day Care Centers	2	$1,081,600		
	Construction Companies	3	$3,048,100		
	Fire Stations	1	$1,393,000		
	Medical Offices	2	$65,000		
	Apartment Complexes	18	$26,489,000		
	Residential Properties	773	$27,726,900		
	TOTALS	830	$93,398,300	1,709	22,797
Indian River	Apartment Complexes	1	$31,330,900		
	Residential Properties	625	$82,487,400		
	TOTALS	626	$113,818,300	1,015	19,444
Western Branch	Places of Worship	1	$579,800		
	Agricultural Properties	29	$11,954,000		
	Residential Properties	1,641	$277,258,500		
	TOTALS	1,671	$289,792,300	2,067	28,558
	COMMUNITY TOTALS	13,328	$1,891,017,700	24,769	199,089

As reflected in the table above, Deep Creek, Great Bridge, Greenbrier, Rivercrest, and South Norfolk all have Sara Title 3 facilities located in the floodplain. Locations where hazardous or toxic material are stored, used, processed, or disposed are of a particular concern in vulnerable areas because natural hazard events can result in secondary hazards such as toxic substance releases or hazardous material spills.

Within the city, Deep Creek and Rivercrest have the highest number of properties located in the floodplain at 3,630 and 2,792, respectively. Deep Creek, Great Bridge, Rivercrest, and South Norfolk all have publicly owned facilities in floodplains such as fire stations and schools.

In addition to traditional flooding, the city is also vulnerable to flooding due to storms associated with a coastal or tropical storm, and as defined by the SLOSH model previously discussed. Using the city's GIS data, a list of the number, type, and approximate value of these structures in the potential storm surge areas has also been developed, and is included in Table 18.

TABLE 18 —CITYWIDE ANALYSIS OF POTENTIAL STORM SURGE AREAS

POTENTIAL HURRICANE DAMAGE ESTIMATES			
Property Type	**Category of Storm**	**Number of Properties**	**$VALUE**
Commercial Improved	2	425	$835,196,900
Detached Condo	2	4	$343,700.00
Residential Condo	2	136	$31,927,700
Residential Improved	2	3,733	$527,603,600
Residential Townhouse	2	93	$7,218,100
TOTALS		**4,391**	**$1,402,290,000**
Commercial Improved	3	220	$416,413,300
Detached Condo	3	2	$251,800
Residential Condo	3	76	$18,958,600
Residential Improved	3	3,180	$371,236,100
Residential Townhouse	3	280	$15,233,100
Mobile Home	3	2	$66,900
TOTALS		**3,760**	**$822,159,800**
Commercial Improved	4 & 5	510	$697,874,400
Detached Condo	4 & 5	52	$9,414,100
Residential Condo	4 & 5	475	$119,898,600
Residential Improved	4 & 5	9,948	$1,144,760,300
Residential Townhouse	4 & 5	592	$47,696,000
TOTALS		**11,577**	**$2,109,643,400**
GRAND TOTALS		**19,278**	**$4,244,093,200**

The amounts of damage these facilities could sustain depend on a variety of factors. A description of each of these factors and the relative impact of each to the City of Chesapeake is included below.

Event-Specific Factors

Flood depth: An analysis of the floodplain in the community reveals that the approximate depth of flooding throughout the city is consistent, ranging from 0.5 to 1.5 feet. These depths were estimated using the Base Flood Elevations (BFEs) determined for each of the waterways and community topographic information. The full description of the methodology is included in the Potential Losses section below. Due to the consistency of the flood depths throughout the community, areas of increased vulnerability due to flood depth cannot be identified. However, specific localized areas may be subject to increased flood depths. The structures located in these areas would be more vulnerable to significant damage due to flooding.

Flood duration: The longer duration of time that flood waters are in contact with building components (such as structural members, interior finishes, and mechanical equipment), the greater the potential for damage. The duration of flooding is very specific to the nature of an event. However, the structures closest to a flooding source (such as a river, bay, or canal) are more likely to sustain longer durations of flooding and be more vulnerable to flood damage. As flood waters recede, these structures will be last to be un-impacted, increasing the potential for damage.

Velocity: The velocity of flood waters is an important factor concerning potential damage due to flooding. Flowing water exerts forces on the structural members of a building, increasing the likelihood of significant damage. In addition, flowing waters can increase erosion and scour around the foundation of a structure, which can further increase the vulnerability of a building to damage. A large portion of the flooding occurring in the City of Chesapeake could be classified as stillwater flooding. However, any structure located along the channel of a river, stream or creek, will be more susceptible to damage due to moving floodwaters.

Site-Specific Factors

Elevation: The lowest possible point where flood waters may enter a structure is the most significant factor contributing to its vulnerability to damage due to flooding. For most structures, the lowest point of entry is the lowest floor elevation, although it could also be a utility connection or opening in the foundation, if present. The lower the elevation of this entry point, the more frequently a structure will be impacted by flood waters and generally the longer the duration of flooding. The City of Chesapeake has a floodplain ordinance included in its building code, which was adopted in 1977 in accordance with the

city's participation in the NFIP. This ordinance requires that all structures constructed in the floodplain be elevated to a level such that the lowest floor elevation is above the BFE. The structures are classified as post-FIRM structures as they were constructed after the adoption of the FIRMs. The remainders of the structures in the floodplain are classified as pre-FIRM structures, and since they were constructed prior to the adoption of the local floodplain ordinance, there is no provision that these structures be elevated above the BFE. Therefore, generally, pre-FIRM structures, or those constructed prior to 1977, will have a higher vulnerability to flood damage.

Construction Type: Certain types of construction are more resistant to the effects of flood waters. Typically, masonry buildings, constructed of brick or concrete blocks, are the most resistant to damages simply because masonry materials can come into contact with limited depths of flooding without sustaining significant damages. Deeper floods can cause damages by the forces exerted on the structure from the water surrounding it. Wood frame structures are more susceptible to damages because the construction materials are easily damaged when inundated with water.

Estimating Losses for Floods

The potential impacts on structures in the event of a 100-year flood have been estimated using a potential 100-year flood depth and utilizing the Flood Insurance Administration's (FIA's) previously determined depth damage functions to anticipate damage to buildings and contents as well as a loss of function or displacement cost estimate. These functions estimate the damages to a structure as a percentage of the building value, and are differentiated by building type. An average estimated damage per structure was calculated and then applied to all the structures in the floodplain of the same use for that planning area.

After estimating structure age from Census 2000 data, it was determined that approximately 44% of the all the structures in the community were built prior to the adoption to the floodplain ordinance requiring them to be elevated above the 100-year floodplain. Based on this analysis, the damage estimate was applied to 44% of all structures in the floodplain areas.

The full calculations for this analysis are in provided in Appendix B and are summarized in Table 19 on the next page. Note that Table 19 is only intended to provide a rough estimate of the potential damages to the buildings in each planning area from a 100-year flood event, and does not include infrastructure

damages or secondary impacts. In addition, although Table 19 estimates damages to structures in both riverine and coastal floodplains from the 100-year flood depth, it is not intended to estimate damages due to storm surge. Since the hurricane surges provided by the SLOSH Model and surge maps do not provide surge depths; damages due to storm surge could not be estimated. FEMA is currently working to develop its own methodology to address storm surge. The most significant amount of damage in the community from the 100-year flood will be sustained to residential properties. This is due to the large amount of these properties currently located within the floodplain. The total number of residential properties in the floodplain is approximately 12,900. The structures built after the adoption of the floodplain ordinance will most likely not be subject to this flooding because they will be constructed above 100-year flood elevation in accordance with NFIP requirements.

TABLE 19 —SUMMARY BY PLANNING AREA OF ESTIMATED 100-YEAR FLOOD DAMAGES

PLANNING AREA	ESTIMATED 100-YEAR FLOOD DAMAGES BY PLANNING AREA	PERCENT OF PLANNING AREA DAMAGED	PERCENT OF TOTAL COMMUNITY DAMAGED	USE WITH HIGHEST DAMAGE	USE WITH SECOND HIGHEST DAMAGE
Camelot	$3,816,194	14%	2.6%	Residential 49.0%	Mobile Homes 44.2%
Deep Creek	$33,313,272	9%	23.0%	Residential 85.0%	Agricultural 4.6%
Great Bridge	$25,801,222	7%	17.8%	Residential 66.2%	Schools 13.5%
Southern Chesapeake	$10,868,334	6%	7.5%	Residential 64.2%	Agricultural 35.4%
Greenbrier	$3,762,986	9%	2.6%	Residential 58.9%	Title 3 Facilities 21.8%
Rivercrest	$33,369,280	8%	23.1%	Residential 79.4%	Apartments 7.7%
South Norfolk	$9,583,889	10%	6.6%	Title 3 Facilities 28.5%	Apartments 27.9%
Indian River	$7,700,915	7%	5.3%	Residential 59.2%	Apartments 40.8%
Western Branch	$16,412,774	6%	11.3%	Residential 93.6%	Agricultural 6.1%
ESTIMATED COMMUNITY TOTAL	$144,628,865				

The Deep Creek and Camelot areas are estimated to suffer the greatest amount of damage in a 100-year flood. This is due to the high percentage of residential properties found in these planning areas. A majority of the damages will be to residential properties, apartment complexes, and agricultural properties.

Vulnerability Assessment

Based on all local and regional hazard data collected, flood vulnerability assessment for the City of Chesapeake involved an analysis of several parameters that are discussed below. A table describing the vulnerability assessment parameters, along with computations used to estimate the 100-year flood damages that may be experienced by the City of Chesapeake, is provided in Appendix B of this report.

- Flood Depth
- Number of Basic Building Types in Flood Zone
- Assumed Building Type
- Building Replacement Value (BRV)
- Contents Replacement Value (CRV)
- Loss of Function (LOF)
- Number and Value of Critical Facilities in Flood Zone
- Depth Damage Function (DDF) for Buildings, Contents and LOF
- Number of Pre-FIRM Buildings in Flood Zone

Once these parameters were determined, the estimated per capita damage (building, contents, and loss of function) in dollars per person within each planning area was used to arrive at a flood vulnerability index for each of the nine planning areas. For each planning area, the estimated per capita damage was determined using the following formula:

Estimated Per Capita Damage = (Building Damage + Contents Damage + LOF) / (Total Planning Area Population)

-
- The building damage costs were computed by multiplying the building replacement value by the corresponding building DDF. The contents damage costs were determined by multiplying the contents replacement value by the

corresponding contents DDF. LOF costs applied some of the principles of the preference scale method used for the hazard identification analysis. For example, critical facilities such as fire stations used larger annual budget values, thereby increasing their LOF values and their total costs to reflect their importance. Finally, the total damage cost for each planning area was divided by the total population within the planning area, and the planning areas with the highest per capita damage costs were considered to have the highest potential vulnerability.

•

A summary of the 100-year flood vulnerability assessment results for the City of Chesapeake is presented in Table 20 on the following page. The calculations used to estimate the total damages to each building class in the flood zone and the vulnerability index for each planning area in the City of Chesapeake are summarized in tabular form in Appendix B. Note that the assigning of numerical values and importance factors for parameters is qualitative in nature and based on data from a number of sources with varying degrees of accuracy. For this reason, a margin of error of ±10 percent was assumed for the total unit costs used to arrive at the vulnerability index values.

The ***100-Year Flood Vulnerability Index Map*** for the City of Chesapeake at the end of this section provides the results of the flood vulnerability index computations in graphical form.

TABLE 20 — VULNERABILITY ASSESSMENT FOR 100-YEAR FLOOD CITY OF CHESAPEAKE, VA

PLANNING AREA	TOTAL NO. OF UNITS IN FLOOD ZONE	APPROXIMATE TOTAL VALUE IN FLOOD ZONE	ESTIMATED 100-YEAR FLOOD DAMAGES PER PLANNING AREA	PERCENT OF TOTAL COMMUNITY DAMAGED	TOTAL PLANNING AREA POPULATION	PERCENT POPULATION DISTRIBUTION	ESTIMATED PER CAPITA PLANNING AREA DAMAGE	VULNERABILITY INDEX
Camelot	357	$27,056,300	$3,816,194	2.6%	7,702	3.9%	$495	Medium
Deep Creek	3,630	$355,957,400	$33,313,272	23.0%	23,800	12.0%	$1,400	High
Great Bridge	2,234	$368,720,600	$25,801,222	17.8%	43,918	22.1%	$587	Medium
Southern Chesapeake	998	$173,012,700	$10,868,334	7.5%	11,987	6.0%	$907	Medium
Greenbrier	190	$41,359,600	$3,762,986	2.6%	23,864	12.0%	$158	Low
Rivercrest	2,792	$427,902,200	$33,369,280	23.1%	17,019	8.5%	$1,961	High
South Norfolk	830	$93,398,300	$9,583,889	6.6%	22,797	11.5%	$420	Low
Indian River	626	$113,818,300	$7,700,915	5.3%	19,444	9.8%	$396	Low
Western Branch	1,671	$289,792,300	$16,412,774	11.3%	28,558	14.3%	$575	Medium
ESTIMATED TOTALS	13,328	$1,891,017,700	$144,628,865	100.0%	199,089	100.0%	$726	

Wind Events

Wind can be one of the most destructive forces of nature. Strong winds can erode mountains and shorelines, topple trees and buildings, and cause tidal surges and subsequent flooding. Damaging wind events in the City of Chesapeake can occur in the form of tornadoes, hurricanes, and nor'easters. Only those effects of tornadoes, hurricanes, and nor'easters that are wind-related will be discussed in this section.

Tropical Cyclones (Hurricanes)

A tropical cyclone is a low-pressure area of closed circulation that forms over a large tropical body of water. Tropical cyclones rotate counterclockwise throughout the Northern Hemisphere and are called tropical depressions when their wind speed is less than 39 mph, but become tropical storms when their wind speeds are between 39 mph and 73 mph. When these wind speeds reach 74 mph they become hurricanes.

The hurricane season in the North Atlantic runs from June 1 until November 30, with the peak season between August 15 and October 15. The average hurricane duration is 12 to 18 hours. Wind speeds may be reduced by 50% within 12 hours. These storms are capable of producing a large amount of rain in a short period; as much as 6 to 12 inches of rain has occurred within a 12 to 16 hour timeframe.

Hurricanes striking near Chesapeake have spawned tornadoes and straight-line wind events. Tropical Storm Doria in 1971 and Hurricane Bonnie in 1998 are two examples of tropical cyclones that have resulted in tornadoes touching down in the City of Chesapeake.

The strength of a hurricane is classified according to wind speed using the Saffir-Simpson Hurricane Damage Scale. This scale is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf in the landfall region. Note that all winds are using the U.S. 1-minute average. Table 21 provides a description of typical damages associated with each hurricane category.

TABLE 21 — SAFFIR-SIMPSON HURRICANE DAMAGE SCALE

CATEGORY	Wind Speed (mph)	Description of Typical Damages
1	74-95	Minimal damage — Storm surge generally 4-5 feet above normal. No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Some damage to poorly constructed signs. Also, some coastal road flooding and minor pier damage.
2	96-110	Moderate damage — Storm surge generally 6-8 feet above normal. Some damage to buildings. Considerable damage to shrubbery and trees with some trees blown down. Considerable damage to mobile homes, poorly constructed signs, and piers. Coastal and low-lying escape routes flood 2-4 hours before arrival of the hurricane center. Small craft in unprotected anchorages break moorings.
3	111-130	Extensive damage — Storm surge generally 9-12 feet above normal. Some structural damage to small residences and utility buildings. Damage to shrubbery and trees with foliage blown off trees and large trees blown down. Mobile homes and poorly constructed signs are destroyed. Low-lying escape routes are cut off by rising water 3-5 hours before arrival of the center of the hurricane. Flooding near the coast destroys smaller structures with larger structures damaged by battering from floating debris. Terrain continuously lower than 5 feet above mean sea level may be flooded inland 8 miles (13 km) or more. Evacuation of low-lying residences may be required.
4	131-155	Extreme damage — Storm surge generally 13-18 feet above normal. More extensive structural failures on small residences. Shrubs, trees, and all signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows. Low-lying escape routes may be cut off by rising water 3-5 hours before arrival of the center of the hurricane. Major damage to lower floors of structures near the shoreline. Terrain lower than 10 feet above sea level may be flooded requiring massive evacuation of residential areas as far inland as 6 miles (10 km).
5	>155	Catastrophic damage — Storm surge generally greater than 18 feet above normal. Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destruction of mobile homes. Severe and extensive window and door damage. Low-lying escape routes are cut off by rising water 3-5 hours before arrival of the center of the hurricane. Major damage to lower floors of all structures located less than 15 feet above sea level and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within 5-10 miles of the shoreline may be required.

The recurrence interval for a hurricane is derived from the probability for coastal flooding caused by storm surge and from the number of direct and indirect landfall “hits” a community takes from hurricanes. The National Weather Service tabulated these data and has developed a map showing the 5% or greater chance of a hurricane making landfall on coastal communities during any given

year. According to these data, Chesapeake has a 5% or greater chance of a category 2 or 3 hurricane landing in any given year. Based on the data included for 1900 to 2002, the city has a 15.5% chance of being affected by a hurricane in some way (directly or indirectly) in any given year.

Tornadoes

A tornado is a column of rapidly rotating wind that extends from a thunderstorm cloud to the ground. It often appears as a funnel-shaped cloud or a spiraling column of debris. Tornadoes may be only several yards across, or in rare cases, over a mile wide. Most of the tornadoes that occur in Chesapeake are caused as a result of hurricanes or heavy thunderstorms. Tornadoes can form during any time of year, but they are more frequent in Chesapeake between April and July. Due to the unpredictability of tornadoes, communities usually have little or no warning before a tornado hits. When tornadoes strike a community, they can be expected to last anywhere from a few minutes to 20 minutes or more. The City of Chesapeake has experienced 11 tornadoes since 1960, five of those occurring since 1990. The tornadoes occurring since 1990 had strengths of F0, F1, and F2. Damage estimates for these tornadoes exceed $1.7 million.

Table 22 lists historical tornadoes that touched down in the City of Chesapeake ("Tornadoes, The Killer Storm", NCDC Website).

TABLE 22 — TORNADOES IN THE CITY OF CHESAPEAKE

DATE	DESCRIPTION OF TORNADIC EVENT
11/26/1926	A waterspout came ashore from the Elizabeth River and collapsed two 700 feet long warehouses.
4/8/1962	An F2 tornado tracked approximately 9 miles across the southeast portion of Norfolk County near St. Brides, Hickory and Fentress. Many roofs were blown off and some outbuildings were leveled.
6/18/1969	An F1 tornado touched down at 11:01 PM.
8/27/1971	An F1 tornado touched down at 1:30 PM causing an estimated $250,000 in damage.
11/3/1971	An F2 tornado touched down at 10:30 AM.
4/4/1976	An F1 tornado touched down at 3:00 PM causing an estimated $2,500 in damage.
5/8/1984	A cluster of thunderstorms caused damage in Chesapeake. Numerous tornadoes were spotted around the state.
2/9/1990	An F0 tornado touched down causing an estimated $25,000 in damage.
8/6/1993	An F2 tornado hit Etheridge Manor, Etheridge Woods, Windlesham Plantation, Hanbury corridor, and the Hampton Roads Airport causing an estimated $1,651,500 in damage.
7/24/1997	A tornado touched down near Gorier Ave. and Poindexter St. traveling north along the railroad tracks. At 1:20 PM, the tornado was sighted in the South Norfolk area of the City. Damage was estimated at $60,000.

TABLE 22 — TORNADOES IN THE CITY OF CHESAPEAKE

DATE	DESCRIPTION OF TORNADIC EVENT
4/9/1998	An F0 tornado uprooted several trees and sheared the tops off many others in a 4 to 5 mile path along the northern portions of the City. The tornado appeared to remain just above the ground, with all structural damage resulting from falling limbs/trees. There were no deaths or injuries associated with the event that caused an estimated $25,000 in damage.
8/27/1998	A tornado associated with the remnants of Hurricane Bonnie initially affected the Riverwalk section of the City, then tracked east-northeast through the Greenbrier section.

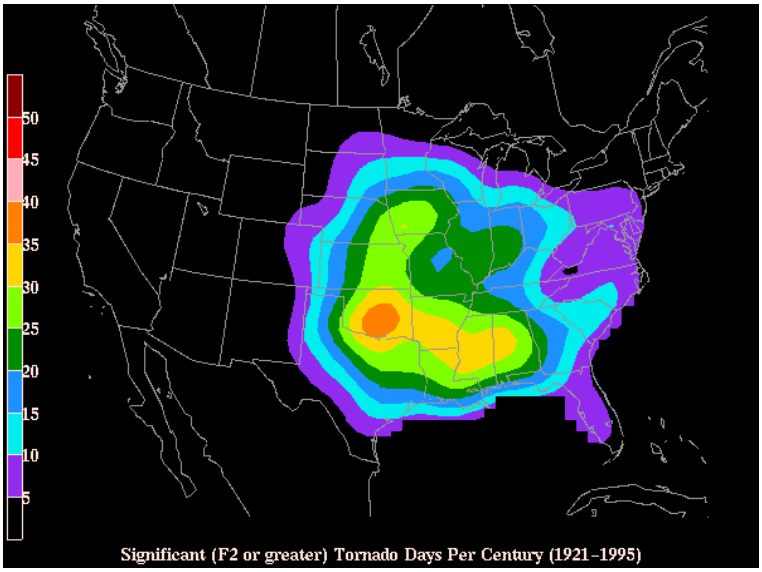
The intensity of a tornado is commonly measured by the Fujita Scale, which has been illustrated in Table 23.

TABLE 23 — THE FUJITA SCALE

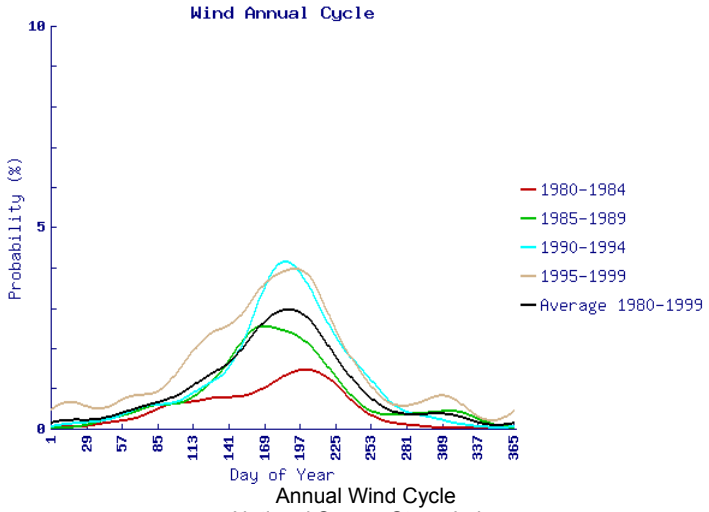
SCALE VALUE	Wind Speed (mph)	Description of Typical Damages
F0	40-72	Light damage. Tree branches snapped; antennas and signs damaged.
F1	73-112	Moderate damage. Roofs off; trees snapped; trailers moved and/or overturned.
F2	113-157	Considerable damage. Weak structures and trailers demolished; cars moved.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed buildings; trains overturned; trees uprooted; cars lifted up and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures blown off weak foundations; cars thrown; large missiles generated.
F5	261-318	Incredible damage. Houses lifted off foundations and carried some distance; large missiles thrown over 100 yards; trees debarked.

The National Weather Service (NWS) states that F0 and F1 tornadoes comprise 70% of all tornadoes that occur in the United States. In addition, the NWS concludes that these tornadoes typically touch down only briefly and cause minor damages.

The National Severe Storms Laboratory has developed maps showing the number of significant tornado days that communities have experienced during the 20th Century. There have been between five and ten significant (F2 or greater) tornado days during the 20th Century in Chesapeake.



A tornado wind event could occur in Chesapeake at any time of the year, but are most likely to occur from April to August, with peak probability in June, as can be seen in the Wind Annual Cycle for Chesapeake below.



Annual Wind Cycle
National Severe Storm Labs

Nor'easters

Nor'easters are fierce storms that typically form either in the Gulf of Mexico or in the Atlantic Ocean off of the East Coast. Although typically associated with winter storm events, nor'easters can occur at any time of year. If a jet stream passing over the West Coast splits, the southern branch can draw warm air back into the cold northern branch of the jet stream. Moisture is pulled from the

Atlantic Ocean, fueling the storm and increasing the amount of precipitation. The warm air tends to move and develop strong winds moving in a counter-clockwise direction. As the warm air rises and cools, precipitation forms. These storms are known for producing heavy snowfalls, rain, immense waves, and strong winds that can exceed hurricane intensities.

The Chesapeake community is susceptible to hazards generated by nor'easters throughout the year; however the majority occur between September and March. Nor'easters have the potential to occur anywhere, and are not confined to specific areas within the city. The hazard boundaries encompass the entire Chesapeake area. Winds associated with these storms can sometimes blow without appreciable change in direction or speed for 1,500 miles or more and typically linger 48 to 72 hours.

The Dolan/Davis Nor'easter Scale below is similar to the Saffir-Simpson Scale used for hurricanes. The Dolan/Davis Nor'easter scale was developed in an attempt to classify the damages that may occur during these storm events. Although this scale is not as well known as the Saffir-Simpson Scale, it is a useful tool for showing the true damage potential of nor'easters. The intensity of a nor'easter is commonly measured by Dolan/Davis Nor'easter scale, which has been illustrated in Table 24.

TABLE 25 — DOLAN / DAVIS NOR'EASTER SCALE

Storm Class	Beach Erosion	Dune Erosion	Over Wash	Property Damage
Class 1 (Weak)	Minor Changes	None	No	No
Class 2 (Moderate)	Modest: mostly to lower beach	Minor	No	Modest
Class 3 (Significant)	Erosion: extends across beach	Can be significant	No	Loss of many structures at local scale
Class 4 (Severe)	Severe beach erosion or recession	Severe dune erosion or destruction	On low beaches	Loss of structures at community scale
Class 5 (Extreme)	Extreme beach erosion	Dunes destroyed over extensive areas	Massive in sheets and channels	Extensive at regional scale; millions of dollars

Source: Coch, 1995

The Chesapeake/Hampton Roads Region has experienced numerous nor'easters since the first recorded event in 1821. These events have been summarized in Table 25 on the following page.

TABLE 25 — NOR'EASTERS IN THE CITY OF CHESAPEAKE

DATE	Nor'easter Storm Events
JANUARY 6-7 1821	A nor'easter of great intensity hit the Eastern Seaboard from Charleston, SC to New England. The band of deep snow stretched from the Virginia interior to the New Jersey Coast. Temperatures fell to below zero in some areas behind the storm.
FEBRUARY 27 TO MARCH 2, 1846	A severe coastal storm known as "The Great Gust" hit the Virginia and the Northeast. Norfolk recorded tides up to five feet above normal. The storm did half million dollars damage on the East Coast.
APRIL 6 1889	Hampton Roads recorded a sustained wind of 75 mph from the north and Cape Henry 105 mph though it was estimated to have reached 120 mph. Tides at Norfolk reached 8.37 ft above Mean Low Water which is over 4 feet above flood. It was estimated that damage was heavier and the water was 18 inches higher than that of the August 1879 hurricane. Rain, snow and sleet fell with the storm and totaled 3.2 inches liquid. Drummonds Bridge was swept away (later replaced by the Ghent Bridge). Trees were uprooted and roofs were torn off.
MARCH 1-3, 1927	High winds around the nor'easter gusted to 62 mph at Cape Henry and 52 mph at Norfolk. Heavy snow fell across North Carolina into Virginia and travel was delayed for 2 to 3 days. In Virginia Beach, high tide and heavy surf on March 2 inflicted considerable damage. The beaches in some places were washed back 50 feet and denuded of the overlying sand so that the clay beneath was exposed. The large hotel in Virginia Beach and other buildings were severely damaged along with the boardwalk and other protective structures.
APRIL 11, 1956	A severe nor'easter gave gale winds (40 mph +) and unusually high tides to the Tidewater Virginia area. At Norfolk, the strongest gust was 70 mph. The strong northeast winds blew for almost 30 hours and pushed up the tide, which reached 4.6 feet above normal in Hampton Roads. Thousands of homes were flooded by the wind-driven high water and damages were large. Two ships were driven aground. Water front fires were fanned by the high winds and, the flooded streets made access to fire fighters very difficult and it added to the losses.
MARCH 5-9, 1962	The Ash Wednesday Storm hit Virginia during "Spring Tide" (sun and moon phase to produce a higher than normal tide). The storm moved north off the coast past Virginia Beach and then reversed its course moving again to the south and bringing with it higher tides and higher waves which battered the coast for several days. The storm's center was 500 miles off the Virginia Capes when water reached nine feet at Norfolk and 7 feet on the coast. Huge waves toppled houses into the ocean and broke through Virginia Beach's concrete boardwalk and sea wall. Houses on the Bay side also saw extensive tidal flooding and wave damage. The beaches and shorefront had severe erosion. Locals felt the damage from this storm was worst in Virginia Beach than that of the 1933 Hurricane. An estimated $4 million in wind and flood damages occurred to the City of Hampton. Winds up to 70 mph built 40-foot waves at sea.
JANUARY 19-20, 1978	A strong nor'easter developed off the Southeast Coast. It was the third snow in a week for Virginia. East of the mountains saw 4 to 8 inches until you reached Richmond. Richmond got a devastating ice storm causing major power disruptions and tree damage. Many small buildings and roofs collapsed from the weight of the snow in the west. One man was injured when a roof fell. One person died while shoveling snow.
FEBRUARY 2-3 AND FEBRUARY 16, 1996, STORMS	A continuing series of Alberta clippers followed by strong nor'easters struck the Commonwealth. To the north of the heavy snow band fell 6 to 10 inches of snow and to the south of the band was a significant ice storm. Some counties along the North Carolina border saw about half of its population lose power. The ice caused about a half million dollars in damage and caused widespread disruptions in the Hampton Roads area. Following the fresh snow and ice came a cold wave from the 3rd through the 6th with many areas dropping below zero. On the 5th, several places set new records. On the 16th, another nor'easter moved up the coast

	dumping 6 to 12 inches of snow in a swath across Virginia from Nottoway to Fredericksburg with Charlottesville on the west side of the heavy band and Richmond on the east side.
JANUARY 27-28 AND FEBRUARY 3-6, 1998:	"Back-to-Back Nor'easters" pounded the Tidewater area and produced coastal flooding. Tides remained higher than normal from astronomical high tides and the January 27-28 Nor'easter. Then came the February nor'easter. Its slow movement and gale force winds pushed the tide to 7.0 feet above Mean Low Water at Norfolk and resulted in moderate to severe flooding. The entire town of Chincoteague on the Eastern Shore was under water. Willoughby Spit was the hardest hit area in Norfolk and homes in Sandbridge and Chick's Beach were severely damaged in Virginia Beach. Inland, heavy rains fell. Most areas that saw 2 to 4 inches with the January 27-28 storm again saw it with the February storm. Some locations received as much as 7.5 inches of rain. The rain lead to flooding on small streams and creeks closing numerous roads. The flood waters eventually flowed into the main stem of the rivers, which reached bank full or minor flood levels. When the next storm on February 3rd began snowing, over 1000 customers were without power. A charter bus on Interstate-81 overturned injuring 20 people. Areas east of the Allegheny Highlands saw 4 to 8 inches before the snow changed to freezing rain. Some areas got significant ice on top of the snow causing trees to come down and in one case a roof collapsed.

Source : (http://www.vdem.state.va.us/library/vawinter/va-win.htm)

Estimating Losses for Wind Events

Although no specific areas of Chesapeake can be designated as having a higher risk of being affected by a severe wind event, there are a number of factors that contribute to a particular area's vulnerability to damages if a high-wind event should occur. Certain characteristics of an area or of a structure can increase its resistance to damages, but these factors are usually specific to a particular location or a particular structure in question. However, each factor's affects on vulnerability will be discussed in general later in this section.

Potential Impacts

The damage sustained from a wind event can be wide-ranging and devastating. Tornadoes and hurricanes have caused damage to natural resources, infrastructure, buildings, and personal property. Past wind events in Chesapeake have broken tree branches and uprooted trees; snapped power, cable, and telephone lines; damaged radio, television, and communication towers; caused flooding; torn roofs off buildings; blown out walls; overturned vehicles; and damaged and destroyed businesses. Downed trees and power lines across roads have blocked key access routes and cut off parts of the city. Downed power lines have also resulted in extended power outages. Damaged radio, television, and communication towers have disrupted the city's telephone service, cell phone service, and taken radio and television stations off-air for extended periods. This inability to communicate effectively with the community

has resulted in the 911 emergency call systems being overloaded with calls for information, possibly preventing real emergency calls from being answered in a timely manner. Damage estimates for the August 6, 1993, hurricane are between $1.65 and $1.8 million, and the estimates for the July 24, 1997, tornado are $60,000.

Based upon NOAA mapping, the areas most likely to be affected by a tornado include: Riverwalk, Greenbrier, South Norfolk, Etheridge Manor, Etheridge Woods; Windlesham Plantation; Hanbury corridor, the Hampton Roads Airport, as well as those areas bordering Currituck and Pasquotank Counties in North Carolina, and the City of Suffolk in Virginia.

All planning areas within the City of Chesapeake are likely affected most by the direct wind and flooding effects of a hurricane. In addition to spawning tornadoes, other hazards associated with tropical cyclones include extensive damage to electric, telephone, and cable lines, breaks in utility lines, damaged communication towers, and possible incidents involving hazardous materials.

Storm surges from nor'easters often result in flooded streets and yards. In coastal areas, the waves that accompany these storms could affect structures with enough force to destroy walls and undermine the foundation of houses. In addition, these waves could erode the protective frontal dune systems resulting in overwash that exposes structures to high-velocity flood flows, interior flooding, foundation scour, and other damages (FEMA, 1996).

Wind Zones

Due to Chesapeake's proximity to the coast, the city is located in higher than average wind zones. Generally, average wind speed during the winter months varies between 9.4 mph to 13.0 mph. Average wind speed during the spring months is nearly identical to the winter months, ranging from 9.2 mph to 13.0 mph. During the summer months, average wind speed slows to a range of 7.4 mph to 10.7 mph. Average wind speed during the fall months is between 8.5 mph to 11.9 mph.

Wind Zone Boundaries

Chesapeake is located in Wind Zone II in the United States, which means the design-tornado wind speed for community shelters is 160 mph (FEMA 386-2, 2001). A map of fastest wind speeds for a 50-year return period for special high wind regions shows wind speeds of 90 mph to 100 mph for Chesapeake (Data

from American National Standards Institute, 1982). The 2000 edition of the International Building Code requires structures west of approximately Centerville Turnpike to be designed to withstand three-second wind gusts of 100-110 mph. Structures in the eastern portion of South Chesapeake east of Centerville Turnpike should be designed for wind speeds of 110-120 mph. However, in an effort to simplify the enforcement of this code in communities that are located in multiple wind zones, the Virginia Department of Housing and Urban Development, through the Virginia Uniform Statewide Building Code, has designated these communities to enforce the requirements of a single wind zone. The wind zone for the City of Chesapeake has been designated as 100 – 110 mph zone, and is in effect and enforced for the entire community.

Warning Systems

The amount of warning time citizens have to an approaching high-wind event, and the availability of shelters or safe rooms, is the most crucial factor regarding potential injury or loss of life. The National Hurricane Center publishes the Tropical Weather Outlook, which includes the location of all tropical systems, as well as local statements, which are published at regular intervals. When a tropical system is close to the coast, these statements are issued every 2-3 hours or more frequently if circumstances warrant. In addition, Public Advisories, including Watches and Warnings, and Strike Probability Forecasts are issued when the 72-hour position approaches the coast. Another warning tool is the HURREVAC 2001 Forecast Program. Using these tools, the National Hurricane Center is typically able to give more than 24 hours warning before a hurricane makes landfall.

NOAA publishes a tornado watch, which includes the following information — type of severe weather; watch area; valid period; type of severe weather; watch axis; meaning of watch; call to action statement; discussion of meteorological reasoning; and other watch information. When severe weather or a tornado is eminent, or a tornado has been spotted on the ground, the National Weather Service will issue a tornado warning. The warning will include the hazard; affected area; expiration time; a basis of warning; a threat conformation; the location and movement; and a call to action statement. These messages are broadcast over NOAA's weather radio network. Within the City of Chesapeake, each city department and each city-run school is equipped with a NOAA Weather Radio. The city also maintains contact with the National Weather Service office located in Wakefield, Virginia, through the city's Emergency Management Office. In the event of a tornado warning for a specific sector within the city, the city can activate the reverse 911 communications system. Other measures include the

training of city personnel and citizens of Chesapeake in the NOAA Spotter's Course. This course is designed to train individuals on how to spot tornadoes and other severe weather.

Population Density

Population density is another important factor when analyzing vulnerability to high-wind events. Because tornadoes can affect a small, localized area, the highest potential for damages, injuries, and loss of life, will be where the highest concentration of development exists. Although most of the City of Chesapeake is developed to some degree, the density of development does vary, primarily by land use. Therefore, although the likelihood of occurrence is equal throughout the city, the potential for damage, injury, and loss of life does vary significantly.

Design Wind Pressures

Buildings must be designed to withstand both external and internal wind pressures on the structural framing and exterior elements. The level to which these structures are designed, as expected, directly correlates with its ability to resist damages due to high winds. The community's building code dictates to what design wind speed a structure must be designed to. For some building types, those structures constructed in these areas subsequent to the adoption of the building code are the most likely to be the most resistant to damages from wind.

Building Types

The type of building construction will have a significant impact on potential damages from high wind events. A summary of basic building types – listed in order of decreasing vulnerability (from most to least vulnerable) – is provided below.

Non–Engineered Wood: Wood buildings that have not been specifically engineered during design. These structures may include single and multi-family residences, some one-story or two-story apartment units, and small commercial buildings.

Non-Engineered Masonry: Masonry buildings that have not been specifically engineered during design. These structures may include single-family and multi-family residences, some one-story or two-story apartment units, and some small commercial buildings.

Manufactured: This building type includes manufactured buildings that are produced in large numbers of identical or smaller units. These structures typically include light metal structures or mobile homes.

Lightly Engineered: Structures of this type may combine masonry, light steel framing, open-web steel joists, wood framing, and wood rafters. Some portions of these buildings have been engineered while others have not. Examples of these structures include motels, commercial, and light industrial buildings.

Fully Engineered: These buildings typically have been designed for a specific location, and have been fully engineered during design. Examples include high-rise office buildings, hotels, hospitals, and most public buildings.

Other building-related factors include height, shape, and the integrity of the building envelope. Taller buildings and those with complex shapes and complicated roofs are subject to higher wind pressures than those with simple configurations. The building envelope is composed of exterior building components and cladding elements including doors and windows, exterior siding, roof coverings, and roof sheathing. Any failure or breach of the building envelope can lead to increased pressures on the interior of the structure, further damage to contents and framing, and possible collapse.

Estimating Losses

The City of Chesapeake's number, type, and assessed values of facilities in each planning sector were evaluated in order to estimate the potential impacts on these structures from a 100-year wind event, which is defined as a 100-mph wind, or a Category 2 hurricane. The estimate has been completed by utilizing previously determined wind damage functions provided in FEMA's Hurricane Wind Benefit-Cost Module (Full Data Module Version 5.1 dated December 31, 1997) to anticipate damage to buildings and contents, as well as a loss of function or displacement cost estimate. The wind damage functions from the Module are differentiated by the building type, and estimate damages to a structure as a percentage of the building value. An average damage per structure was calculated and then applied to all the structures in the floodplain of the same use for that sector.

After estimating structure age from Census 2000 data, it was determined that approximately 34% of all the structures in the community were constructed prior to the adoption of the local building code in the Commonwealth of Virginia in 1973. The full calculations for this analysis are provided in Appendix C, and the results are summarized in Table 26 on the following page. Note that Table 26 is only intended to provide a rough estimate of the potential damages to the buildings in each planning area from a 100-year wind event, and does not include infrastructure damages or secondary impacts. The most significant amount of damage in the city will be to buildings of type non-engineered wood, with light-engineered buildings and non-engineered masonry also sustaining high amounts of damage. These building types are commonly found in residential and agricultural areas. The combination of vulnerable building types in highly concentrated residential areas contributes to the high damages sustained by residential properties.

PLANNING AREA	ESTIMATED 100-YEAR WIND EVENT DAMAGES BY PLANNING AREA	PERCENT OF PLANNING AREA DAMAGED	PERCENT OF TOTAL COMMUNITY DAMAGED	USE WITH HIGHEST DAMAGE	USE WITH SECOND HIGHEST DAMAGE
Camelot	$33,657,878	11%	3.2%	Residential 58.7%	Warehouses 23.6%
Deep Creek	$112,821,811	10%	10.6%	Residential 83.9%	Schools 3.8%
Great Bridge	$267,155,976	10%	25.1%	Residential 90.6%	Schools 4.9%
Southern Chesapeake	$96,386,246	11%	9.1%	Residential 70.9%	Agricultural 20.7%
Greenbrier	$150,687,727	10%	14.2%	Residential 76.2%	Warehouses 8.0%
Rivercrest	$103,942,081	10%	9.8%	Residential 80.7%	Schools 4.3%
South Norfolk	$64,661,510	10%	6.1%	Residential 61.5%	Warehouses 10.0%
Indian River	$78,186,704	10%	7.4%	Residential 75.7%	Warehouses 5.0%
Western Branch	$155,524,682	10%	14.6%	Residential 87.6%	Schools 4.9%
ESTIMATED COMMUNITY TOTAL	$1,063,024,617				

The Great Bridge and Southern Chesapeake sectors are estimated to suffer the greatest amount of damage in a 100-year wind event. This can be attributed to these sectors having the highest percentage of residential properties in the City of Chesapeake.

Vulnerability Assessment

Based on all local and regional hazard data collected, wind vulnerability assessment for the City of Chesapeake involved an analysis of several parameters that are discussed below. A table describing the vulnerability assessment parameters, along with computations used to estimate the 100-year wind event damages that may be experienced by the City of Chesapeake, is provided in Appendix C of this report.

- Basic Wind Speed
- Number of Basic Building Types
- Assumed Building Type
- Building Replacement Value (BRV)
- Contents Replacement Value (CRV)
- Loss of Function (LOF)
- Number and Value of Critical Facilities
- Wind Damage Function (WDF) for Buildings, Contents and LOF
- Number of Pre-Wind Code Buildings

Once these parameters were determined, the estimated per capita damage (building, contents, and loss of function) in dollars per person within each planning area was used to arrive at a wind vulnerability index for each of the nine planning areas. For each planning area, the estimated per capita damage was determined using the following formula:

Estimated Per Capita Damage = (Building Damage + Contents Damage + LOF) / (Total Planning Area Population)

-
- The building damage costs were computed by multiplying the building replacement value by the corresponding building WDF. The contents damage

costs were determined by multiplying the contents replacement value by the corresponding contents WDF. LOF costs applied some of the principles of the preference scale method used for the hazard identification analysis. For example, critical facilities such as fire stations used larger annual budget values, thereby increasing their LOF values and their total costs to reflect their importance. Finally, the total damage cost for each planning area was divided by the total population within the planning area, and the planning areas with the highest per capita damage costs were considered to have the highest potential vulnerability.

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A summary of the vulnerability assessment results for the 100-year wind event in City of Chesapeake is presented in Table 27 on the following page. The calculations used to estimate the total damages to each building class and the vulnerability index for each planning area in the City of Chesapeake are summarized in tabular form in Appendix C. Note that the assigning of numerical values and importance factors for parameters is qualitative in nature and based on data from a number of sources with varying degrees of accuracy. For this reason, a margin of error of ±10 percent was assumed for the total unit costs used to arrive at the vulnerability index values.

TABLE 27 —VULNERABILITY ASSESSMENT FOR 100-YEAR WIND EVENT CITY OF CHESAPEAKE, VA

PLANNING AREA	TOTAL NO. OF UNITS	APPROXIMATE TOTAL VALUE	ESTIMATED 100-YEAR WIND DAMAGES PER PLANNING AREA	PERCENT OF TOTAL COMMUNITY DAMAGED	TOTAL PLANNING AREA POPULATION	PERCENT POPULATION DISTRIBUTION	ESTIMATED PER CAPITA PLANNING AREA DAMAGE	VULNERABILITY INDEX
Camelot	**2,581**	**$308,503,000**	**$33,657,878**	**3.2%**	**7,702**	**3.9%**	**$4,370**	**Low**
Deep Creek	**9,147**	**$1,084,217,300**	**$112,821,811**	**10.6%**	**23,800**	**12.0%**	**$4,740**	**Medium**
Great Bridge	**16,776**	**$2,664,397,300**	**$267,155,976**	**25.1%**	**43,918**	**22.1%**	**$6,083**	**Medium**
Southern Chesapeake	**5,218**	**$871,784,500**	**$96,386,246**	**9.1%**	**11,987**	**6.0%**	**$8,041**	**High**
Greenbrier	**7,345**	**$1,482,459,900**	**$150,687,727**	**14.2%**	**23,864**	**12.0%**	**$6,314**	**High**
Rivercrest	**6,217**	**$1,011,927,700**	**$103,942,081**	**9.8%**	**17,019**	**8.5%**	**$6,107**	**High**
South Norfolk	**7,335**	**$622,006,400**	**$64,661,510**	**6.1%**	**22,797**	**11.5%**	**$2,836**	**Low**
Indian River	**6,320**	**$785,496,100**	**$78,186,704**	**7.4%**	**19,444**	**9.8%**	**$4,021**	**Low**
Western Branch	**10,525**	**$1,558,717,249**	**$155,524,682**	**14.6%**	**28,558**	**14.3%**	**$5,446**	**Medium**
ESTIMATED TOTALS	**71,464**	**$10,389,509,449**	**$1,063,024,617**	**100.0%**	**199,089**	**100.0%**	**$5,339**	

The ***100-Year Wind Vulnerability Index Map*** for the City of Chesapeake at the end of this section provides the results of the wind vulnerability index computations in graphical form.

Drought

"Drought is a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and man over a sizeable area" (USGS, 2000). Drought can be defined in meteorological, agricultural, or hydrologic terms. Meteorological drought is defined in terms of an extended period of dry weather. Agricultural drought is defined in terms of a shortage of precipitation that affects crops. Hydrologic drought is defined in terms of water content in lakes, rivers, streams, aquifers, and soils (USGS, 2000). Drought is a natural part of most climatic areas, but the severity of droughts differs based on duration, geographic extent, and intensity. Drought can be exacerbated by human demand and the amount of foliage in a geographic area.

Hazard Profile

One commonly used measure of drought is the Palmer Drought Index. The Index was developed in the 1960s by NOAA, and uses temperature and rainfall data to determine dryness. Negative numbers indicate drought, while positive numbers indicate surplus rainfall. Minus two is considered a moderate drought, minus three is severe drought, and minus four is extreme drought. Likewise, positive two is considered a moderate rainfall, positive three a severe rainfall, and positive four, an extreme rainfall.

According to the Virginia Department of Emergency Management (VDEM), drought affects more people in North America than any other natural hazard. Drought losses in the U.S. average $6 to $8 billion per year, and the drought in 1998 alone cost $40 billion (VDEM, 2003). These losses are typically agriculturally related in nature.

Soil Conditions

The soils in Chesapeake generally drain poorly and have a seasonal high water table at or near the ground surface. Many of the soils have ponded water on the surface after a heavy rainfall or period of prolonged wetness. In developed areas, these soils are often sloped to drain to existing drainage systems. In agricultural areas, local farmers often construct a series of ditches to promote drainage from fields under cultivation.

Hazard History

Virginia has experienced five major droughts since the early 1900s. The recurrence period for drought in Virginia ranges from 15 to more than 80 years. The drought of 1930-32 was one of the most severe droughts in the Commonwealth. Less severe droughts occurred during 1938-42 and 1962-71. The Tidewater region experienced a localized drought from 1976 until 1978. The statewide drought of 1980-82 was the least severe. The Commonwealth experienced severe drought during 1999-2002, called the worst since the drought of the 1930s (Commonwealth Currents, 2002). Executive Order No. 31 issued by the Governor on July 31, 2002, declared a state of emergency in Virginia from drought. The declaration was expanded on August 30, 2002, by the issuance of Executive Order No. 33. The latter Executive Order remained in effect until June 30, 2003.

Because of the most recent drought in Virginia, 84 counties have submitted 98 requests for agricultural economic aid (VDEQ, 2002). The USDA has approved a primary disaster designation for 45 of the counties, with 36 more counties' requests pending. Fifty-eight localities have received a secondary designation. Chesapeake was declared a secondary disaster area on October 22, 2002.

In November 2001, the Chesapeake City Council voted to establish voluntary water conservation for all residents. In July 2002, the Chesapeake City Council voted again to establish mandatory water conservation restrictions for the Western Branch, Northwest River, and South Norfolk waterworks systems. Chesapeake obtains most of its water from the Northwest River, but also purchases water from Portsmouth and Norfolk.

Potential Impacts

Drought can affect a community economically, socially, and environmentally. Drought can also create conditions that promote the occurrence of other natural hazards such as wildfires and wind erosion. Drought conditions can also increase the likelihood of flooding if a period of severe drought is followed by an extreme precipitation event.

Economic losses to a community from drought include agricultural production, livestock production, fisheries, water transportation, recreation, tourism, and water consumption. Additionally, Chesapeake's waterways are used as a means of transportation by commercial vessels. Under severe drought conditions, the

water levels could fall to levels that may not permit commercial vessels to pass, affecting the region's commerce.

Environmental drought impacts include both human and animal habitats, and hydrologic units. During periods of drought, the amount of available water decreases in lakes, streams, aquifers, soil, wetlands, springs, and other surface and subsurface water sources. This decrease in water availability can affect water quality such as salinity, bacteria, turbidity, as well as temperature increase and pH changes. Low water flow can result in decreased sewage flows and subsequent increases in contaminants in the water supply.

Past Regional Water Supply Problems

Water supply and drought became a political issue between Virginia and North Carolina in the 1970s. Congress had ordered the U.S. Army Corps of Engineers to study water supply issues for the rapidly growing Tidewater region. The Corps had determined, with North Carolina's permission, to use water from Lake Gaston. During the 1978 gubernatorial race, North Carolina reversed its position on Lake Gaston. Chesapeake and other Tidewater cities undertook studying water supply alternatives on their own. In 1980, Chesapeake began the Northwest River project, but in 1985, the Northwest River project encountered supply problems. In 1987, the Lake Gaston project was resolved in the courts in favor of Virginia and was revived; Chesapeake entered into a partnership agreement with Virginia Beach and Sussex County to share the Lake Gaston project. The project remained in the courts for Virginia and North Carolina throughout the property acquisition and construction phases of the project until construction on the project was completed in 1998 (Goddard Space Flight Center, 2001). The City of Chesapeake has not yet come online since the project's completion.

The City recently signed a 40-year rainwater contract with Norfolk to provide 7 to 10 million gallons of water per day. This water will be treated at the Lake Gaston Water Treatment Plant in the Western Branch area, and should provide the city with enough water to meet water demand until 2040.

The drought of 1999-2002 demonstrates the social, environmental, and economic ways in which Chesapeake was affected by the drought. As a result of the mandatory water restrictions imposed on citizens by the City Council in 2002, members of the community could not water their lawns, fill their pools, wash streets or driveways, or operate ornamental fountains. In addition, limitations were placed on the manner in which outdoor shrubs and plants could be watered

and cars could be washed. Restaurants were not allowed to serve water to patrons unless specifically requested, and fire hydrants could be used only for public health and safety.

Citizens and businesses were encouraged to make long-term changes to reduce their demand on water. Many suggestions centered on landscaping issues. The community was encouraged to replace fescue with hot-weather grasses like Bermuda or wire grass (Beizer, 2002). They were also asked to consider planting bushes and flowers native to the Chesapeake region that can adapt to hot, dry weather conditions.

Farmers suffered economic losses as they lost some crops and the physical size of what could be harvested was smaller than usual. Farmers in nearby Suffolk lost 50% of their soybeans and corn crops and 30% of peanuts and cotton (Stone and McNatt, 2002). Some 135 Chesapeake farmers were also adversely affected in late 2002 and 2003 when a period of wet weather saturated and, in some cases, flooded their fields, killing and washing away crops. The wet weather damaged soybean crops and made harvesting difficult. Farmers had difficulty planting winter crops such as wheat and rye (Beizer, 2002).

SECTION VI — CAPABILITY ANALYSIS

Form of Governance

The City of Chesapeake utilizes the council-manager form of local governance, which includes both elected officials and an appointed city manager. Chesapeake has eight council members and a mayor elected at large, which means that members represent the entire city rather than specific districts.

The City Council is Chesapeake's legislative body, setting policy, approving budgets, and setting tax rates. Members also hire the City Manager, who is responsible for the day-to-day administration of the city, and serves as the Council's chief advisor. The City Manager prepares a recommended budget, recruits and hires most of the government's staff, and carries out the council's policies. While the City Manager may recommend policy decisions, he or she is ultimately bound by the actions of the Council. The Council appoints three additional staff members — the City Attorney, City Clerk, and City’s Real Estate Assessor.

Guiding Community Documents

The City of Chesapeake has a range of guidance documents and plans for each of their departments. These include a comprehensive plan, public works and public utilities plans, capital improvement plans, and emergency management plans. The city uses building codes, zoning ordinances, subdivision ordinances, and various planning strategies to address how and where development occurs. One of the essential ways the city guides its future is through policies laid out in the Comprehensive Plan.

The Comprehensive Plan

The Comprehensive Plan for the City of Chesapeake was adopted in 1990 and is now more than a decade old. Several amendments to the 1990 document have been adopted; however, the amendments were specific to an area of the city and not citywide in scope. The city is currently revising the document, for the entire city, and is anticipating that major revisions will be made to the current document. The city has been routinely posting updates on its websites to keep the community informed of the progress and to allow access to the draft documents and analyses.

In late 2002, the city published a Visioning Report, which laid out many of the key components that will be included in the new plan. Although the majority of these community components have a de-facto ability to lessen vulnerability to natural hazards, their intent to specifically incorporate mitigation principles would be institutionalized if referenced somewhere in the plan.

The report stated that the city will adhere closely to the policies of the new Comprehensive Plan and will strive to achieve a strong level of citizen involvement in planning and government policymaking. According to the report, the city will be taking steps to foster the revitalization, preservation, and redevelopment of older neighborhoods and commercial corridors. These activities will provide an excellent opportunity for the city to incorporate mitigation techniques into the existing development.

The report also discussed undeveloped portions of the environment, calling for citywide efforts to maintain areas with rural character, natural areas, and open spaces to protect quality of life. Select portions of the waterfront areas will be preserved in a natural state, while other portions will be developed for compatible recreational and commercial activities. Additionally, the report called for the preservation and maintenance of the visual quality and ecological functions of the open space system centered on waterways and other important natural resources. Preserving open spaces, particularly around floodplain areas, will

allow the floodplains to function more naturally and reduce the potential for flooding, and should be encouraged whenever possible.

The report called for land-use strategies, such as economically stable and sustainable land-use patterns, the coordination of joint planning activities with neighboring localities in the region, and the locating of new housing so that it provides safe and convenient access to employment, shopping, recreation, and educational facilities. Each of these initiatives has a mitigation component, even though it is not specifically referenced, and provides an opportunity for creating a more disaster-resistant community.

The report called for public facilities (including new school facilities) to be located and designed with the goals and policies of the Comprehensive Plan. Adding mitigation components to the Plan could help to integrate and institutionalize standards, thereby increasing resistance to hazards and their proximity to hazardous areas. The report also stated that land uses and public facilities should be developed in conjunction with the regional transportation system in order to ensure safety, efficiency, and convenience. Although it is not specifically mentioned, this could provide an opportunity to include the consideration of evacuation capabilities in future regional development projects.

Zoning and Subdivision Ordinances

The Commonwealth of Virginia has empowered all towns, cities, and counties to adopt zoning ordinances. The City of Chesapeake's original Zoning Ordinance was adopted on September 27, 1969. This ordinance brought together the Zoning Ordinances of Norfolk County (adopted Oct 9, 1934) and the City of South Norfolk (adopted Jan 20, 1955) The City of Chesapeake is currently operating under the 1993 revision of the original ordinance (date of adoption October 21, 1993).

The City of Chesapeake also has a board of zoning appeals (BZA), which is a quasi-judicial body established under Commonwealth law to provide relief in special cases where the exact application of the terms of the ordinance would be unduly restrictive and cause a hardship. The BZA hears and decides upon the interpretation and the application of the provisions of the zoning ordinance. Although the board has certain discretionary powers in making its decisions, the board must always abide by and comply with the powers granted to it by the local zoning ordinance and the Commonwealth enabling act.

Since the adoption of the Zoning Ordinance in September 1993, numerous amendments have been drafted and processed. The City's Planning Department estimates an average of 20 text amendments annually.

Stormwater Coalition Recommendations to the Zoning Ordinance
Due to stormwater flooding problems encountered during the 1999 Hurricane Season, the City Council formed a Stormwater Coalition to address the problems and recommend possible solutions. Some of the recommendations involved changes to the Zoning Ordinance and Subdivision Ordinance, which are summarized below:

- Amend the Zoning Ordinance to exclude drainage easements from lot area calculations. As directed by the City Council, city staff is exploring alternatives to this recommendation.
- Amend the Subdivision Ordinance to increase the performance bond period from one year to five years. The City Council adopted an amendment on February 20, 2001, increasing the bond period from one year to two years.
- Amend the Chesapeake Bay Preservation Area Overlay District to eliminate reductions to the 100-foot Resource Protection Area buffer in non-agricultural areas.

Building Codes

The Commonwealth of Virginia is responsible for enacting the Virginia Uniform Statewide Building Code, which the city is responsible for enforcing locally. The Virginia Uniform Statewide Building Code is based on the 1996 National Building Code with Commonwealth amendments. In October of 2003, the Uniform Statewide Building Code is now based on the IBC, IRC, and IFPC.

The City Inspections Department is principally responsible for enforcing Commonwealth and city codes for building residential and commercial structures, enforcing environmental codes and guidelines for maintaining existing structures. The City Inspections Department received a rating of "three" recently for its building code effectiveness in residential, commercial, and industrial construction from the Insurance Services Office (ISO).

The ISO is an insurer-supported organization that provides advisory insurance underwriting and rating information to insurers. The ISO uses a rating scale of 1 to 10 with 1 to 3 being the highest rating given. The city's evaluation can be used as a basis for providing rating credits to individual property insurance

policies. The city scored better than other municipal inspections departments in the Hampton Roads region.

The City of Chesapeake has an enforced floodplain ordinance requiring that all habitable floors must be built above the 100-year floodplain and the special flood hazard areas. It is important to note, however, that many parts of the city flood due to the inadequate capacities of their stormwater infrastructure – not because of their proximity to 100-year floodplains.

The City of Chesapeake's Flood Insurance Rate Map (FIRM) is number I 1-116, which became effective May 2, 1999. The FIRMs are used by both the public and private sector to determine flood insurance requirements and rates and to administer the City's Flood Zone Management Ordinance (Chapter 26, Article IV of the City Code).

Floodplain districts identified in the FIRMs include the following flood hazard zones and definitions:

- **Zone A** is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analysis is not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
- **Zone AE** is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
- **Zone X** is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, and to areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No Base Flood Elevations or depths are shown within this zone.

Interpretations of floodplain district locations are made by the City's Zoning Officer. Disputes regarding the locations of these areas are referred to the Board of Zoning Appeals who shall make the necessary determinations. The ordinance contains provisions for public utilities and facilities, such as sewer, gas electrical and water systems, manufactured homes, recreational vehicles, and existing structures.

All potential development projects located within floodplains must follow an established development review process. Developments involving drainage ditches or watercourses in floodplains must receive U.S. Corps of Engineers, Virginia Marine Resources Commission, and Virginia State Water Control Board permits and must undergo reviews by all adjacent jurisdictions, the Department of Conservation and Recreation and the Federal Insurance Administration.

Chesapeake Bay Preservation Act

The Virginia General Assembly enacted the Chesapeake Bay Preservation Act in 1988. The Act requires local governments statewide to include water quality protection measures in their zoning and subdivision ordinances and in their comprehensive plans. The Chesapeake Bay Local Assistance Board adopted amendments to the Chesapeake Bay Preservation Area Designation and Management Regulations in 2001.

The changes to the regulations, adopted by the Board in December 2001, and effective March 2002, necessitate that localities maintain compliance with some policy changes immediately, and that localities revise local ordinances and programs to come into full compliance by December 31, 2003. The city is in the process of finalizing its ordinances.

The previous Chesapeake Bay Preservation Area (CBPA) Overlay District (Section 12-500 of the Chesapeake Zoning Ordinance; effective date: January 21, 1992) is composed of all lands identified on the map entitled "Chesapeake Bay Preservation Overlay District Map," including revisions dated September 22, 1994.

Although the Act was developed with the intent of improving water quality throughout Virginia, the regulations have the additional benefit of controlling or restricting development in floodplain areas. The CBPA Overlay District consists of a Resource Protection Area (RPA) and a Resource Management Area (RMA). The lands that make up Chesapeake Bay Preservation Areas are those that have the potential to impact floodplains and water quality most directly. Generally, there are two types of land features — those that protect and benefit water quality (RPAs) and those that, without proper management, have the potential to damage water quality (RMAs).

The Stormwater Management Program

In October 1990, the National Pollutant Discharge Elimination System (NPDES) became the Federal law for regulating stormwater runoff to reduce pollution. Shortly thereafter, Chesapeake implemented a stormwater utility to fund the required improvements to water quality, which is based on a property's amount of impervious surfaces.

The City of Chesapeake's Stormwater Management and Drainage Division continually maintains over 2,500 miles of open ditch, nearly 1,000 miles of underground pipe and 36,936 drainage structures throughout the City's drainage system. The division has a Stormwater Management Plan, which outlines design criteria and policies, city standards, and technical specifications for infrastructure development.

Mitigation Activities

In 2000, the City of Chesapeake received Hazard Mitigation Grant Program funding of $12,006 to install 138 watertight manhole inserts under the lids of sanitary sewer manholes for pump stations in several flood prone areas. This helps to prevent the overflow of untreated sewage discharges into public storm sewers, which discharge into Virginia waters during flooding conditions. The grant from the Federal Emergency Management Agency provided 75% ($9,004) of the total cost requiring the City of Chesapeake and the Commonwealth of Virginia to provide the remaining 25%.

Due to the success of this project, the city allocated $170,000 of capital improvement funds in 2002 for the installation of an additional 1,735 watertight manhole inserts in flood prone areas throughout the City Wastewater collection system. In addition, the Public Facilities Manual (PFM) was changed to include the requirement for stainless steel watertight manhole inserts to be included in all new sanitary sewer manholes constructed in the City of Chesapeake.

Following significant damages that resulted during Hurricanes Irene and Floyd in 1999, the city appointed a Stormwater Coalition to develop recommendations for addressing stormwater drainage issues, and began to implement over $2 million in projects to neighborhoods vulnerable to flooding from stormwater infrastructure. Some of these projects included infrastructure improvements, embankment repairs, cleaning, and maintenance of existing ditches, as well as stormwater runoff areas. Numerous neighborhoods have benefited from these projects including Plantation Lakes, Elmwood Landing, Washington Manor, Oakdale, and King James Colony. These improvements have significantly

reduced the frequency and severity of flooding throughout the city since 2000, and projects continue to be implemented as funding resources become available.

In January 2000, Chesapeake was selected by the Federal Emergency Management Agency (FEMA) to become a Project Impact Community. Project Impact was intended to be a catalyst to develop private/public partnerships that would bring residents, businesses, citizens, and the local government together to address hazards and risks. The program was effective in bringing the different community and regional stakeholders to the table, and was involved in numerous public education and outreach initiatives. The program was funded through a grant for $300,000, and the grant will be finished in late 2003.

One of the most well known and publicized Project Impact efforts was through their involvement with Homearama, a major builder's show event held each year in October . The city collaborated with the City of Virginia Beach Project Impact Committee to promote disaster-resistant building materials and methods into newly constructed showcase homes. Jack Jackson, a local builder, and the Tidewater Builders Association worked with the Committee to promote the City of Chesapeake's Hurricane House, which was built to withstand hurricane-force winds.

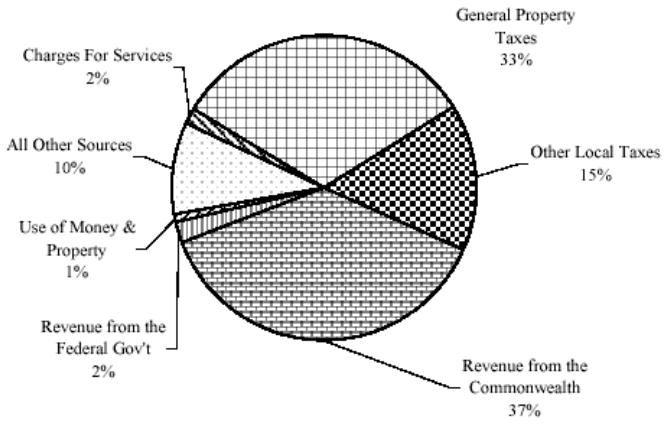
The exterior walls were constructed with formed concrete reinforced with rebar, and rated to withstand winds of 200 mph. The house featured a safe room with eight-inch concrete walls that were built to withstand 250 mph winds and a shuttered doorway to provide additional protection against flying glass and debris. Hurricane straps and extra thick glass added to the house's ability to withstand damages from high winds.

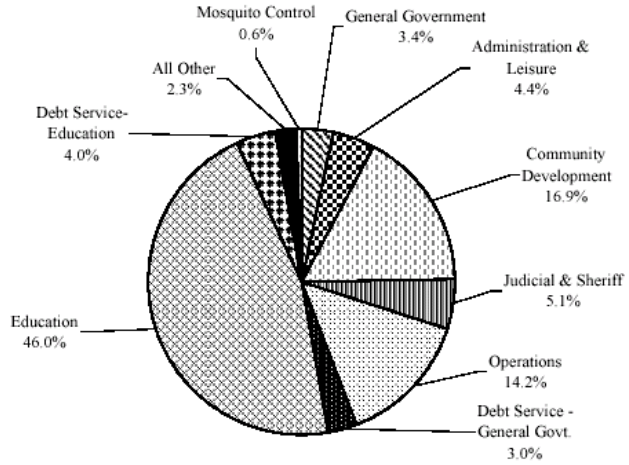
Financial Resources

The city's financial worth has steadily grown over the years. Between 1998 and 2002, general government revenue was up 29.3% and revenue from taxes was up 13.9%. The full value of assessed property has grown 25.5% since 1998. Figures recently released by Willie Rice, Real Estate Assessor, indicated the city has over 74,000 properties with a total taxable value of approximately $12.3 billion. The city issued 1,349 total occupancy permits in 2002.

The General Fund balance is an important element that can show the city's financial strengths or weaknesses. For Fiscal Year 2003-2004 (FY 03-04), the City of Chesapeake's operating budget has been set at $623,518,422. The revenue budget for the city contains more than 700 line items representing

different sources, each governed by a distinct set of conditions particular to that revenue source. The largest revenue factor and the core of the resource base that enables the city's provision of community services is the local revenue portion of Chesapeake's General Fund. The city's revenue base is determined by different community conditions such as the current population, employment and income, economic activity within the city, and the growth of invested value from residential and commercial construction, business investment in plant and equipment, and demand for local real property. National, State, and regional economic conditions can also affect the city's revenue base by creating demand for community goods and services produced within Chesapeake. The charts below are from the city's approved operating budget, which begins on July 1, 2003. The chart on the left shows the major revenue categories and percentages of the total budget the city anticipates it will receive from different funding sources. The largest revenue categories are from general property taxes (from real estate values) and the Commonwealth of Virginia. The chart on the right shows the major expenditure categories and percentages of the total budget that the city anticipates it will spend during FY 03-04. The largest expenditure categories are for education and community development.





Over the last few years, Virginia's budget has grown rapidly due to tax revenues from an economic expansion driven by the technology industry. The overall health of Virginia's economy has a significant influence on local cities and counties, as local government appropriations are usually the first to have their

appropriations diminished due to downturns in the economy. This past fiscal year experienced downturns in Virginia's economy and revenues from market corrections in asset values to the technology industry and the associated demands for services.

The city proposed to issue $66.1 million in General Obligation Bonds in 2003 for three projects:

1. $53.5 million for Public Utilities, to be funded by approved rate increases.
2. $10.5 million for Cedar Road Project, Phases IV and V — to be funded with designated revenue (Cigarette Tax),
3. $2.1 million for the Deep Creek Fire Station, to be funded by the city's operating budget.

The city's major economic drivers for its revenue base are from population growth, employment, construction, property values, and commercial activities. According to the City Manager's FY 03-04 Economic Outlook, Chesapeake will begin to see a deceleration of population growth and construction over the next seven years. Although the City Manager is anticipating more infill and commercial development, he believes that the nationwide trends of slower revenue growth and maturation of service demands, unmet infrastructure needs, and maintenance costs often seen in older communities will begin to affect Chesapeake.

The city has published a list of long-term financial and programmatic policies that are to be achieved over the next few years. Policies that demonstrate the city's dedication to protecting the life and property of city residents and businesses include:

- Continue development of the stormwater management system and continue qualitative drainage measures.
- Provide support in public safety to maintain current response time and professionalism, to limit injury, loss of life, and property.

Overall, the City of Chesapeake has indirectly referenced mitigation and hazard reduction principles throughout many of the city's aforementioned documents, plans, and policies. Integrating more direct language referencing mitigation and hazard reduction will help to reinforce the city's commitment to these principles. The indirect references can also indicate that the responsibility for hazard reduction is shared among numerous departments within the city, making it a challenge to identify a particular department to take the lead in these efforts. To address this potential issue and increase community capabilities globally, the

establishment of a formalized Mitigation Advisory Committee is recommended. The Committee should receive official recognition as a working group as soon as it is feasible to begin sharing the responsibilities required to implement the city's mitigation program.

SECTION VII — MITIGATION STRATEGY

The Mitigation Advisory Committee attended a workshop to discuss the results of the hazard identification and risk assessments, review mitigation goals and alternatives based on the priority areas and hazard types, discuss community strengths and weaknesses, and begin developing the mitigation strategy.

General Observations — Strengths

- The City of Chesapeake has several policies that have hazard mitigation elements or effects such as development and building code regulations, the floodplain ordinance, Chesapeake Bay Preservation Areas, and other zoning ordinances, and an active stormwater management program. Building code regulations, such as the freeboard and other statewide building codes and local enforcement, have helped to ensure that new development is built to accepted safety standards for development overall.
- Much of the language used for flood hazard mitigation is already present in the city's existing and draft comprehensive plans. These concepts involve floodplain management and the preservation of open space and natural areas.
- Over the next few years, Chesapeake will continue to have opportunities to experience new development within the community built to the most recent codes and standards.
- The city has been recognized for exemplary financial management practices, notable public and private housing developments, and proactive building codes and enforcement procedures. The city has an impressive degree of inter-governmental coordination between the various departments and agencies, which help the community function efficiently and effectively.
- The city had a highly successful Project Impact program that was very active in promoting the concepts of disaster resistance and preparedness.

General Observations — Weaknesses

- While the city enforces its floodplain ordinance, the current ordinance is out of date and has needed to be revised for several years. The ordinance is consistent with the statewide building code that mandates that structures located within the 100-year floodplain be elevated above the Base Flood Elevation. The city could offer an even greater degree of protection if it adopted a one-foot freeboard.
- Much of the older development lies in the most potentially hazardous areas along the major water bodies. Some of these areas are occupied by heavy industrial facilities that use potentially hazardous materials.
- Evacuation remains an issue, particularly as the city and surrounding localities and North Carolina communities continue to grow in population. The city must remain vigilant in coordinating with North Carolina and Virginia, as well as regional and local communities.

During the presentation of findings for the hazard identification and risk assessment workshop, the Mitigation Advisory Committee was asked to provide their preliminary input and ideas. Ranges of alternatives were then considered by the Mitigation Advisory Committee based on their comments and suggestions. The Mitigation Advisory Committee was asked to rank the alternatives using the STAPLE/E process. The STAPLE/E criteria and alternatives considered by the Mitigation Advisory Committee have been included following the preliminary comments below:

- *Top priorities for the city were public safety, public education, and reducing potential economic impacts of disasters.*
- *Alternatives should consider the impacts on the community as a whole.*
- *Alternatives must not conflict with other city programs.*
- *Community Rating System (CRS) and floodplain management policies and activities should be a priority.*
- *Experiences from disasters should be built upon.*
- *The success of past mitigation projects (from the Department of Public Works) should be used as a base for alternatives.*
- *Outreach and other efforts should be attempted to FEMA's Repetitive Loss Properties.*
- *The Project Impact program was an effective public outreach tool and should be built upon.*
- *Recent disasters have been less damaging to structures but more significant in terms of lost road access, time, and inconvenience.*

PRIORITIZING ALTERNATIVES

The Mitigation Advisory Committee used the STAPLE/E Criteria (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) to select and prioritize the most appropriate mitigation alternatives for the City of Chesapeake. This methodology requires that the social, technical, administrative, political, legal, economic, and environmental considerations be taken into account when reviewing potential actions for the city to undertake. This process was used to help ensure that the most equitable and feasible actions would be undertaken based on Chesapeake's capabilities. Table 28 below provides information regarding the review and selection criteria for alternatives.

SOCIAL
• Is the proposed action socially acceptable to the community? • Are there equity issues involved that would mean that one segment of the community are treated unfairly? • Will the action cause social disruption?
TECHNICAL
• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of other community goals?
ADMINISTRATIVE
• Can the community implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
POLITICAL
• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
LEGAL
• Is the community authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? • Are there legal side effects? Could the activity be construed as a taking? • Is the proposed action allowed by the comprehensive plan, or must the comprehensive plan be amended to allow the proposed action? • Will the community be liable for action or lack of action? • Will the activity be challenged?
ECONOMIC
• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account? • Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the community? • What burden will this action place on the tax base or local economy? • What are the budget and revenue effects of this activity?

- Does the action contribute to other community goals, such as capital improvements or economic development?
- What benefits will the action provide?

ENVIRONMENTAL

- How will the action affect the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?

Are endangered or threatened species likely to be affected?

During the presentation of findings meeting on April 7, 2003, the Mitigation Advisory Committee (MAC) reviewed and commented on the city's previous Hazard Vulnerability Assessment (HVA). Discussions held during the meeting resulted in the generation of a range of potential mitigation goals and actions to address the hazards (the master grouping of alternatives the MAC chose from is included in the next section). These actions were then compiled into a master list for the MAC to rank the goals on a scale of 1 to 6 and the actions on a scale of 1 to 10. Ranking was done in order of relative priority based on the STAPLE/ E criteria and the potential goal/ action's ability to reduce vulnerability to natural hazards.

POTENTIAL ALTERNATIVES CONSIDERED BY THE MITIGATION ADVISORY COMMITTEE

General Multi-Hazard Mitigation Alternatives

The mitigation alternatives selected should be linked to the city's goals and objectives, and must address the city's hazard risks and vulnerability outlined in the plan's Hazard Identification and Risk Assessment and the city's original Hazard Vulnerability Assessment. The following is a list of potential mitigation measures not specific to one hazard, which can benefit a community's overall hazard reduction efforts.

Comprehensive Plans

Comprehensive plans address how and where a community should grow by guiding the rate, intensity, form, and quality of physical development. These plans address land use, economic development, transportation, recreation, environmental protection, the provision of infrastructure, and other municipal functions. Comprehensive plans help to guide other local measures such as capital improvement programs, zoning ordinances, subdivision ordinances and other community policies and programs. By integrating hazard considerations

into the city's plan, mitigation would become integrated with other community functions and could therefore be an institutionalized part of the city's planning.

Density and development patterns should reflect the city's ability to protect the community, the environment, and the ability to evacuate the area. Development management tools should be incorporated into the city's policies that address the location, density, and use of land, with a particular emphasis on development within high-risk areas. Efforts should be made to keep people and property out of high-hazard areas whenever possible. Particularly hazardous areas could be used for recreational uses, open space, or wildlife refuges.

Capital Budget Plans

Capital budget plans typically provide for the future and ongoing provision of public facilities and infrastructure. These plans can be vital tools in keeping new development out of high-hazard areas by limiting the availability of public infrastructure.

Public facilities can often be relocated to less hazardous areas in the aftermath of a disaster. Public utilities can also be relocated, or they can be upgraded or floodproofed. Power and telephone lines can be buried underground. In order to maximize the gravity flow area of wastewater treatment plants, the facilities are often located at the lowest elevation in the community. If this point lies within a floodplain, consideration may be given to relocating or floodproofing such facilities.

New locations for critical facilities should not be in hazard-prone areas, or in areas where their function may be impaired by a given hazard event (i.e., where water can flood the access roads). Critical facilities should be designed and/or retrofitted in order to remain functional and safe before, during, and after a hazard event.

Zoning

Zoning is by far the most common land-use control technique used by local governments. While a useful tool for regulating and restricting undesirable land uses, zoning has a somewhat more limited benefit when it comes to mitigation. Zoning is most effective on new development rather than existing development, which does little to address the pre-existing development in hazardous areas. Communities with a large amount of undeveloped land will benefit much more than older, more established communities. Even for new development, the

issuance of variances, special use permits, rezoning, and the failure to enforce existing codes, however, will weaken zoning's ability to prevent certain types of building practices.

Building Codes

Building codes regulate the design, construction, and maintenance of construction within most communities. These regulations prescribe standards and requirements for occupancy, maintenance, operation, construction, use, and appearance of buildings. Building codes are an effective way to ensure than new and extensive re-development projects are built to resist natural hazards. In Virginia, communities are required by law to adopt and enforce the Virginia Uniform Statewide Building Code, which has provisions for wind, water, and seismicity.

Public Outreach and Education Programs

Educating the public about what actions they can take to protect themselves and their property from the effects of natural hazards can be an effective means for reducing losses. These types of programs could target public officials, citizens, businesses, or the local construction trade. The program could cover preparedness, recovery, mitigation, and general hazard awareness information. The information could be presented in a variety of ways, from workshops, brochures, advertisements, or local media. Potential outreach and education topics include:

- Code Awareness Training
- Sheltering and Evacuation
- Flood Insurance
- School Information (Primary, Secondary, Colleges, and Universities)
- New Homeowner/Resident Information
- Emergency Preparedness for Families, Businesses, and Tourists
- Driver Safety in Disasters
- Special Needs Outreach
- Hazard Mitigation for Homeowners (Including Manufactured Homes and Trailers), Renters, and Businesses

Vegetative Maintenance

Vegetative maintenance is the pruning and maintenance of trees, bushes, and other vegetation that could increases threats to power lines during storms, or could act as fuels during wildfires. This could be applied in limited areas that have a significant vulnerability to these hazards, such as an easement or along the urban-wildland interface.

Vegetative Planting and Treatment

Vegetative planting and treatments can help to capture and filter runoff and can reduce landslides. Perennial vegetation includes grass, trees, and shrubs, which cover the soil, reduce water pollution, slow the rate of runoff, increase filtration, and prevent erosion. This type of land treatment includes maintaining trees, shrubberies, and the vegetative cover, terracing (a raised bank of earth with vertical sloping sides and a flat top to reduce surface runoff) , stabilizing slopes, grass filter strips, contour plowing, and strip farming (the growing of crops in rows along a contour). Other potential options include vegetated swales, infiltration ditches, and permeable paving blocks.

Hazard-Specific Alternatives

The following is a list of potential mitigation measures that tend to work better when applied to a specific hazard.

Flood

Flood mitigation measures can be classified as structural or non-structural. In simple terms, structural mitigation attempts to eliminate the possibility of flooding at a particular location. Non-structural mitigation removes the potentially effected people or property from the potentially flooded area. The following is a list of potential mitigation measures.

Floodplain Management Ordinances

Floodplain management ordinances are weakened by development pressures, a lack of suitable sites outside of the floodplain, community desires to be near the water, inability to effectively monitor floodplain management activities, or by land-use planning policies that are encouraging development into floodplain areas. Plans or policies that place more properties at risk are also reducing the storage capacity and functions of the natural floodplains. Degradation of the floodplain in this way increases flood depths and affects the reliability of Flood Insurance Rate Maps. Structures built in floodplains, particularly those that do not utilize a freeboard (that exceeds the minimum Base Flood Elevation), are consequently even more vulnerable to damage by floods.

Acquisition

Acquisition involves the purchasing of a property that is cleared and permanently held as open space. Acquisition permanently moves people and property out of harm's way, increases floodplain capacities, recreation areas and open space, and can help to preserve wetlands, forests, estuaries and other natural habitats. Participation in federally funded grant programs requires voluntary participation by the owner. Acquisition programs can be expensive to undertake, and the property will no longer accrue taxes for the community and must be maintained, but it is by far the most effective and permanent mitigation technique. Acquisition is most effective when targeting repetitive loss structures, extremely vulnerable structures, or other high-hazard areas.

Elevation

Elevation is the raising of a structure above the Base Flood Elevation. Elevation is often the best alternative for structures that must be built or remain in flood prone areas, and is less costly than acquisition or relocation. However, elevating a structure can increase its vulnerability to high winds and earthquakes. Some building types are either unsuitable or cost-prohibitive to elevate.

Relocation

Relocation involves the moving of a building or facility to a less hazardous area, on either the same parcel or another parcel. This measure also moves people and property out of harm's way, and is a very effective measure overall. Some building types are either unsuitable or cost-prohibitive to relocate.

Stormwater Management Plans

New development that increases the amount of impervious surfaces affects the land's ability to absorb the water and can intensify the volume of peak flow runoff. Without efficient stormwater management, runoff could cause flooding, erosion, and water quality problems. Stormwater management plans should incorporate both structural and nonstructural measures in order to be most effective. Structural measures include retention and detention facilities that minimize the increase of runoff due to impervious surfaces and new development. Retention facilities allow stormwater to seep into the groundwater. Detention systems accumulate water during peak runoff periods that will be released at off-peak times. Nonstructural measures include establishing impervious surface limit policies and maintenance programs for existing drainage systems.

Dry Floodproofing

Dry floodproofing involves making all areas below the flood protection level watertight by strengthening walls, sealing openings, using waterproof compounds, or applying plastic sheeting on the walls. This method is not recommended for residential structures, but may work well for new construction, retrofitting, or repairing a non-residential structure. Due to pressure exerted on walls and floors by floodwater, dry floodproofing is effective on depths less than 2 to 3 feet above the foundation.

Wet Floodproofing

Opposite of dry floodproofing, wet floodproofing lets the floodwater actually enter a structure. This technique is effective on deeper flood depths, as it does not have the same potential to build up exterior pressure. This method may not be used for basements under new construction, substantial improvements, or substantially damaged structures.

Storm Drainage Systems

Mitigation efforts include the installation, re-routing, or increasing the capacity of storm drainage systems. Examples include the separation of storm and sanitary sewers, addition or increase in size of drainage or retention ponds, drainage easements, or creeks and streams.

Drainage Easements

Easements can be granted enabling regulated public use of privately owned land for temporary water retention and drainage areas.

Structural Flood Control Measures

Water can be channeled away from people and property with structural control measures such as levees, dams, or floodwalls. These measures may also increase drainage and absorption capacities. These structural control measures may also increase Base Flood Elevations and could create a false sense of security.

Basement Backflow Prevention

Chesapeake communities should encourage the use of check valves, sump pumps, and backflow prevention devices in homes and buildings if the infrastructure allows.

Wind

Proper engineering and design of a structure can increase a structure's ability to withstand the lateral and uplift forces of wind. Building techniques that provide a continuous load path from the roof of the structure to the foundation are generally recommended.

Windproofing

Windproofing is the modification of the design and construction of a building to resist damages from wind events, and can help to protect the building's occupants from broken glass and debris. Windproofing involves the consideration of aerodynamics, materials, and the use of external features such as storm shutters. These modifications could be integrated into the design and construction of a new structure or applied to reinforce an existing structure. Manufactured homes, which tend to be vulnerable to the effects of extreme wind events, can be protected by anchoring the structures to their foundations. Mobile homes could be tied down to their pads in order to prevent them from being destroyed. Public facilities, critical infrastructure, and public infrastructure (such as signage and traffic signals) should all be windproofed in vulnerable areas. However, windproofing is not a viable mitigation technique to protect against tornadoes.

Community Shelters/Safe Rooms

Community shelters and concrete safe rooms can offer protection and reduce the risk to life. Locations for these shelters or safe rooms are usually in concrete buildings such as shopping malls or schools. Communities lacking basements and other protection nearby should consider developing tornado shelters.

Burying Power Lines

Buried power lines can offer uninterrupted power during and after severe wind events and storms. Burying power lines can significantly enhance a community's ability to recover in the aftermath of a disaster. Buried power lines are typically

more expensive to maintain and are more vulnerable to flooding. Encouraging back-up power resources in areas where burial is not feasible will enable the continuity of basic operations (e.g., security, refrigeration, heat, etc.) for businesses and facilities when there is a loss of power.

Infrastructure Hardening

Structures identified as critical can be hardened (strengthened) to meet design guidelines for hurricanes and potentially reduce the risk of significant damage or injury.

GOALS AND IMPLEMENTATION

Through a series of follow-up evaluation and ranking worksheets and a teleconference, the following strategy for the City of Chesapeake has been developed by the Mitigation Advisory Committee.

Overarching Community Goal

"To develop and maintain a disaster resistant community that is less vulnerable to the economic and physical devastation associated with natural hazard events."

This overarching goal is intended to represent the vision of Chesapeake's future as it relates to natural hazards, safety, and economic prosperity. Community officials should consider the vision and goals that follow before making community policies, public investment programs, economic development programs, or community development decisions for the city. Following each Goal Statement is a future oriented vision in italics of what the city will look like when these goals are accomplished.

Goals and Implementation

GOAL 1

Enhance the safety of residents and businesses by protecting new and existing development from the effects of hazards.

The City of Chesapeake recognizes that a safe and economically sustainable community must protect the life and property of citizens, businesses, and the day-to-day functions of the city itself. As resources have allowed, the city has undertaken a series of preliminary studies to evaluate manufactured homes, trailers, and other residential and commercial properties at-risk from wind and flood hazards. Repetitive loss properties have been targeted for mitigation studies and efforts, as they are also extremely vulnerable to the impacts of hazard events. Table 29 provides information on residential and commercial mitigation strategies, implementation of those strategies, and timeframes for implementation.

TABLE 29 — MITIGATION STRATEGIES AND IMPLEMENTATION FOR RESIDENTS AND BUSINESSES

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Investigate all manufactured homes and trailers citywide to evaluate their resistance to wind and flood hazards.	Inspections works with the Natural Event Mitigation Advisory Committee to identify properties and obtain grant funds for a study. Included in this analysis will be an assessment of the most cost-beneficial mitigation alternatives for the at-risk properties.	X		
	In order to finance this initiative, the (City) NEMAC submits a Pre-Disaster Mitigation Grant Application to the Virginia Department of Emergency Management.	X		
Target FEMA's Repetitive Loss Properties throughout the city for potential mitigation projects.	The Natural Event Mitigation Advisory Committee, Planning Department and Emergency Management will develop a potential mitigation project list for targeting FEMA's Repetitive Loss Properties		X	X
	In order to finance this initiative, the NEMAC submits a Pre-Disaster Mitigation Grant Application to the Virginia Department of Emergency Management.		X	
Distribute 100 NOAA weather radios to residents that are most vulnerable to wind events for free.	Emergency Management will identify and distribute radios to residents	X		

Goal 2

Protect new and existing public and private infrastructure and facilities from the effects of hazards.

The city has improved its ability to respond, recover, and provide continuity of services in the aftermath of a hazardous event. Public facilities and critical facilities continue to be evaluated for their ability to withstand a variety of hazards and are retrofitted as resources have become available. Additionally, signs, hydrants, and other forms of public property are retrofitted as resources allow. The city has also initiated dialogue with the private utility companies and are working together to create private inspection and maintenance programs and to develop the most practical and safe ways to lay, repair, and maintain infrastructure throughout the city. Table 30 provides information on infrastructure-related mitigation strategies, implementation of those strategies, and timeframes for implementation.

TABLE 30 — INFRASTRUCTURE MITIGATION STRATEGIES AND IMPLEMENTATION

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Investigate all primary and secondary schools to evaluate their resistance to wind and flood hazards.	The School Board and the Virginia Center for School Safety works with the Natural Event Mitigation Advisory Committee to undertake this study.	X		
	In order to finance this initiative, the NEMAC submits a Pre-Disaster Mitigation Grant Application to the Virginia Department of Emergency Management, or to the Department of Education for the Department of Homeland Security School Preparedness Grants.	X	X	
Replace glass in public safety building with impact resistive glass.	Study already completed by facilities management. Emergency Management and Fire Department apply for Pre disaster mitigation funds	X	X	
Investigate all critical community facilities to evaluate their resistance to wind and flood hazards.	Facilities Management and Emergency Management works with the Natural Event Mitigation Advisory Committee to undertake a future study.	X		X
	In order to finance this initiative, the NEMAC submits a Pre-Disaster Mitigation Grant Application to the Virginia Department of Emergency Management.	X		
Label all public hydrants in the city to assist in street identification in the event of wide spread destruction.	Fire Department and Public Utilities identify funding opportunities. Seek funding for this initiative through Homeland Security grants	X		
Develop a sign retrofitting or new sign program to decrease their vulnerability to wind hazards.	To reduce costs, Public Works begins to implement upgraded signs while performing periodic maintenance. In the post-disaster environment, all damaged or destroyed signs are replaced with the upgraded design.	X		X

TABLE 30 — INFRASTRUCTURE MITIGATION STRATEGIES AND IMPLEMENTATION

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Initiate discussions with private utility companies to discuss incorporating mitigation measures into new and pre-existing development and repairs for infrastructure.	Public Utilities and Emergency Management works with the Natural Event Mitigation Advisory Committee and the Chamber of Commerce to begin dialogue with private utility companies about incorporating mitigation as infrastructure is laid, maintained, or repaired.	X	X	X
Strengthen and enforce inspection and maintenance programs for private infrastructure facilities.	Virginia State Building Code Administrative Office, Economic Development, and Inspections form a task force to develop a set of "best practices" and evaluate potential "reward" programs for compliance.	X	X	X
Adjust the timing, location, and design of public infrastructure (e.g., water, sewer, roads) to limit damage from hazards.	Public Facilities and Emergency Management works with the Natural Event Mitigation Advisory Committee to review best practices alternatives in vulnerable areas.	X	X	X
Hazard-proof new community facilities to minimize damages.	Facilities Management and Emergency Management works with the Natural Event Mitigation Advisory Committee to discuss mitigation alternatives to incorporate into all new public facilities.	X	X	
	Additionally, the team works together to develop a strategy to ensure that mitigation measures will be incorporated into all public facilities and infrastructure that must be repaired or replaced following a disaster.		X	X
Install dry hydrants at Indian Creek Rd and Centerville Turnpike, 3900 Block of Ballahack Rd, Route 17 and Douglas Rd, and Northwest River Park.	Fire Department Continues program and partnership through Department of Forestry to obtain the hydrants through a Virginia Department of Forestry (DOF) grant.	X	X	
Reduce flooding at Fire Station 2 (Freeman and Bainbridge) and the surrounding community.	Public Works provides an additional 36" pipe from Godwin Ave across Bainbridge Blvd. Install a 42" pipe from 2nd St and Villanova to the west end of Rutgers Ave. Add additional basins and pipe along Rutgers Ave from 2nd Street to 4th Street	X		

TABLE 30 — INFRASTRUCTURE MITIGATION STRATEGIES AND IMPLEMENTATION

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Conduct a study to evaluate moving Station 8 (Deep Creek) out of the 100-year floodplain.	The Fire Department conducts analyses in conjunction with NFPA 1710 evaluations.	X		
Support Public Works initiatives to improve stormwater infrastructure as part of the required Phase III improvements.	The NEMAC in conjunction with Public Works seeks alternative funds for Phase III implementation of infrastructure improvements in Deep Creek, Portlock, Elmwood Landing, etc.	X	X	

Goal 3

Increase the city's floodplain management activities and participation in the National Flood Insurance Program.

The City is incorporating a range of techniques to reduce exposure and increase awareness to protect the city from flood hazards. Additionally, the city has updated and adopted their amended floodplain ordinance. High-risk properties such as FEMA's Repetitive Loss Properties are routinely targeted for outreach and education opportunities and the property owners are aware of potential mitigation options that are available to reduce future damages from flooding. The city is participating in the Community Rating System, which is providing discounts on annual insurance premiums to citizens and businesses throughout the community. To assist the city in their efforts and to ensure local consistency with statewide goals and initiatives, the Virginia Department of Emergency Management, and the Virginia Department of Conservation and Recreation's Floodplain Program representatives have been working with the city to evaluate other opportunities and best practices for floodplain management, training, and mitigation funding opportunities. Table 31 provides information on floodplain management strategies, implementation of those strategies, and timeframes for implementation.

TABLE 31 — FLOODPLAIN MANAGEMENT STRATEGIES AND IMPLEMENTATION

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Update the city's Floodplain Ordinance.	The NEMAC in conjunction with The Department of Inspections evaluates and makes recommendations concerning the Floodplain Ordinance.	X		
Evaluate the Floodplain manager's roles and responsibilities.	The NEMAC evaluates and comes to consensus on the identification of responsibilities and duties of the person to be designated as the Floodplain manager. This recommendation is forwarded to the City Manager's Office.	X		
Target FEMA's Repetitive Loss Properties for educational outreach and mitigation activities.	The Natural Event Mitigation Advisory Committee and Public Communications works with the State Floodplain Program Planner at the Department of Conservation and Recreation to develop outreach activities. including brochures, flood proofing options, and available grant monies for relocation.	X	X	X
	The Natural Event Mitigation Advisory Committee requests grant assistance to fund this initiative from both the Department of Conservation and Recreation and the Virginia Department of Emergency Management.		X	
Increase education opportunities for city employees, NEMAC representatives, and public officials on floodplains, floodplain management, floodplain regulations, and enforcement.	The Natural Event Mitigation Advisory Committee and Public Communications works with the State Floodplain Program Planner at the Department of Conservation and Recreation to develop outreach activities.	X	X	
	The NEMAC obtains and makes available annual schedules of "free" classes for city employees and public officials at the Virginia Department of Emergency Management (VDEM) and the National Emergency Management Institute (EMI) related to floodplain management.	X	X	

TABLE 31 — FLOODPLAIN MANAGEMENT STRATEGIES AND IMPLEMENTATION

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Evaluate the potential costs versus benefits of implementing a freeboard requirement for all new and substantially improved or damaged structures in the 100-year floodplain.	Department of Inspections works with the State National Floodplain Program Coordinator at the Department of Conservation and Recreation to evaluate costs and benefits of a freeboard ordinance.	X	X	
Submit an application for participation in the NFIP's Community Rating System (CRS) program that can offer up to 45% flood insurance premium discounts to residents and businesses in the city.	The Community Rating System Task Force, the NEMAC, the planning and inspections department, as well as the Floodplain Manager works with the State Floodplain Program Planner at the Department of Conservation and Recreation to submit a CRS application.	X		
Coordinate with other hazard mitigation efforts of State (Virginia Department of Emergency Management, Department of Conservation and Recreation, and Department of Environmental Quality) and local governments.	The Natural Event Mitigation Advisory Committee meets annually with the Virginia Department of Emergency Management to discuss statewide hazard mitigation initiatives.	X	X	X

Goal 4

Ensure hazard awareness and risk reduction principles are institutionalized into the city's daily activities, processes, and functions by incorporating it into policy documents and initiatives.

Chesapeake's hazard reduction program prospers because of the city's willingness to work together as a team to share the responsibility and workload that has resulted from these additional tasks and initiatives. The City Council has demonstrated their commitment to this effort by recognizing the Natural Event Mitigation Advisory Committee as an official working group and requiring annual updates and periodic status reports from the Committee. The concepts of the natural benefits of floodplains, watershed areas, and open spaces have been tied into existing statewide and local programs. Additionally, a special recovery task force has been created which works with city departments and agencies to ensure that mitigation principles will be considered in the aftermath of a disaster and to ensure that mitigation principles will be incorporated within their respective emergency management and recovery plans and policies. The city's numerous successes and ongoing efforts will be promoted and publicized at the Commonwealth, regional, and local levels. Table 32 provides information on potential strategies to institutionalize mitigation in the city, implementation of those strategies, and timeframes for implementation.

TABLE 32 —STRATEGIES AND IMPLEMENTATION TO INSTITUTIONALIZE MITIGATION

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Work with the Department of Public Works to identify locations and identify potential mitigation measures to protect flood-prone structures.	Department of Public Works and the Natural Event Mitigation Advisory Committee undertake a future study to evaluate flooding issues.	X		
	In order to finance this initiative, the NEMAC submits a Pre-Disaster Mitigation Grant Application to the Virginia Department of Emergency Management.	X		
Develop a public education program or tie into pre-existing State programs that will help to reduce illegal dumping and environmentally unfriendly practices that may adversely affect the watershed.	The Natural Event Mitigation Advisory Committee works with local environmental groups (such as the Save the Bay or Elizabeth River Foundation, the Chesapeake Bay Foundation) and the Virginia Department of Conservation and Recreation's Floodplain Program Coordinator to develop projects that incorporate and promote these concepts.	X		
Obtain official recognition of the Natural Event Mitigation Advisory Committee by the city in order to help institutionalize and develop an ongoing mitigation program.	City Council appoints the Natural Event Mitigation Advisory Committee as an official working group. At a minimum, representatives from departments that have roles in emergency management, recovery, the environment and regulatory or development functions should be included.	X		
The Natural Event Mitigation Advisory Committee works with city departments and agencies to ensure that mitigation principles will be incorporated within their respective emergency management and recovery plans.	Emergency Management and the Natural Event Mitigation Advisory Committee request assistance from the Virginia Department of Housing and Community Development Disaster Recovery Task Force to evaluate capabilities and resources.	X		
	Emergency Management works with the Natural Event Mitigation Advisory Committee, and the Virginia Department of Emergency Management to discuss both pre- and post-disaster mitigation and recovery issues.	X		

TABLE 32 —STRATEGIES AND IMPLEMENTATION TO INSTITUTIONALIZE MITIGATION

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Develop recommendations for revenue sources for mitigation, planning, and projects.	The Natural Event Mitigation Advisory Committee submits recommendations annually to City Council regarding the status of current mitigation projects and the plan, programmatic problems, and an inventory of new potential mitigation projects and unmet needs. As the economy begins to improve, the City Council begins evaluating internal funding resources.	X	X	
	The Natural Event Mitigation Advisory Committee aggressively pursues and seeks out public and private grants to support mitigation activities. These include resources that cover multiple objectives, such as environmental grants, preparedness grants, sustainability grants, blight reduction grants, etc. and is prepared to pursue special appropriations and grants that are available in the aftermath of a disaster.	X	X	X
Reduce hazard impacts using methods that also achieve the preservation of natural areas, water quality, and open space.	Virginia Cooperative Extension works with the Natural Event Mitigation Advisory Committee to discuss inter-linkages and outreach with agriculture, hazards, and natural resources.	X	X	
Establish a program to publicize and celebrate successes that ties into the city's promotion of being the FBI's Safest City, Mitigation Program, and former Project Impact initiatives.	The Natural Event Mitigation Advisory Committee works with the Public Communications Department and Police Department to discuss ideas and develop publicity materials that include natural hazard considerations.		X	
	The city works with the Hampton Roads Planning District Commission and the Virginia Department of Emergency Management to distribute news releases summarizing recent successes and ongoing disaster-reduction activities.		X	

Goal 5

Enhance community-wide understanding and awareness of community hazards.

As a result of the City of Chesapeake's consistent and holistic outreach efforts, citizens, businesses, visitors, local officials, and other stakeholders are more aware of potential community hazards and vulnerable locations. Stakeholders seeking information about hazards and hazard-reduction techniques are able to easily find resources to help them. Additionally, the city is collaborating with the Tidewater Builders Association (TBA) to develop a series of mitigation workshops and post-disaster media campaigns. Table 33 provides information on potential strategies to enhance the community's awareness and understanding of hazards, implementation of those strategies, and possible timeframes for implementation.

TABLE 33 —STRATEGIES AND IMPLEMENTATION TO ENHANCE THE COMMUNITY'S HAZARD UNDERSTANDING AND AWARENESS

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Increase outreach and educational opportunities to residents, businesses, tourists, and city officials about hazards.	The Natural Event Mitigation Advisory Committee coordinates with the Public Communications Department to develop awareness and prevention brochures for new residents, and evacuation information. The Committee also works with Public Communications to air seasonal weather awareness shorts on WCTV-48 and for the local hotel cable network.	X	X	
Develop a series of seasonal mitigation workshops with the Tidewater Builders Association (TBA), which focuses on homeowners and contractors.	Department of Inspections and the Natural Event Mitigation Advisory Committee work with the Tidewater Builders Association to develop and sponsor / assist with periodic workshops. Homeowners would be taught topics including relatively inexpensive or simple mitigation techniques, while contractors and tradesmen would be taught about the latest hazard resistant techniques, materials, and other more advanced concepts.	X	X	X

TABLE 33 —STRATEGIES AND IMPLEMENTATION TO ENHANCE THE COMMUNITY'S HAZARD UNDERSTANDING AND AWARENESS

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Develop a series of seasonal mitigation workshops with the Tidewater Builders Association (TBA), which focuses on homeowners and contractors. (Continued)	In a post-disaster environment, the Tidewater Builders Association supports the city's rebuilding efforts by working with the media to discuss how to find legitimate contractors that can assist homeowners and businesses with their recovery efforts and recovery and reconstruction techniques.			X
Identify and target an outreach program to industrial facilities (particularly hazardous facilities) to discuss hazards and mitigation alternatives.	The Natural Event Mitigation Advisory Committee, Local Emergency Planning Committee (LEPC) and Public Communications works with the State Floodplain Program Planner at the Department of Conservation and Recreation to develop outreach activities.		X	
Partner with Parent Teacher Associations and local schools to develop an annual children's and teacher's educational program which focuses on teaching children and adults about hazard seasons, effects, and mitigation opportunities.	The School Board and the Virginia Center for School Safety works with the Natural Event Mitigation Advisory Committee to research and implement a local program.		X	
Partner with adjacent communities and the Hampton Roads Planning District Commission to develop and promote seasonal educational materials and programs regarding the risks of hazards and various methods of hazard mitigation (e.g., websites, pamphlets, lectures, radio and television ads, billboards, newspapers).	The Natural Event Mitigation Advisory Committee, Emergency Management, and Public Communications works with the local emergency coordinators and Hampton Roads Planning District Commission to supplement the region's pre-existing outreach program.	X	X	X

Goal 6

Publicize mitigation activities to reduce the city's vulnerability to hazards.

As a result of the consistent and holistic outreach efforts, citizens, businesses, visitors, local officials, and other stakeholders are more aware of potential community hazards and vulnerable locations.

The City of Chesapeake is effectively utilizing their hazard information centers as one of the many methods of public outreach. Additionally, the city has successfully collaborated with the Department of Economic Development to create and distribute outreach materials aimed specifically at the business community. Table 34 provides

information on outreach and education strategies, implementation of those strategies, and timeframes for implementation.

TABLE 34 —OUTREACH AND EDUCATION STRATEGIES AND IMPLEMENTATION

STRATEGY	IMPLEMENTATION	2003-2005	2005-2008	Post-Disaster
Work with the Department of Economic Development and NEMAC to develop materials for businesses on general preparedness and mitigation alternatives.	Department of Economic Development and the Small Business Development Center of Hampton Roads work with the Natural Event Mitigation Advisory Committee to develop outreach materials.	X		
Develop "hazard information centers" on the city's web site and public libraries where individuals can find hazard and mitigation information.	Department of Information Technology and the Natural Event Mitigation Advisory Committee to work together to develop hazard information centers in both electronic and printed formats. In order to finance this initiative, the NEMAC submits a Pre-Disaster Mitigation Grant Application to the Virginia Department of Emergency Management.	X		

Prioritized Project List

The above mitigation actions can be divided into two broad categories in order of priority. The first are projects that institutionalize mitigation principles and thinking within the city organization. Although these are not traditional "bricks and mortar"-type projects, these projects will help to establish the sound foundation for a mitigation program to be institutionalized within the City of Chesapeake. The following priorities have been ranked in the order in which they are intended to be implemented. It is important to note, however, that this list is flexible and will need to be periodically adjusted based on current conditions and funding availability.

- Formal recognition of the NEMAC.
- Complete, update and adopt the amended Floodplain Ordinance.
- Discussion of designation of individual to be designated as the Floodplain Manager. NEMAC will make recommendations to the City Manager.

- Initiate discussions with public utility companies about incorporating mitigation as infrastructure is laid, maintained, or repaired. Will invite utilities to make a presentation to the NEMAC to begin dialogue.
- Develop and distribute a brochure targeting city staff, which details mitigation principles and options. Can be distributed with payroll.
- Development of "hazard information centers" on the city's web site that explains the various hazards and mitigation alternatives are available to homeowners and businesses.
- Complete the Community Rating System Application.

The second category of projects is more traditional in nature. It is anticipated that the implementation and subsequent success of these projects will facilitate the goal of bringing mitigation principles to the forefront of city thinking. The following priorities have been ranked in the order in which they are intended to be implemented. It is important to note, however, that this list is flexible and will need to be periodically adjusted based on current conditions and funding availability.

- Give away 100 National Oceanic Atmospheric Administration (NOAA) Weather Radios to residents that are most vulnerable to wind events. Mobile homes will be targeted in the South Norfolk and Deep Creek areas of the city and each will be given a radio. Emergency Management will manage the program.
- Label all public hydrants in the city with identification numbers to better identify street locations in the event of a disaster. This project will be administered jointly by Public Utilities and the Fire Department. As periodic maintenance is performed on hydrants, identification tags will be placed on the respective hydrants. Funding will be identified from Homeland Security grants.
- Target FEMA's Repetitive Loss Properties for educational outreach activities. Develop and distribute brochures and education material to FEMA's Repetitive Loss Properties on specific mitigation measures. NEMAC will collaborate to develop the material. Funding will need to be identified for printing and distribution costs.
- Replace glass in the Public Safety Building. The Public Safety Building envelope, which houses the Emergency Operations Center, is clad in glass, making it very susceptible to damage from wind-related hazards. Replace glass in building with impact resistant glass. Emergency Management and Facilities Management will jointly manage the project.

Apply for funding available through competitive Pre-Disaster Mitigation grants.

- Support Public Works initiatives to improve stormwater infrastructure throughout the city. Several of these already identified projects include improvements in Deep Creek, Portlock, and Elmwood Landing.
- Investigate all critical facilities to evaluate their resistance to wind and flood hazards. This study will examine all critical facilities within the community and recommendations made as to ways in which the facilities can be strengthened or hardened. Facilities Management and Emergency Management will oversee the project. Apply for funding available through competitive Pre-Disaster Mitigation grants.

SECTION VIII — PLAN MAINTENANCE PROCEDURES

The long-term success of the city's mitigation plan depends in large part on routine monitoring, evaluating, and updating of the plan so that it will remain a valid tool for the community to use. The first step in ensuring that the plan's activities will be implemented is to formulate a City Council-endorsed Natural Event Mitigation Advisory Committee Workgroup.

Evaluation Methodology

The Natural Event Mitigation Advisory Committee (NEMAC) will monitor the efficiency and effectiveness of various mitigation strategies and will make recommendations for additional improvements. The NEMAC will review the year's local natural hazard events and impacts, community actions that may help or hinder mitigation capabilities, and the progress of mitigation activities. Any changes will be noted in the planning document accordingly, along with a summary of their findings and associated changes in a memorandum to the City Council and to the Virginia Department of Emergency Management.

Once the working group has been formed, the NEMAC will be responsible for working with the City Council to determine the best schedule for these updates. A potential timeframe for these annual updates is just before the annual hurricane season begins on June 1. Reviewing the plan at a time when media coverage and community awareness tends to be high may help serve as a

reminder to local officials that the community needs to be prepared for hurricanes and other disasters.

Every five years, the plan is required to go through a comprehensive review and evaluation process. This process will most likely require a full revision of the document, including updates of community-wide demographics, land uses, policies, and mitigation activities. The first update will be due for review and re-approval to the State and FEMA on or before June 1, 2008.

Continued Public Involvement

The public will remain engaged and involved throughout the planning process by:

- There will be continued representation on the NEMAC by private citizens and businesses;
- Website announcements will be posted to invite the public to provide comments and suggestions during the annual update and evaluation;
- The annual memorandum submitted to the City Council regarding planning updates will be posted on the city's website;
- Public meetings will be held as a part of the planning revisions every five years, and
- Copies of the plan will be available for public review at the City Planning Department, the Office of Emergency Management, on the city's website, and all city libraries. (Addendums and minor revisions will be inserted into the Appendices of these copies as they are completed.)

SECTION IX — APPENDICES

Summary of Data and Information Gaps

Overall, the City of Chesapeake has a plethora of information that proved to be essential in the production of this plan. Most of the data utilized in the planning process has been saved within several boxes at the City's Fire Department for later review and reference if needed.

One of the more significant problems with our ability to perform the risk and capability analyses was the number of revisions and "works in progress" that were being

undertaken during the planning process. A few of these plans and other initiatives were:

- The city's Comprehensive Plan revision and Land Use Plan revision;
- The ongoing implementation of the Chesapeake Bay Preservation Act;
- The city's Emergency Operations Plan revision

Additionally, while the City has an impressive Geographical Information System and associated online database of tax assessor's data, some of this data was not readily available in time to include within the plan. Other problems were tangentially related to the lack of detailed data available, such as which mobile home parks had owners versus renters within the city.

The last problem with accessing data occurred with our inability to get a copy of the old Community Rating System application, previous Community Assistance Visit evaluations, and the Insurance Services Office documentation that detailed the city's regulatory and enforcement capabilities as it pertains to codes and ordinances.

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APPENDIX A — DETAILED HAZARD IDENTIFICATION PARAMETERS AND METHODOLOGY

Based on all local and regional hazard data collected, an analysis of the potential hazards that can affect the City of Chesapeake was performed based on the four parameters that are described below. These four parameters were based on two separate factors — *the probabilities that a potential hazard will affect the city and the potential impacts on the city should a hazard event occur*. Hazard identification parameters and computations used to prioritize the potential hazards that can threaten the City of Chesapeake are listed in tabular form at the end of this appendix.

- **Probability** — This parameter addresses the probability that a potential hazard will affect the city. The probability for each hazard was determined based on the history of events in the City of Chesapeake, as well as any other relevant available data related to the probability for the Tidewater area. Hazard probabilities were classified into one of four distinct categories by estimating the hazard's average annual frequency, which is the probability of a specific hazard event occurring in the City of Chesapeake in a given year. Some average annual frequencies were relatively simple to estimate. For example, a review of Chesapeake's tornado hazard history (Section V) indicated the city has experienced 12 tornadoes over the past 77 years. Therefore, the average annual frequency of a tornado event occurring in any given year was (12/77 x 100) = 15.6%. However, the frequencies of other hazards in Chesapeake were more difficult to determine due to limited historical data. In such cases, frequency estimates relied on experience with similar events that have occurred near the Tidewater area of Virginia.

- **Affected Area** — This parameter is the first of three impact parameters, and addresses the potentially affected geographic area within the city should a hazard event occur. The extent of the affected area for each hazard was determined based on the specific characteristics of each hazard, the history of such events in the City of Chesapeake, and experience with similar events that have occurred near the Tidewater area of Virginia. The affected areas were classified into one of four distinct categories based on the extent of the city directly impacted by the hazard, ranging from a single building or facility to a widespread area of Chesapeake.

- **Primary Impact** — This second impact parameter addresses the potential direct damages to city buildings, facilities, and individuals should a hazard event occur. The primary impact was determined based on the specific characteristics of each

hazard, the history of such events in the City of Chesapeake, and experience with similar events that have occurred near the Tidewater area of Virginia. Primary impacts were classified into one of four distinct categories by estimating the typical damage to a city building or facility from a given hazard, ranging from negligible (less than 10% damage) to catastrophic (greater than 50% damage).

- **Secondary Impacts** — This third impact parameter addresses the potential secondary impacts on the city should a hazard event occur. Note that while primary impacts are a direct result of the hazard, secondary impacts can only arise subsequent to a primary impact. For example, a primary impact of a flood event may be road closures due to submerged pavement; while a secondary impact could be restricted access of emergency vehicles to citizens in a portion of the community due to the road closure. Other examples of secondary impacts include loss of building or facility services (functional downtime), power outages, and mass evacuation of city residents. The secondary impacts were determined based on the specific characteristics of each hazard, the history of such events in the City of Chesapeake, and experience with similar events that have occurred near the Tidewater area of Virginia. Secondary impacts were classified into one of four distinct categories by estimating the typical impacts to the city at large from a given hazard, ranging from negligible (no loss of function, downtime, and/or evacuations) to high (major loss of function, downtime, and/or evacuations).

Once these parameters were determined, a preference scale was utilized to arrive at a hazard level for each of the hazard types considered for the City of Chesapeake. The preference scale method has been used as a means of quantifying hazard assessment results in other communities, and similar scales were developed to rank alternatives in other FEMA documents such as FEMA Publication 259. The preference scale used for this hazard analysis first assigned a numerical value between 1 and 4 to each parameter, with 1 representing the lowest hazard potential and 4 being the highest. These numerical values were then modified by weighing each parameter by a factor to reflect the overall importance of that parameter, with 0.5 representing parameters of lowest importance and 2.0 representing parameters of highest importance. Importance factors may also be adjusted to reflect the level of confidence with the information supplied for a given parameter. For this reason, probability parameters were assigned a factor of 2.0 to reflect their high importance and the generally high confidence in the available information. However, the affected area, primary impact and secondary impacts parameter were assigned factors of 0.8, 0.7 and 0.5 to reflect their lower importance and the low confidence in the available information. Finally, the factored values assigned to the various parameters for each hazard were totaled, and the hazard types with the highest totals were considered the highest potential hazard level.

In order to quantify these hazard parameters, the following formula was developed to assign a value for probability and impact for each of the hazards considered.

Hazard Level = Probability x Impacts

Where: Probability = (Probability score x Importance factor)

Impacts = (Affected Area + Primary Impact + Secondary Impacts)

Affected Area = Affected Area score x Importance factor

Primary Impact = Primary Impact score x Importance factor

Secondary Impact = Secondary Impact score x Importance factor

The preference scale computations used to determine the hazard level for each of the potential hazards impacting the City of Chesapeake are summarized in tabular form at the end of this appendix. The hazard levels are broken down into four distinct categories that represent the likelihood of a hazard event of that type significantly impacting the City of Chesapeake: High, Medium-High, Medium, and Low. Note that the assigning of numerical values and importance factors for parameters is qualitative in nature and based on data from a number of sources with varying degrees of accuracy. For this reason, a margin or error of ±10 percent was assumed for the total scores used to arrive at the hazard level values.

HAZARD ANALYSIS WORKSHEET - CITY OF CHESAPEAKE

Hazard Type	Probability	Impacts			Total Score	Hazard Level
		Affected Area	Primary Impact	Secondary Impacts		
WINTER STORM	4	3.2	0.7	1.5	22	Medium
DROUGHT	6	3.2	2.1	1	38	Medium-High
EARTHQUAKE	2	1.6	2.1	1.5	10	Low
WIND EVENTS*	8	3.2	2.1	2	58	High
WILDFIRE	6	2.4	1.4	1.5	32	Medium
FLOOD	6	3.2	2.1	1.5	41	High
HAIL STORM	6	2.4	1.4	1	29	Medium
HEAT WAVE	6	3.2	0.7	1	29	Medium
HURRICANE	6	3.2	2.1	1	38	Medium-High
ICE STORM	4	3.2	1.4	1.5	24	Medium
LAND CAVE-IN (SINK HOLE)	2	1.6	1.4	0.5	7	Low
NOR'EASTER	6	3.2	1.4	1.5	37	Medium-High
SEVERE THUNDERSTROM	6	2.4	0.7	1.5	28	Medium
SOIL EROSION	2	1.6	1.4	0.5	7	Low
TORNADO	6	2.8	2.1	1	35	Medium-High
TROPICAL STORM	4	3.2	1.4	1.5	24	Medium
TSUNAMI	2	1.6	2.8	1.5	12	Low

* WIND EVENTS include Hurricane, Tornado, and Nor'easter events

Total Score = Probability x Impact, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Level

Total Score (Range)		Hazard Level	Distribution
0.0	12.0	Low	4
12.1	32.0	Medium	7
32.1	39.6	Medium-High	4
39.7	64.0	High	2

The probability of each hazard is determined by assigning a level, from 1 to 4, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. These levels are then multiplied by an importance factor to obtain a score for each category. The probability score is multiplied by the sum of the three impact categories to determine the total score for the hazard. Based on this total score, the hazards will be separated into four categories based on the hazard level they pose to the City: unlikely, possible, critical and highly likely.

Probability Importance 2.0

Based on average annual frequency of occurrence estimated from historical data

Level	Average Annual Frequency	Score
1	Unlikely (less than 1% occurrence)	2
2	Possible (between 1% and 10% occurrence)	4
3	Likely (between 10% and 100% occurrence)	6
4	Highly likely (near 100% occurrence)	8

Affected Area Importance 0.8

Based on size of geographical area of community affected by hazard

Level	Affected Area	Score
1	Isolated - limited to one building/facility	0.8
2	Small - limited to a handful of buildings/facilities	1.6
3	Medium - affecting a portion of an area	2.4
4	Large - affecting a widespread area	3.2

Primary Impact Importance 0.7

Based on percentage of damage to typical facility in community

Level	Impact	Score
1	Negligible - less than 10% damage	0.7
2	Limited - between 10% and 25% damage	1.4
3	Critical - between 25% and 50% damage	2.1
4	Catastrophic - more than 50% damage	2.8

Secondary Impacts Importance 0.5

Based on estimated secondary impacts to community at large

Level	Impact	Score
1	Negligible - no loss of function, downtime, and/or evacuations	0.5
2	Limited - minimal loss of function, downtime, and/or evacuations	1
3	Moderate - some loss of function, downtime, and/or evacuations	1.5
4	High - major loss of function, downtime, and/or evacuations	2

NOTE:
Total Score values assume a margin of error of ± 10 percent.

APPENDIX B — DETAILED FLOOD VULNERABILITY ASSESSMENT PARAMETERS AND METHODOLOGY

Based on all local and regional hazard data collected, flood vulnerability assessment for the City of Chesapeake involved an analysis of several parameters that are listed below. A table describing the vulnerability assessment parameters, along with computations used to estimate the 100-year flood damages that may be experienced by the City of Chesapeake, is provided at the end of this appendix.

- **Flood Depth**
- **Number of Basic Building Types in Flood Zone**
- **Assumed Building Type**
- **Building Replacement Value (BRV)**
- **Contents Replacement Value (CRV)**
- **Loss of Function (LOF)**
- **Number and Value of Critical Facilities in Flood Zone**
- **Depth Damage Function (DDF) for Buildings, Contents and LOF**
- **Number of Pre-FIRM Buildings in Flood Zone**
  - Once these parameters were determined, the estimated per capita damage (building, contents, and loss of function) in dollars per person within each planning area was used to arrive at a flood vulnerability index for each of the nine planning areas. For each planning area, the estimated per capita damage was determined using the following formula:

Estimated Per Capita Damage = (Building Damage + Contents Damage + LOF) / (Total Planning Area Population)

- The building damage costs were computed by multiplying the building replacement value by the corresponding building DDF. The contents damage costs were determined by multiplying the contents replacement value by the corresponding contents DDF. The LOF costs applied some of the principles of the preference scale method used for the hazard identification analysis. For example, critical facilities such as fire stations used larger annual budget values, thereby increasing their LOF values and their total costs to reflect their importance. Finally, the total damage cost for each planning area was divided by the total population within the planning area, and the planning areas with the highest per capita damage costs were considered to have the highest potential vulnerability.

A summary of the 100-year flood vulnerability assessment results for the City of Chesapeake is presented in tabular form at the end of this appendix. The calculations used to estimate the total damages to each building class in the flood zone and the vulnerability index for each planning area in the City of Chesapeake are summarized in tabular form at the end of this appendix. Note that the assigning of numerical values and importance factors for parameters is qualitative in nature and based on data from a number of sources with varying degrees of accuracy. For this reason, a margin of error of ±10 percent was assumed for the total unit costs used to arrive at the vulnerability index values.

The ***100-Year Flood Vulnerability Index Map*** for the City of Chesapeake enclosed in this report provides the results of the flood vulnerability index computations in graphical form.

Estimated Losses Due to 100-Year Flood Event – City of Chesapeake, VA

Sector (Planning Area)	Type of Complex	No. of Units	$ Value in Flood Zone	Average Value Per Structure	BFE	Avg. Topo. Elev.	Elevation Adjust.	Flood Depth	Assumed Building Type	% Building Damage	Estimated Building Damage ($)	Contents Value as % of Building Value	Contents Value	% Contents Damaged	Estimated Contents Damage ($)	Annual Budget or Housing Expenses	No. of Days	Total Loss of Function Per Event	Estimated Total Damages Per Structure	Approximate Percentage of Pre-FIRM Structures	Estimated Total Damages Per Sector	% Damage of Assessed Value	% Damage of Total Assessed Value All Sectors All Assists	Damage as Percent of Sector Damage	Damage as Percent Total Community Damage
Camelot	Places of Worship	2	$662,100	$331,050	8.5	5	2	1.5	2 w/o	11%	$36,416	100%	$331,050	17%	$56,279	$200,000	11	$6,027	$98,721	43.6%	$86,085	13%	0.0046%	2.26%	0.1%
	Warehouses	1	$271,300	$271,300	8.5	5	2	1.5	1 w/o	18%	$48,834	100%	$271,300	25%	$67,825	$500,000	18	$24,658	$141,317	43.6%	$61,614	23%	0.0033%	1.61%	0.0%
	Day Care Centers	3	$224,100	$74,700	8.5	5	2	1.5	1 w/o	18%	$13,446	100%	$74,700	25%	$18,675	$250,000	18	$12,329	$44,450	43.6%	$58,140	26%	0.0031%	1.52%	0.0%
	Agricultural Properties	2	$405,600	$202,800	8.5	5	2	1.5	2 w/o	11%	$22,308	100%	$202,800	17%	$34,476	$150,000	11	$4,521	$61,305	43.6%	$53,458	13%	0.0028%	1.40%	0.0%
	Mobile Home Parks	1	$4,163,500	$4,163,500	8.5	5	2	1.5	manu	54%	$2,248,290	50%	$2,081,750	78%	$1,623,765	$10,000	30	$822	$3,872,877	43.6%	$1,688,574	41%	0.0893%	44.25%	1.2%
	Residential Properties	348	$21,329,700	$61,292	8.5	5	2	1.5	2 w/o	11%	$6,742	50%	$30,646	17%	$5,210	$12,000	11	$362	$12,314	43.6%	$1,868,323	9%	0.0988%	48.96%	1.3%
	TOTALS	**357**	**$27,056,300**																		**$3,816,194**	**14%**	**0.2018%**	100.00%	**2.6%**
Deep Creek	Places of Worship	21	$4,082,500	$194,405	8.5	5	2	1.5	2 w/o	11%	$21,385	100%	$194,405	17%	$33,049	$200,000	11	$6,027	$60,461	43.6%	$553,578	14%	0.0293%	1.66%	0.4%
	Warehouses	2	$235,000	$117,500	8.5	5	2	1.5	1 w/o	18%	$21,150	100%	$117,500	25%	$29,375	$500,000	18	$24,658	$75,183	43.6%	$65,559	28%	0.0035%	0.20%	0.0%
	Sara Title 3 Facilities	2	$5,965,500	$2,982,750	8.5	5	2	1.5	1 w/o	18%	$536,895	150%	$4,474,125	25%	$1,118,531	$500,000	18	$24,658	$1,680,084	43.6%	$1,465,033	25%	0.0775%	4.40%	1.0%
	Day Care Centers	4	$593,500	$148,375	8.5	5	2	1.5	1 w/o	18%	$26,708	100%	$148,375	25%	$37,094	$250,000	18	$12,329	$76,130	43.6%	$132,771	22%	0.0070%	0.40%	0.1%
	Construction Companies	1	$118,200	$118,200	8.5	5	2	1.5	1 w/o	18%	$21,276	100%	$118,200	25%	$29,550	$1,000,000	18	$49,315	$100,141	43.6%	$43,662	37%	0.0023%	0.13%	0.0%
	Fire Stations	1	$485,000	$485,000	8.5	5	2	1.5	2 w/o	11%	$53,350	150%	$727,500	17%	$123,675	$500,000	11	$15,068	$192,093	43.6%	$83,753	17%	0.0044%	0.25%	0.1%
	Agricultural Properties	43	$11,819,000	$274,860	8.5	5	2	1.5	2 w/o	11%	$30,235	100%	$274,860	17%	$46,726	$150,000	11	$4,521	$81,481	43.6%	$1,527,615	13%	0.0808%	4.59%	1.1%
	Apartment Complexes	2	$4,789,400	$2,394,700	8.5	5	2	1.5	2 w	18%	$419,073	50%	$1,197,350	24%	$281,377	$50,000	13	$1,781	$702,231	43.6%	$612,345	13%	0.0324%	1.84%	0.4%
	Mobile Home Parks	2	$1,225,500	$612,750	8.5	5	2	1.5	manu	54%	$330,885	50%	$306,375	78%	$238,973	$10,000	30	$822	$570,679	43.6%	$497,632	41%	0.0263%	1.49%	0.3%
	Residential Properties	3,552	$326,643,800	$91,961	8.5	5	2	1.5	2 w/o	11%	$10,116	50%	$45,980	17%	$7,817	$12,000	11	$362	$18,294	43.6%	$28,331,324	9%	1.4982%	85.05%	19.6%
	TOTALS	**3,630**	**$355,957,400**																		**$33,313,272**	**9%**	**1.7617%**	100.00%	**23.0%**
Great Bridge	Places of Worship	9	$6,100,800	$677,867	8.5	5	2	1.5	2 w/o	11%	$74,565	100%	$677,867	17%	$115,237	$200,000	11	$6,027	$195,830	43.6%	$768,437	13%	0.0406%	2.98%	0.5%
	Warehouses	2	$1,926,400	$963,200	8.5	5	2	1.5	1 w/o	18%	$173,376	100%	$963,200	27%	$260,064	$500,000	18	$24,658	$458,098	43.6%	$399,461	21%	0.0211%	1.55%	0.3%
	Senior Centers	1	$1,557,800	$1,557,800	8.5	5	2	1.5	2 w/o	11%	$171,358	100%	$1,557,800	17%	$264,826	$250,000	11	$7,534	$443,718	43.6%	$193,461	12%	0.0102%	0.75%	0.1%
	Fire Stations	1	$1,631,100	$1,631,100	8.5	5	2	1.5	2 w/o	11%	$179,421	150%	$2,446,650	17%	$415,931	$500,000	11	$15,068	$610,420	43.6%	$266,143	16%	0.0141%	1.03%	0.2%
	Schools	2	$28,359,200	$14,179,600	8.5	5	2	1.5	2 w/o	11%	$1,559,756	100%	$14,179,600	17%	$2,410,532	$500,000	11	$15,068	$3,985,356	43.6%	$3,475,231	12%	0.1838%	13.47%	2.4%
	Sara Title 3 Facilities	5	$5,283,700	$1,056,740	8.5	5	2	1.5	1 w/o	18%	$190,213	150%	$1,585,110	27%	$427,980	$500,000	18	$24,658	$642,850	43.6%	$1,401,414	27%	0.0741%	5.43%	1.0%
	Day Care Centers	8	$2,914,000	$364,250	8.5	5	2	1.5	1 w/o	18%	$65,565	100%	$364,250	27%	$98,348	$250,000	18	$12,329	$176,241	43.6%	$614,730	21%	0.0325%	2.38%	0.4%
	Community Centers*	1	$3,553,300	$3,553,300	8.5	5	2	1.5	1 w/o	18%	$639,594	100%	$3,553,300	27%	$959,391	$250,000	18	$12,329	$1,611,314	43.6%	$702,533	20%	0.0372%	2.72%	0.5%
	Construction Companies	2	$1,491,800	$745,900	8.5	5	2	1.5	1 w/o	18%	$134,262	100%	$745,900	27%	$201,393	$1,000,000	18	$49,315	$384,970	43.6%	$335,694	23%	0.0178%	1.30%	0.2%
	Apartment Complexes	3	$1,776,700	$592,233	6.2	3.66667	2	0.5	2 w	13%	$76,990	50%	$296,117	20%	$59,223	$50,000	13	$1,781	$137,994	43.6%	$180,497	10%	0.0095%	0.70%	0.1%
	Agricultural Properties	11	$4,600,700	$418,245	6.2	3.66667	2	0.5	2 w/o	7%	$29,277	100%	$418,245	11%	$46,007	$150,000	7	$2,877	$78,161	43.6%	$374,860	8%	0.0198%	1.45%	0.3%
	Residential Properties	2,189	$309,525,100	$141,400	6.2	3.66667	2	0.5	2 w/o	7%	$9,898	50%	$70,700	11%	$7,777	$12,000	7	$230	$17,905	43.6%	$17,088,762	6%	0.9037%	66.23%	11.8%
	TOTALS	**2,234**	**$368,720,600**																		**$25,801,222**	**7%**	**1.3644%**	100.00%	**17.8%**
Southern Chesapeake	Places of Worship	2	$370,200	$185,100	8.5	5	2	1.5	2 w/o	11%	$20,361	100%	$185,100	17%	$31,467	$200,000	11	$6,027	$57,855	43.6%	$50,450	14%	0.0027%	0.46%	0.0%
	Agricultural Properties	174	$46,211,400	$265,583	6.2	3.66667	2	0.5	2 w/o	7%	$18,591	100%	$265,583	11%	$29,214	$150,000	7	$2,877	$50,682	43.6%	$3,844,910	8%	0.2033%	35.38%	2.7%
	Residential Properties	822	$126,431,100	$153,809	6.2	3.66667	2	0.5	2 w/o	7%	$10,767	50%	$76,905	11%	$8,460	$12,000	7	$230	$19,456	43.6%	$6,972,974	6%	0.3687%	64.16%	4.8%
	TOTALS	**998**	**$173,012,700**																		**$10,868,334**	**6%**	**0.5747%**	100.00%	**7.5%**
Greenbrier	Places of Worship	3	$439,800	$146,600	7.3	4.3	2	1	2 w/o	9%	$13,194	100%	$146,600	14%	$20,524	$200,000	9	$4,932	$38,650	43.6%	$50,554	11%	0.0027%	1.34%	0.0%
	Warehouses	2	$1,892,300	$946,150	7.3	4.3	2	1	1 w/o	14%	$132,461	100%	$946,150	21%	$198,692	$500,000	14	$19,178	$350,331	43.6%	$305,488	16%	0.0162%	8.12%	0.2%
	Sara Title 3 Facilities	1	$4,096,800	$4,096,800	7.3	4.3	2	1	1 w/o	14%	$573,552	150%	$6,145,200	21%	$1,290,492	$500,000	14	$19,178	$1,883,222	43.6%	$821,085	20%	0.0434%	21.82%	0.6%
	Agricultural Properties	13	$3,475,400	$267,338	7.3	4.3	2	1	2 w/o	9%	$24,060	100%	$267,338	14%	$37,427	$150,000	9	$3,699	$65,186	43.6%	$369,477	11%	0.0195%	9.82%	0.3%
	Residential Properties	171	$31,455,300	$183,949	7.3	4.3	2	1	2 w/o	9%	$16,555	50%	$91,975	14%	$12,876	$12,000	9	$296	$29,728	43.6%	$2,216,382	7%	0.1172%	58.90%	1.5%
	TOTALS	**190**	**$41,359,600**																		**$3,762,986**	**9%**	**0.1990%**	100.00%	**2.6%**
Rivercrest	Places of Worship	3	$502,800	$167,600	7.3	4.3	2	1	2 w/o	9%	$15,084	100%	$167,600	14%	$23,464	$200,000	9	$4,932	$43,480	43.6%	$56,871	11%	0.0030%	0.17%	0.0%
	Warehouses	5	$4,723,100	$944,620	7.3	4.3	2	1	1 w/o	14%	$132,247	100%	$944,620	21%	$198,370	$500,000	14	$19,178	$349,795	43.6%	$762,553	16%	0.0403%	2.29%	0.5%
	Schools	2	$10,708,400	$5,354,200	7.3	4.3	2	1	2 w/o	9%	$481,878	100%	$5,354,200	14%	$749,588	$500,000	9	$12,329	$1,243,795	43.6%	$1,084,589	10%	0.0574%	3.25%	0.7%
	Sara Title 3 Facilities	5	$2,150,500	$430,100	7.3	4.3	2	1	1 w/o	14%	$60,214	150%	$645,150	21%	$135,482	$500,000	14	$19,178	$214,874	43.6%	$468,424	22%	0.0248%	1.40%	0.3%
	Day Care Centers	2	$862,500	$431,250	7.3	4.3	2	1	1 w/o	14%	$60,375	100%	$431,250	21%	$90,563	$250,000	14	$9,589	$160,527	43.6%	$139,979	16%	0.0074%	0.42%	0.1%
	Community Centers	1	$3,553,300	$3,553,300	7.3	4.3	2	1	2 w/o	9%	$319,797	100%	$3,553,300	14%	$497,462	$250,000	9	$6,164	$823,423	43.6%	$359,013	10%	0.0190%	1.08%	0.2%
	Construction Companies	2	$4,317,000	$2,158,500	7.3	4.3	2	1	1 w/o	14%	$302,190	100%	$2,158,500	21%	$453,285	$1,000,000	14	$38,356	$793,831	43.6%	$692,221	16%	0.0366%	2.07%	0.5%
	Apartment Complexes	6	$22,185,700	$3,697,617	7.3	4.3	2	1	2 w	15%	$554,643	50%	$1,848,808	23%	$425,226	$50,000	15	$2,055	$981,923	43.6%	$2,568,711	12%	0.1358%	7.70%	1.8%
	Agricultural Properties	3	$2,746,400	$915,467	7.3	4.3	2	1	2 w/o	9%	$82,392	100%	$915,467	14%	$128,165	$150,000	9	$3,699	$214,256	43.6%	$280,247	10%	0.0148%	0.84%	0.2%
	Mobile Home Parks	2	$1,351,200	$675,600	7.3	4.3	2	1	manu	44%	$297,264	50%	$337,800	66%	$222,948	$10,000	30	$822	$521,034	43.6%	$454,342	34%	0.0240%	1.36%	0.3%
	Residential Properties	2,761	$374,801,300	$135,748	7.3	4.3	2	1	2 w/o	9%	$12,217	50%	$67,874	14%	$9,502	$12,000	9	$296	$22,016	43.6%	$26,502,330	7%	1.4015%	79.42%	18.3%
	TOTALS	**2,792**	**$427,902,200**																		**$33,369,280**	**8%**	**1.7646%**	100.00%	**23.1%**
South Norfolk	Places of Worship	4	$1,304,300	$326,075	8.5	6	2	0.5	2 w/o	7%	$22,825	100%	$326,075	11%	$35,868	$200,000	7	$3,836	$62,529	43.6%	$109,051	8%	0.0058%	1.14%	0.1%
	Warehouses	12	$8,729,800	$727,483	8.5	6	2	0.5	1 w/o	12%	$83,661	100%	$727,483	18%	$127,310	$500,000	11.5	$15,753	$226,724	43.6%	$1,186,218	14%	0.0627%	12.38%	0.8%
	Schools	2	$7,515,400	$3,757,700	8.5	6	2	0.5	2 w/o	7%	$263,039	100%	$3,757,700	11%	$413,347	$500,000	7	$9,589	$685,975	43.6%	$598,170	8%	0.0316%	6.24%	0.4%
	Sara Title 3 Facilities	13	$16,045,200	$1,234,246	8.5	6	2	0.5	1 w/o	12%	$141,938	150%	$1,851,369	18%	$323,990	$500,000	11.5	$15,753	$481,681	43.6%	$2,730,170	17%	0.1444%	28.49%	1.9%
	Day Care Centers	2	$1,081,600	$540,800	8.5	6	2	0.5	1 w/o	12%	$62,192	100%	$540,800	18%	$94,640	$250,000	11.5	$7,877	$164,709	43.6%	$143,626	13%	0.0076%	1.50%	0.1%
	Construction Companies	3	$3,048,100	$1,016,033	8.5	6	2	0.5	1 w/o	12%	$116,844	100%	$1,016,033	18%	$177,806	$1,000,000	11.5	$31,507	$326,157	43.6%	$426,613	14%	0.0226%	4.45%	0.3%
	Fire Stations	1	$1,393,000	$1,393,000	8.5	6	2	0.5	2 w/o	7%	$97,510	100%	$1,393,000	11%	$153,230	$500,000	7	$9,589	$260,329	43.6%	$113,503	8%	0.0060%	1.18%	0.1%
	Medical Offices	2	$65,000	$32,500	8.5	6	2	0.5	1 w/o	12%	$3,738	150%	$48,750	18%	$8,531	$250,000	11.5	$7,877	$20,145	43.6%	$17,567	27%	0.0009%	0.18%	0.0%
	Apartment Complexes	18	$26,489,000	$1,471,611	8.5	6	2	0.5	2 w	13%	$191,309	50%	$735,806	20%	$147,161	$50,000	13	$1,781	$340,251	43.6%	$2,670,293	10%	0.1412%	27.86%	1.8%
	Residential Properties	773	$27,726,900	$35,869	8.5	6	2	0.5	2 w/o	7%	$2,511	50%	$17,935	11%	$1,973	$12,000	7	$230	$4,714	43.6%	$1,588,679	6%	0.0840%	16.58%	1.1%
	TOTALS	**830**	**$93,398,300**																		**$9,583,889**	**10%**	**0.5068%**	100.00%	**6.6%**

Estimated Losses Due to 100-Year Flood Event – City of Chesapeake, VA

Estimated Losses Due to 100-Year Flood Event – City of Chesapeake, VA

Sector (Planning Area)	Type of Complex	No. of Units	$ Value in Flood Zone	Average Value Per Structure	BFE	Avg. Topo. Elev.	Elevation Adjust.	Flood Depth	Assumed Building Type	% Building Damage	Estimated Building Damage ($)	Contents Value as % of Building Value	Contents Value	% Contents Damaged	Estimated Contents Damage ($)	Annual Budget or Housing Expenses	No. of Days	Total Loss of Function Per Event	Estimated Total Damages Per Structure	Approximate Percentage of Pre-FIRM Structures	Estimated Total Damages Per Sector	% Damage of Assessed Value	% Damage of Total Assessed Value All Sectors All Assists	Damage as Percent of Sector Damage	Damage as Percent Total Community Damage
Indian River	Apartment Complexes	1	$31,330,900	$31,330,900	8.5	6	2	0.5	2 w	13%	$4,073,017	50%	$15,665,450	20%	$3,133,090	$50,000	13	$1,781	$7,207,888	43.6%	$3,142,639	10%	0.1662%	40.81%	2.2%
	Residential Properties	625	$82,487,400	$131,980	8.5	6	2	0.5	2 w/o	7%	$9,239	50%	$65,990	11%	$7,259	$12,000	7	$230	$16,728	43.6%	$4,558,276	6%	0.2410%	59.19%	3.2%
	TOTALS	**626**	**$113,818,300**																		**$7,700,915**	**7%**	**0.4072%**	100.00%	**5.3%**
Western Branch	Places of Worship	1	$579,800	$579,800	8.5	6	2	0.5	2 w/o	7%	$40,586	100%	$579,800	11%	$63,778	$200,000	11	$6,027	$110,391	43.6%	$48,131	8%	0.0025%	0.29%	0.0%
	Agricultural Properties	29	$11,954,000	$412,207	8.5	6	2	0.5	2 w/o	7%	$28,854	100%	$412,207	11%	$45,343	$150,000	11	$4,521	$78,718	43.6%	$995,308	8%	0.0526%	6.06%	0.7%
	Residential Properties	1,641	$277,258,500	$168,957	8.5	6	2	0.5	2 w/o	7%	$11,827	50%	$84,479	11%	$9,293	$12,000	11	$362	$21,481	43.6%	$15,369,336	6%	0.8128%	93.64%	10.6%
	TOTALS	**1,671**	**$289,792,300**																		**$16,412,774**	**6%**	**0.8679%**	100.00%	**11.3%**
	COMMUNITY TOTALS	**13,328**	**$1,891,017,700**																	**Total Community**	**$144,628,865**	**7.6482%**	**7.6482%**		

List of Parameters	Definition of Parameters
Sector (Planning Area)	One of nine planning areas within the City of Chesapeake.
Type of Complex	Property type; primary focus on residential and public buildings.
No. of Units	Total number of units in the flood zone for each planning area.
$ Value in Flood Zone	= (No. of Units x Average Value per Structure); represents the total dollar value of all units in the flood zone for each planning area.
Average Value Per Structure	Pre-determined average value for a single structure of a given complex type.
BFE	Base Flood Elevation: the estimated elevation of flooding during a 100-year event.
Avg. Topo. Elev.	Average ground surface elevation within each planning area, based on topographic maps.
Elevation Adjust.	= 2 feet; elevation adjustment assumed to reflect the average height of the first floor elevation above exsiting grade.
Average Flood Depth	= (BFE - Avg. Topo. Elev. - Elevation Adjust.); the calculated average flood depth for all structures in the planning area with first floor elevations below BFE (pre-FIRM structures).
Assumed Building Type	Building type assumed based on typical structure encountered for a given Type of Complex. Building types listed below reflect the number of stories within a structure, and whether or not it has a basement 1 w/o: Single-story structure without basement; assumed for building type for Warehouses, Sara Title 3 Facilities, Day Care Centers, Construction Companies, and Medical Offices. 2 w/o: Two story structure without basement; assumed building type for Places of Worship, Senior Centers, Fire Stations, Schools, Agricultural Properties, and Residential Properties. 2 w: Two story structure without basement; assumed building type for Apartment Complexes. manu: Manufactured home; assumed building type for Mobile Home Parks.
% Building Damage	Taken from the Federal Insurance Administration building Depth Damage Function (DDF) tables for each building type.
Estimated Building Damage ($)	= (Average Value Per Structure x % Building Damage); represents the total dollar value of building damage for each structure.
Contents Value as % of Building Value	The ratio of the value of building contents to the value of the structure itself; taken from HAZUS data based on Type of Complex.
Contents Value	= (Content Values as % of Building x Average Value per Structure); estimated value of all contents within a structure.
% Contents Damage	Taken from the Federal Insurance Administration contents Depth Damage Function (DDF) tables for each building type.
Estimated Contents Damage ($)	= (Contents Value x % Contents Damaged); represents the total dollar value of contents damage for each structure.
Annual Budget or Housing Expenses	Estimated annual operating budget for non-residential properties, or annual average housing costs for residential properties.
No. of Days	The duration of building loss of function (LOF) after a flood; taken from the Federal Insurance Administration functional downtime Depth Damage Function (DDF) tables for each building type.
Total Loss of Function per Event	= (Yearly Budget/365) x No. of Days; represents the total dollar value of lost services in a flood event for each structure.
Estimated Total Damages Per Structure	= (Building Damage $ + Contents Damaged $ + Total Loss of Function Per Event); represents the sum of all flood damages for each structure.
Approximate Percentage of Pre-FIRM Structures	The proportion of structures constructed in the flood zone prior to the adoption of the NFIP Flood Insurance Rate Maps (FIRMs); pre-FIRM structures are assumed to be constructed with first floor elevations below BFE.
Estimated Total Damages Per Sector	= (Total Damages Per Structure x Approximate Percentage of Pre-FIRM Structures x No. of Units); represents total dollar amount of damages for the properties within the flood zone for each planning area.
% Damage of Assessed Value	= (Total Damages Per Sector / $ Value in Flood Zone); ratio between the total damage value and the overall property value in the flood zone for each planning area.
% Damage of Assessed Value All Sectors All Assets	= (Total Damages Per Sector / Total Community $ Value in Flood Zone); ratio between the total damage value and the overall property value in the flood zone for all planning areas.
Damage as Percent of Sector Damage	= (Total Damages Per Sector / Σ Total Damages Per Sector); ratio between the total damage value and the total sector damage value in the flood zone for each sector.
Damage as Percent of Total Community Damage	= (Total Damages Per Sector / Total Community Damages in Flood Zone); ratio between the total damage value and the total damage value in the flood zone for all planning areas.

VULNERABILITY ASSESSMENT FOR 100-YEAR FLOOD - CITY OF CHESAPEAKE, VA

PLANNING AREA	TOTAL NO. OF UNITS IN FLOOD ZONE	APPROXIMATE TOTAL VALUE IN FLOOD ZONE	ESTIMATED 100-YEAR FLOOD DAMAGES PER PLANNING AREA	PERCENT OF TOTAL COMMUNITY DAMAGED	TOTAL PLANNING AREA POPULATION	PERCENT POPULATION DISTRIBUTION	ESTIMATED PER CAPITA PLANNING AREA DAMAGE	VULNERABILITY INDEX
Camelot	**357**	**$27,056,300**	**$3,816,194**	**2.6%**	**7,702**	**3.9%**	**$495**	**Medium**
Deep Creek	**3,630**	**$355,957,400**	**$33,313,272**	**23.0%**	**23,800**	**12.0%**	**$1,400**	**High**
Great Bridge	**2,234**	**$368,720,600**	**$25,801,222**	**17.8%**	**43,918**	**22.1%**	**$587**	**Medium**
Southern Chesapeake	**998**	**$173,012,700**	**$10,868,334**	**7.5%**	**11,987**	**6.0%**	**$907**	**Medium**
Greenbrier	**190**	**$41,359,600**	**$3,762,986**	**2.6%**	**23,864**	**12.0%**	**$158**	**Low**
Rivercrest	**2,792**	**$427,902,200**	**$33,369,280**	**23.1%**	**17,019**	**8.5%**	**$1,961**	**High**
South Norfolk	**830**	**$93,398,300**	**$9,583,889**	**6.6%**	**22,797**	**11.5%**	**$420**	**Low**
Indian River	**626**	**$113,818,300**	**$7,700,915**	**5.3%**	**19,444**	**9.8%**	**$396**	**Low**
Western Branch	**1,671**	**$289,792,300**	**$16,412,774**	**11.3%**	**28,558**	**14.3%**	**$575**	**Medium**
ESTIMATED TOTALS	**13,328**	**$1,891,017,700**	**$144,628,865**	**100.0%**	**199,089**	**100.0%**	**$726**	

Vulnerability Index Determination

Avg. Sector Damages Per Person Range		Vulnerability Index	Distribution
0	$426	Low	3
$427	$1,026	Medium	4
$1,027	$2,726	High	2

 NOTE: Damage ($/Person) values assume a margin of error of ± 10 percent.

APPENDIX C — DETAILED WIND VULNERABILITY ASSESSMENT PARAMETERS AND METHODOLOGY

Based on all local and regional hazard data collected, wind vulnerability assessment for the City of Chesapeake involved an analysis of several parameters that are listed below. A table describing the vulnerability assessment parameters, along with computations used to estimate the 100-year wind event damages that may be experienced by the City of Chesapeake is provided at the end of this appendix.

- **Basic Wind Speed**
- **Number of Basic Building Types**
- **Assumed Building Type**
- **Building Replacement Value (BRV)**
- **Contents Replacement Value (CRV)**
- **Loss of Function (LOF)**
- **Number and Value of Critical Facilities**
- **Wind Damage Function (WDF) for Buildings, Contents and LOF**
- **Number of Pre-Wind Code Buildings**

Once these parameters were determined, the estimated per capita damage (building, contents, and loss of function) in dollars per person within each planning area was used to arrive at a wind vulnerability index for each of the nine planning areas. For each planning area, the per capita damage was determined using the following formula:

Estimated Per Capita Damage = (Building Damage + Contents Damage + LOF) / (Total Planning Area Population)

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- The building damage costs were computed by multiplying the building replacement value by the corresponding building WDF. The contents damage costs were determined by multiplying the contents replacement value by the

corresponding contents WDF. LOF costs applied some of the principles of the preference scale method used for the hazard identification analysis. For example, critical facilities such as fire stations used larger annual budget values, thereby increasing their LOF values and their total costs to reflect their importance. Finally, the total damage cost for each planning area was divided by the total population within the planning area, and the planning areas with the highest per capita damage costs were considered to have the highest potential vulnerability.

A summary of the vulnerability assessment results for the 100-year wind event in City of Chesapeake is presented in tabular form at the end of this appendix. The calculations used to determine the total damages to each building class and the vulnerability index for each planning area in the City of Chesapeake are summarized in tabular form at the end of this appendix. Note that the assigning of numerical values and importance factors for parameters is qualitative in nature and based on data from a number of sources with varying degrees of accuracy. For this reason, a margin of error of ±10 percent was assumed for the total unit costs used to arrive at the vulnerability index values.

The ***100-Year Wind Vulnerability Index Map*** for the City of Chesapeake enclosed in this report provides the results of the wind vulnerability index computations in graphical form.

Estimated Losses Due to 100-Year Wind Event – City of Chesapeake, VA

Planning Area	Type of Complex	No. of Units	$ Value	Average Value Per Structure	Basic Wind Speed (mph)	Assumed Storm Class	Assumed Building Type	Expected Damage as % Building Value	Estimated Building Damage ($)	Contents Value as % of Building Value	Contents Value	% of Contents Damaged	Estimated Contents Damage ($)	Annual Budget or Housing Expenses	# Days Without Function	Estimated Total Loss of Function Per Event	Estimated Total Damages Per Structure	Approximate Percentage of Pre-Wind Code Structures in Community	Estimated Total Damages Per Sector	% Damage of Assessed Value	% Damage of Total Assessed Value All Sectors All Assists	Damage as Percent of Sector Damage	Sector Damage as Percentage of Community Damage
Camelot	Places of Worship	8	$662,100	$82,763	110	2	LE	15%	$12,414	100%	$82,763	15%	$12,414	$200,000	15	$8,219	$33,048	33.6%	$88,833	13%	0.0009%	0.26%	0.0%
	Warehouses	45	$75,585,100	$1,679,669	110	2	LE	15%	$251,950	100%	$1,679,669	15%	$251,950	$500,000	15	$20,548	$524,449	33.6%	$7,929,663	10%	0.0763%	23.56%	0.7%
	Senior Centers	7	$3,567,900	$509,700	110	2	LE	15%	$76,455	100%	$509,700	15%	$76,455	$250,000	15	$10,274	$163,184	33.6%	$383,809	11%	0.0037%	1.14%	0.0%
	Schools	1	$4,068,100	$4,068,100	110	2	FE	5%	$203,405	100%	$4,068,100	15%	$610,215	$500,000	5	$6,849	$820,469	33.6%	$275,678	7%	0.0027%	0.82%	0.0%
	Sara Title 3 Facilities	9	$18,400,800	$2,044,533	110	2	N-EM	15%	$306,680	150%	$3,066,800	15%	$460,020	$500,000	15	$20,548	$787,248	33.6%	$2,380,638	13%	0.0229%	7.07%	0.2%
	Day Care Centers	11	$967,000	$87,909	110	2	LE	15%	$13,186	100%	$87,909	15%	$13,186	$250,000	15	$10,274	$36,647	33.6%	$135,446	14%	0.0013%	0.40%	0.0%
	Community Centers	1	$3,553,300	$3,553,300	110	2	FE	5%	$177,665	100%	$3,553,300	15%	$532,995	$250,000	5	$3,425	$714,085	33.6%	$239,932	7%	0.0023%	0.71%	0.0%
	Construction Companies	8	$5,461,500	$682,688	110	2	LE	15%	$102,403	100%	$682,688	15%	$102,403	$1,000,000	15	$41,096	$245,902	33.6%	$660,985	12%	0.0064%	1.96%	0.1%
	Agricultural Properties	3	$503,000	$167,667	110	2	N-EW	20%	$33,533	100%	$167,667	20%	$33,533	$150,000	20	$8,219	$75,286	33.6%	$75,888	15%	0.0007%	0.23%	0.0%
	Mobile Home Parks	2	$5,132,700	$2,566,350	110	2	M	50%	$1,283,175	50%	$1,283,175	100%	$1,283,175	$10,000	30	$822	$2,567,172	33.6%	$1,725,140	34%	0.0166%	5.13%	0.2%
	Residential Properties	2,486	$190,601,500	$76,670	110	2	N-EW	20%	$15,334	50%	$38,335	20%	$7,667	$12,000	20	$658	$23,659	33.6%	$19,761,867	10%	0.1902%	58.71%	1.9%
	TOTALS	**2,581**	**$308,503,000**																**$33,657,878**	**11%**	**0.3240%**	100.00%	**3.2%**
Deep Creek	Places of Worship	34	$4,082,500	$120,074	110	2	LE	15%	$18,011	100%	$120,074	15%	$18,011	$200,000	15	$8,219	$44,241	33.6%	$505,412	12%	0.0049%	0.45%	0.0%
	Warehouses	13	$10,142,400	$780,185	110	2	LE	15%	$117,028	100%	$780,185	15%	$117,028	$500,000	15	$20,548	$254,603	33.6%	$1,112,107	11%	0.0107%	0.99%	0.1%
	Senior Centers	7	$10,279,100	$1,468,443	110	2	LE	15%	$220,266	100%	$1,468,443	15%	$220,266	$250,000	15	$10,274	$450,807	33.6%	$1,060,298	11%	0.0102%	0.94%	0.1%
	Schools	7	$64,134,200	$9,162,029	110	2	FE	5%	$458,101	100%	$9,162,029	15%	$1,374,304	$500,000	5	$6,849	$1,839,255	33.6%	$4,325,928	7%	0.0416%	3.83%	0.4%
	Sara Title 3 Facilities	11	$30,275,600	$2,752,327	110	2	N-EM	15%	$412,849	150%	$4,128,491	15%	$619,274	$500,000	15	$20,548	$1,052,671	33.6%	$3,890,671	13%	0.0374%	3.45%	0.4%
	Day Care Centers	12	$3,555,100	$296,258	110	2	LE	15%	$44,439	100%	$296,258	15%	$44,439	$250,000	15	$10,274	$99,151	33.6%	$399,779	11%	0.0038%	0.35%	0.0%
	Community Centers	1	$3,553,300	$3,553,300	110	2	FE	5%	$177,665	100%	$3,553,300	15%	$532,995	$250,000	5	$3,425	$714,085	33.6%	$239,932	7%	0.0023%	0.21%	0.0%
	Construction Companies	3	$638,000	$212,667	110	2	LE	15%	$31,900	100%	$212,667	15%	$31,900	$1,000,000	15	$41,096	$104,896	33.6%	$105,735	17%	0.0010%	0.09%	0.0%
	Fire Stations	3	$1,259,100	$419,700	110	2	FE	5%	$20,985	150%	$629,550	15%	$94,433	$500,000	5	$13,699	$129,116	33.6%	$130,149	10%	0.0013%	0.12%	0.0%
	Medical Facilities	3	$403,900	$134,633	110	2	FE	5%	$6,732	150%	$201,950	15%	$30,293	$250,000	5	$3,425	$40,449	33.6%	$40,772	10%	0.0004%	0.04%	0.0%
	Agricultural Properties	138	$24,956,300	$180,843	110	2	N-EW	20%	$36,169	100%	$180,843	20%	$36,169	$150,000	20	$8,219	$80,556	33.6%	$3,735,234	15%	0.0360%	3.31%	0.4%
	Apartment Complexes	19	$4,789,400	$252,074	110	2	N-EM	15%	$37,811	50%	$126,037	15%	$18,906	$50,000	15	$2,055	$58,771	33.6%	$375,196	8%	0.0036%	0.33%	0.0%
	Mobile Home Parks	5	$6,714,100	$1,342,820	110	2	M	50%	$671,410	50%	$671,410	100%	$671,410	$10,000	30	$822	$1,343,642	33.6%	$2,257,318	34%	0.0217%	2.00%	0.2%
	Residential Properties	8,891	$919,434,300	$103,412	110	2	N-EW	20%	$20,682	50%	$51,706	20%	$10,341	$12,000	20	$658	$31,681	33.6%	$94,643,279	10%	0.9110%	83.89%	8.9%
	TOTALS	**9,147**	**$1,084,217,300**																**$112,821,811**	**10%**	**1.0859%**	100.00%	**10.6%**
Great Bridge	Places of Worship	20	$14,532,600	$726,630	110	2	LE	15%	$108,995	100%	$726,630	15%	$108,995	$200,000	15	$8,219	$226,208	33.6%	$1,520,119	10%	0.0146%	0.57%	0.1%
	Warehouses	4	$11,066,300	$2,766,575	110	2	LE	15%	$414,986	100%	$2,766,575	15%	$414,986	$500,000	15	$20,548	$850,520	33.6%	$1,143,099	10%	0.0110%	0.43%	0.1%
	Senior Centers	5	$2,475,700	$495,140	110	2	LE	15%	$74,271	100%	$495,140	15%	$74,271	$250,000	15	$10,274	$158,816	33.6%	$266,811	11%	0.0026%	0.10%	0.0%
	Fire Stations	2	$3,255,100	$1,627,550	110	2	FE	5%	$81,378	150%	$2,441,325	15%	$366,199	$500,000	5	$13,699	$461,275	33.6%	$309,977	10%	0.0030%	0.12%	0.0%
	Schools	10	$195,125,500	$19,512,550	110	2	FE	5%	$975,628	100%	$19,512,550	15%	$2,926,883	$500,000	5	$6,849	$3,909,359	33.6%	$13,135,447	7%	0.1264%	4.92%	1.2%
	Sara Title 3 Facilities	12	$10,555,600	$879,633	110	2	N-EM	15%	$131,945	150%	$1,319,450	15%	$197,918	$500,000	15	$20,548	$350,410	33.6%	$1,412,855	13%	0.0136%	0.53%	0.1%
	Day Care Centers	23	$7,197,600	$312,939	110	2	LE	15%	$46,941	100%	$312,939	15%	$46,941	$250,000	15	$10,274	$104,156	33.6%	$804,915	11%	0.0077%	0.30%	0.1%
	Community Centers	1	$3,553,300	$3,553,300	110	2	FE	5%	$177,665	100%	$3,553,300	15%	$532,995	$250,000	5	$3,425	$714,085	33.6%	$239,932	7%	0.0023%	0.09%	0.0%
	Construction Companies	2	$1,491,800	$745,900	110	2	LE	15%	$111,885	100%	$745,900	15%	$111,885	$1,000,000	15	$41,096	$264,866	33.6%	$177,990	12%	0.0017%	0.07%	0.0%
	Medical Facilities	4	$1,618,000	$404,500	110	2	FE	5%	$20,225	150%	$606,750	15%	$91,013	$250,000	5	$3,425	$114,662	33.6%	$154,106	10%	0.0015%	0.06%	0.0%
	Apartment Complexes	10	$15,834,000	$1,583,400	110	2	N-EM	15%	$237,510	50%	$791,700	15%	$118,755	$50,000	15	$2,055	$358,320	33.6%	$1,203,955	8%	0.0116%	0.45%	0.1%
	Agricultural Properties	110	$33,754,700	$306,861	110	2	N-EW	20%	$61,372	100%	$306,861	20%	$61,372	$150,000	20	$8,219	$130,964	33.6%	$4,840,413	14%	0.0466%	1.81%	0.5%
	Residential Properties	16,573	$2,363,937,100	$142,638	110	2	N-EW	20%	$28,528	50%	$71,319	20%	$14,264	$12,000	20	$658	$43,449	33.6%	$241,946,358	10%	2.3288%	90.56%	22.8%
	TOTALS	**16,776**	**$2,664,397,300**																**$267,155,976**	**10%**	**2.5714%**	100.00%	**25.1%**
Southern Chesapeake	Places of Worship	17	$5,763,600	$339,035	110	2	LE	15%	$50,855	100%	$339,035	15%	$50,855	$200,000	15	$8,219	$109,930	33.6%	$627,919	11%	0.0060%	0.65%	0.1%
	Senior Centers	1	$417,500	$417,500	110	2	LE	15%	$62,625	100%	$417,500	15%	$62,625	$250,000	15	$10,274	$135,524	33.6%	$45,536	11%	0.0004%	0.05%	0.0%
	Fire Stations	3	$850,600	$283,533	110	2	FE	5%	$14,177	150%	$425,300	15%	$63,795	$500,000	5	$13,699	$91,670	33.6%	$92,404	11%	0.0009%	0.10%	0.0%
	Schools	3	$8,174,000	$2,724,667	110	2	FE	5%	$136,233	100%	$2,724,667	15%	$408,700	$500,000	5	$6,849	$551,783	33.6%	$556,197	7%	0.0054%	0.58%	0.1%
	Sara Title 3 Facilities	3	$53,649,800	$17,883,267	110	2	N-EM	15%	$2,682,490	150%	$26,824,900	15%	$4,023,735	$500,000	15	$20,548	$6,726,773	33.6%	$6,780,587	13%	0.0653%	7.03%	0.6%
	Agricultural Properties	657	$134,888,600	$205,310	110	2	N-EW	20%	$41,062	100%	$205,310	20%	$41,062	$150,000	20	$8,219	$90,343	33.6%	$19,943,428	15%	0.1920%	20.69%	1.9%
	Residential Properties	4,534	$668,040,400	$147,340	110	2	N-EW	20%	$29,468	50%	$73,670	20%	$14,734	$12,000	20	$658	$44,860	33.6%	$68,340,176	10%	0.6578%	70.90%	6.4%
	TOTALS	**5,218**	**$871,784,500**																**$96,386,246**	**11%**	**0.9277%**	100.00%	**9.1%**
Greenbrier	Places of Worship	17	$10,430,300	$613,547	110	2	LE	15%	$92,032	100%	$613,547	15%	$92,032	$200,000	15	$8,219	$192,283	33.6%	$1,098,322	11%	0.0106%	0.73%	0.1%
	Warehouses	37	$117,118,200	$3,165,357	110	2	LE	15%	$474,804	100%	$3,165,357	15%	$474,804	$500,000	15	$20,548	$970,155	33.6%	$12,060,967	10%	0.1161%	8.00%	1.1%
	Senior Centers	1	$1,353,600	$1,353,600	110	2	LE	15%	$203,040	100%	$1,353,600	15%	$203,040	$250,000	15	$10,274	$416,354	33.6%	$139,895	11%	0.0013%	0.09%	0.0%
	Fire Stations	1	$1,128,500	$1,128,500	110	2	FE	15%	$169,275	150%	$1,692,750	15%	$253,913	$500,000	5	$6,849	$430,037	33.6%	$144,492	10%	0.0014%	0.10%	0.0%
	Schools	3	$16,127,000	$5,375,667	110	2	FE	15%	$806,350	100%	$5,375,667	15%	$806,350	$500,000	5	$6,849	$1,619,549	33.6%	$1,632,506	10%	0.0157%	1.08%	0.2%
	Sara Title 3 Facilities	14	$52,373,300	$3,740,950	110	2	N-EM	15%	$561,143	150%	$5,611,425	15%	$841,714	$500,000	15	$20,548	$1,423,404	33.6%	$6,695,693	13%	0.0644%	4.44%	0.6%
	Day Care Centers	16	$6,141,800	$383,863	110	2	LE	15%	$57,579	100%	$383,863	15%	$57,579	$250,000	15	$10,274	$125,433	33.6%	$674,326	11%	0.0065%	0.45%	0.1%
	Medical Facilities	7	$3,875,100	$553,586	110	2	FE	5%	$27,679	150%	$830,379	15%	$124,557	$250,000	5	$3,425	$155,661	33.6%	$366,114	9%	0.0035%	0.24%	0.0%
	Construction Companies	11	$13,660,700	$1,241,882	110	2	LE	15%	$186,282	100%	$1,241,882	15%	$186,282	$1,000,000	15	$41,096	$413,660	33.6%	$1,528,889	11%	0.0147%	1.01%	0.1%
	Apartment Complexes	17	$124,636,700	$7,331,571	110	2	N-EM	15%	$1,099,736	50%	$3,665,785	15%	$549,868	$50,000	15	$2,055	$1,651,658	33.6%	$9,434,272	8%	0.0908%	6.26%	0.9%
	Agricultural Properties	34	$10,885,000	$320,147	110	2	N-EW	20%	$64,029	100%	$320,147	20%	$64,029	$150,000	20	$8,219	$136,278	33.6%	$1,556,840	14%	0.0150%	1.03%	0.1%
	Mobile Home Parks	2	$1,678,200	$839,100	110	2	M	50%	$419,550	50%	$419,550	100%	$419,550	$10,000	30	$822	$839,922	33.6%	$564,428	34%	0.0054%	0.37%	0.1%
	Residential Properties	7,185	$1,123,051,500	$156,305	110	2	N-EW	20%	$31,261	50%	$78,153	20%	$15,631	$12,000	20	$658	$47,549	33.6%	$114,790,984	10%	1.1049%	76.18%	10.8%
	TOTALS	**7,345**	**$1,482,459,900**																**$150,687,727**	**10%**	**1.4504%**	100.00%	**14.2%**

Estimated Losses Due to 100-Year Wind Event – City of Chesapeake, VA

Estimated Losses Due to 100-Year Wind Event – City of Chesapeake, VA

Estimated Losses Due to 100-Year Wind Event – City of Chesapeake, VA

Planning Area	Type of Complex	No. of Units	$ Value	Average Value Per Structure	Basic Wind Speed (mph)	Assumed Storm Class	Assumed Building Type	Expected Damage as % Building Value	Estimated Building Damage ($)	Contents Value as % of Building Value	Contents Value	% of Contents Damaged	Estimated Contents Damage ($)	Annual Budget or Housing Expenses	# Days Without Function	Estimated Total Loss of Function Per Event	Estimated Total Damages Per Structure	Approximate Percentage of Pre-Wind Code Structures in Community	Estimated Total Damages Per Sector	% Damage of Assessed Value	% Damage of Total Assessed Value All Sectors All Assists	Damage as Percent of Sector Damage	Sector Damage as Percentage of Community Damage
Rivercrest	Places of Worship	13	$7,650,300	$588,485	110	2	LE	15%	$88,273	100%	$588,485	15%	$88,273	$200,000	15	$8,219	$184,765	33.6%	$807,052	11%	0.0078%	0.78%	0.1%
	Warehouses	9	$8,019,600	$891,067	110	2	LE	15%	$133,660	100%	$891,067	15%	$133,660	$500,000	15	$20,548	$287,868	33.6%	$870,513	11%	0.0084%	0.84%	0.1%
	Senior Centers	10	$28,320,400	$2,832,040	110	2	LE	15%	$424,806	100%	$2,832,040	15%	$424,806	$250,000	15	$10,274	$859,886	33.6%	$2,889,217	11%	0.0278%	2.78%	0.3%
	Fire Stations	1	$487,100	$487,100	110	2	FE	15%	$73,065	150%	$730,650	15%	$109,598	$500,000	5	$6,849	$189,512	33.6%	$63,676	10%	0.0006%	0.06%	0.0%
	Schools	4	$44,677,700	$11,169,425	110	2	FE	15%	$1,675,414	100%	$11,169,425	15%	$1,675,414	$500,000	5	$6,849	$3,357,677	33.6%	$4,512,718	10%	0.0434%	4.34%	0.4%
	Sara Title 3 Facilities	15	$19,462,000	$1,297,467	110	2	N-EM	15%	$194,620	150%	$1,946,200	15%	$291,930	$500,000	15	$20,548	$507,098	33.6%	$2,555,774	13%	0.0246%	2.46%	0.2%
	Day Care Centers	8	$2,200,000	$275,000	110	2	LE	15%	$41,250	100%	$275,000	15%	$41,250	$250,000	15	$10,274	$92,774	33.6%	$249,376	11%	0.0024%	0.24%	0.0%
	Community Centers	2	$7,106,600	$3,553,300	110	2	FE	5%	$177,665	100%	$3,553,300	15%	$532,995	$250,000	5	$3,425	$714,085	33.6%	$479,865	7%	0.0046%	0.46%	0.0%
	Construction Companies	3	$6,662,100	$2,220,700	110	2	LE	15%	$333,105	100%	$2,220,700	15%	$333,105	$1,000,000	15	$41,096	$707,306	33.6%	$712,964	11%	0.0069%	0.69%	0.1%
	Medical Facilities	11	$32,471,400	$2,951,945	110	2	FE	5%	$147,597	150%	$4,427,918	15%	$664,188	$250,000	5	$3,425	$815,210	33.6%	$3,013,015	9%	0.0290%	2.90%	0.3%
	Apartment Complexes	7	$29,389,400	$4,198,486	110	2	N-EM	15%	$629,773	50%	$2,099,243	15%	$314,886	$50,000	15	$2,055	$946,714	33.6%	$2,226,672	8%	0.0214%	2.14%	0.2%
	Agricultural Properties	7	$2,935,800	$419,400	110	2	N-EW	20%	$83,880	100%	$419,400	20%	$83,880	$150,000	20	$8,219	$175,979	33.6%	$413,903	14%	0.0040%	0.40%	0.0%
	Mobile Home Parks	5	$3,745,100	$749,020	110	2	M	50%	$374,510	50%	$374,510	100%	$374,510	$10,000	30	$822	$749,842	33.6%	$1,259,734	34%	0.0121%	1.21%	0.1%
	Residential Properties	6,122	$818,800,200	$133,747	110	2	N-EW	20%	$26,749	50%	$66,874	20%	$13,375	$12,000	20	$658	$40,782	33.6%	$83,887,603	10%	0.8074%	80.71%	7.9%
	TOTALS	**6,217**	**$1,011,927,700**																**$103,942,081**	**10%**	**1.0005%**	100.00%	**9.8%**
South Norfolk	Places of Worship	42	$11,033,900	$262,712	110	2	LE	15%	$39,407	100%	$262,712	15%	$39,407	$200,000	15	$8,219	$87,033	33.6%	$1,228,206	11%	0.0118%	1.90%	0.1%
	Warehouses	57	$60,190,200	$1,055,968	110	2	LE	15%	$158,395	100%	$1,055,968	15%	$158,395	$500,000	15	$20,548	$337,338	33.6%	$6,460,706	11%	0.0622%	9.99%	0.6%
	Senior Centers	6	$6,095,500	$1,015,917	110	2	LE	15%	$152,388	100%	$1,015,917	15%	$152,388	$250,000	15	$10,274	$315,049	33.6%	$635,139	11%	0.0061%	0.98%	0.1%
	Fire Stations	2	$2,447,500	$1,223,750	110	2	FE	5%	$61,188	150%	$1,835,625	15%	$275,344	$500,000	5	$6,849	$343,381	33.6%	$230,752	10%	0.0022%	0.36%	0.0%
	Schools	7	$18,970,700	$2,710,100	110	2	FE	5%	$135,505	100%	$2,710,100	15%	$406,515	$500,000	5	$6,849	$548,869	33.6%	$1,290,941	7%	0.0124%	2.00%	0.1%
	Sara Title 3 Facilities	20	$23,891,600	$1,194,580	110	2	N-EM	15%	$179,187	150%	$1,791,870	15%	$268,781	$500,000	15	$20,548	$468,515	33.6%	$3,148,424	13%	0.0303%	4.87%	0.3%
	Day Care Centers	23	$35,366,100	$1,537,657	110	2	LE	15%	$230,648	100%	$1,537,657	15%	$230,648	$250,000	15	$10,274	$471,571	33.6%	$3,644,300	10%	0.0351%	5.64%	0.3%
	Community Centers	2	$7,106,600	$3,553,300	110	2	FE	5%	$177,665	100%	$3,553,300	15%	$532,995	$250,000	5	$3,425	$714,085	33.6%	$479,865	7%	0.0046%	0.74%	0.0%
	Construction Companies	5	$4,418,200	$883,640	110	2	LE	15%	$132,546	100%	$883,640	15%	$132,546	$1,000,000	15	$41,096	$306,188	33.6%	$514,396	12%	0.0050%	0.80%	0.0%
	Medical Facilities	9	$2,934,500	$326,056	110	2	FE	5%	$16,303	150%	$489,083	15%	$73,363	$250,000	5	$3,425	$93,090	33.6%	$281,504	10%	0.0027%	0.44%	0.0%
	Apartment Complexes	46	$64,456,400	$1,401,226	110	2	N-EM	15%	$210,184	50%	$700,613	15%	$105,092	$50,000	15	$2,055	$317,331	33.6%	$4,904,663	8%	0.0472%	7.59%	0.5%
	Mobile Home Parks	2	$6,176,700	$3,088,350	110	2	M	50%	$1,544,175	50%	$1,544,175	100%	$1,544,175	$10,000	30	$822	$3,089,172	33.6%	$2,075,924	34%	0.0200%	3.21%	0.2%
	Residential Properties	7,114	$378,918,500	$53,264	110	2	N-EW	20%	$10,653	50%	$26,632	20%	$5,326	$12,000	20	$658	$16,637	33.6%	$39,766,692	10%	0.3828%	61.50%	3.7%
	TOTALS	**7,335**	**$622,006,400**																**$64,661,510**	**10%**	**0.6224%**	100.00%	**6.1%**
Indian River	Places of Worship	17	$10,036,100	$590,359	110	2	LE	15%	$88,554	100%	$590,359	15%	$88,554	$200,000	15	$8,219	$185,327	33.6%	$1,058,587	11%	0.0102%	1.35%	0.1%
	Warehouses	23	$37,320,700	$1,622,639	110	2	LE	15%	$243,396	100%	$1,622,639	15%	$243,396	$500,000	15	$20,548	$507,340	33.6%	$3,920,721	11%	0.0377%	5.01%	0.4%
	Senior Centers	3	$32,516,900	$10,838,967	110	2	LE	15%	$1,625,845	100%	$10,838,967	15%	$1,625,845	$250,000	15	$10,274	$3,261,964	33.6%	$3,288,060	11%	0.0316%	4.21%	0.3%
	Fire Stations	1	$298,300	$298,300	110	2	FE	5%	$14,915	150%	$447,450	15%	$67,118	$500,000	5	$6,849	$88,882	33.6%	$29,864	10%	0.0003%	0.04%	0.0%
	Schools	5	$53,024,900	$10,604,980	110	2	FE	5%	$530,249	100%	$10,604,980	15%	$1,590,747	$500,000	5	$6,849	$2,127,845	33.6%	$3,574,780	7%	0.0344%	4.57%	0.3%
	Sara Title 3 Facilities	1	$1,592,000	$1,592,000	110	2	N-EM	15%	$238,800	150%	$2,388,000	15%	$358,200	$500,000	15	$20,548	$617,548	33.6%	$207,496	13%	0.0020%	0.27%	0.0%
	Day Care Centers	12	$2,860,700	$238,392	110	2	LE	15%	$35,759	100%	$238,392	15%	$35,759	$250,000	15	$10,274	$81,791	33.6%	$329,783	12%	0.0032%	0.42%	0.0%
	Community Centers	1	$3,553,300	$3,553,300	110	2	FE	5%	$177,665	100%	$3,553,300	15%	$532,995	$250,000	5	$3,425	$714,085	33.6%	$239,932	7%	0.0023%	0.31%	0.0%
	Construction Companies	6	$18,004,700	$3,000,783	110	2	LE	15%	$450,118	100%	$3,000,783	15%	$450,118	$1,000,000	15	$41,096	$941,331	33.6%	$1,897,723	11%	0.0183%	2.43%	0.2%
	Medical Facilities	4	$1,045,700	$261,425	110	2	FE	5%	$13,071	150%	$392,138	15%	$58,821	$250,000	5	$3,425	$75,317	33.6%	$101,225	10%	0.0010%	0.13%	0.0%
	Apartment Complexes	9	$49,853,100	$5,539,233	110	2	N-EM	15%	$830,885	50%	$2,769,617	15%	$415,443	$50,000	15	$2,055	$1,248,382	33.6%	$3,775,108	8%	0.0363%	4.83%	0.4%
	Mobile Home Parks	1	$1,640,800	$1,640,800	110	2	M	50%	$820,400	50%	$820,400	100%	$820,400	$10,000	30	$822	$1,641,622	33.6%	$551,585	34%	0.0053%	0.71%	0.1%
	Residential Properties	6,237	$573,748,900	$91,991	110	2	N-EW	20%	$18,398	50%	$45,996	20%	$9,199	$12,000	20	$658	$28,255	33.6%	$59,211,839	10%	0.5699%	75.73%	5.6%
	TOTALS	**6,320**	**$785,496,100**																**$78,186,704**	**10%**	**0.7526%**	100.00%	**7.4%**
Western Branch	Places of Worship	19	$26,134,200	$1,375,484	110	2	LE	15%	$206,323	100%	$1,375,484	15%	$206,323	$200,000	15	$8,219	$420,864	33.6%	$2,686,799	10%	0.0259%	1.73%	0.3%
	Warehouses	3	$5,358,025	$1,786,008	110	2	LE	15%	$267,901	100%	$1,786,008	15%	$267,901	$500,000	15	$20,548	$556,350	33.6%	$560,801	11%	0.0054%	0.36%	0.1%
	Senior Centers	2	$4,821,500	$2,410,750	110	2	LE	15%	$361,613	100%	$2,410,750	15%	$361,613	$250,000	15	$10,274	$733,499	33.6%	$492,911	11%	0.0047%	0.32%	0.0%
	Fire Stations	2	$872,600	$436,300	110	2	FE	5%	$21,815	150%	$654,450	15%	$98,168	$500,000	5	$6,849	$126,832	33.6%	$85,231	10%	0.0008%	0.05%	0.0%
	Schools	7	$112,457,200	$16,065,314	110	2	FE	5%	$803,266	100%	$16,065,314	15%	$2,409,797	$500,000	5	$6,849	$3,219,912	33.6%	$7,573,233	7%	0.0729%	4.87%	0.7%
	Sara Title 3 Facilities	8	$5,258,700	$657,338	110	2	N-EM	15%	$98,601	150%	$986,006	15%	$147,901	$500,000	15	$20,548	$267,050	33.6%	$717,829	13%	0.0069%	0.46%	0.1%
	Day Care Centers	7	$7,025,100	$1,003,586	110	2	LE	15%	$150,538	100%	$1,003,586	15%	$150,538	$250,000	15	$10,274	$311,350	33.6%	$732,294	12%	0.0070%	0.47%	0.1%
	Community Centers	1	$3,553,300	$3,553,300	110	2	FE	5%	$177,665	100%	$3,553,300	15%	$532,995	$250,000	5	$3,425	$714,085	33.6%	$239,932	7%	0.0023%	0.15%	0.0%
	Medical Facilities	13	$9,961,200	$766,246	110	2	FE	5%	$38,312	150%	$1,149,369	15%	$172,405	$250,000	5	$3,425	$214,142	33.6%	$935,374	9%	0.0090%	0.60%	0.1%
	Agricultural Properties	48	$16,963,400	$353,404	110	2	N-EW	20%	$70,681	100%	$353,404	20%	$70,681	$150,000	20	$8,219	$149,581	33.6%	$2,412,440	14%	0.0232%	1.55%	0.2%
	Apartment Complexes	12	$37,422,624	$3,118,552	110	2	N-EM	15%	$467,783	50%	$1,559,276	15%	$233,891	$50,000	15	$2,055	$703,729	33.6%	$2,837,435	8%	0.0273%	1.82%	0.3%
	Residential Properties	10,403	$1,328,889,400	$127,741	110	2	N-EW	20%	$25,548	50%	$63,870	20%	$12,774	$12,000	20	$658	$38,980	33.6%	$136,250,402	10%	1.3114%	87.61%	12.8%
	TOTALS	**10,525**	**$1,558,717,249**																**$155,524,682**	**10%**	**1.4969%**	100.00%	**14.6%**
	COMMUNITY TOTALS	**71,464**	**$10,389,509,449**															**Total Community**	**$1,063,024,617**	**10.2317%**	**10.2317%**		

Estimated Losses Due to 100-Year Wind Event – City of Chesapeake, VA

List of Parameters	Definition of Parameters
Sector (Planning Area)	One of nine planning areas within the City of Chesapeake.
Type of Complex	Property type; primary focus on residential and public buildings.
No. of Units	Total number of units in each planning area.
$ Value	= (No. of Units x Average Value per Structure); represents the total dollar value of all units in each planning area.
Average Value Per Structure	Pre-determined average value for a single structure of a given complex type.
Basic Wind Speed (mph)	The assumed design wind speed for a 100-year wind event in the City of Chesapeake, based on the wind speed for a 3-second peak gust with a 100 year return period from ASCE Standard 7-98.
Assumed Storm Class	= 2; represents the wind speed range for a Category 2 Hurricane (96-110 mph) associated with the Basic Wind Speed (110 mph).
Assumed Building Type	Building type assumed based on typical structure encountered for a given Type of Complex. Building types listed below reflect the type of building construction used for the structure: M: Manufactured buildings that are mass produced in large numbers of identical/smaller units; assumed building type for Mobile Home Parks. N-EW: Non-Engineered Wood buildings that have not been specifically engineered during design; assumed building type for Agricultural Properties and Residential Properties. N-EM: Non-Engineered Masonry buildings that have not been specifically engineered during design; assumed building type for Sara Title 3 Facilities and Apartment Complexes. LE: Lightly Engineered buildings where some portions of these buildings have received engineering attention; assumed building type for Places of Worship, Warehouses, Senior Centers, Day Care Centers and Construction Companies. FE: Fully Engineered buildings that have been designed for a specific location and fully engineered during design; assumed building type for Schools, Fire Stations, Community Centers, and Medical Facilities.
Expected Damage as % Building Value	Taken from FEMA's Hurricane Wind Benefit-Cost Module building Wind Damage Function (WDF) tables for each building type.
Estimated Building Damage ($)	= (Average Value Per Structure x Expect Damage as % Building Damage); represents the total dollar value of building damage for each structure.
Contents Value as % of Building Value	The ratio of the value of building contents to the value of the structure itself; taken from HAZUS data based on Type of Complex.
Contents Value	= (Content Values as % of Building x Average Value per Structure); estimated value of all contents within a structure.
% Contents Damage	Taken from FEMA's Hurricane Wind Benefit-Cost Module contents Wind Damage Function (WDF) tables for each building type.
Estimated Contents Damage ($)	= (Contents Value x % Contents Damaged); represents the total dollar value of contents damage for each structure.
Annual Budget or Housing Expenses	Estimated annual operating budget for non-residential properties, or annual average housing costs for residential properties.
# Days Without Function	The duration of building loss of function (LOF) after a flood; taken from FEMA's Hurricane Wind Benefit-Cost Module LOF Wind Damage Function (WDF) tables for each building type..
Estimated Total Loss of Function per Event	= (Yearly Budget/365) x No. of Days; represents the total dollar value of lost services in a wind event for each structure.
Estimated Total Damages Per Structure	= (Building Damage $ + Contents Damaged $ + Total Loss of Function Per Event); represents the sum of all wind damages for each structure.
Approximate Percentage of Pre-Wind Code Structures in Community	The proportion of structures constructed in the City of Chesapeake prior to the adoption of the local building code in the State of Virginia in 1973; structures constructed before 1973 are assumed to be most vulnerable to wind damage.
Estimated Total Damages Per Sector	= (Total Damages Per Structure x Approximate Percentage of Pre-Wind Code Structures x No. of Units); represents total dollar amount of damages for the properties within each planning area.
% Damage of Assessed Value	= (Total Damages Per Sector / $ Value); ratio between the total damage value and the overall property value for each planning area.
% Damage of Assessed Value All Sectors All Assets	= (Total Damages Per Sector / Total Community $ Value); ratio between the total damage value and the overall property value for all planning areas.
Damage as Percent of Sector Damage	= (Total Damages Per Sector / Σ Total Damages Per Sector); ratio between the total damage value and the total sector damage value for each sector.
Damage as Percent of Total Community Damage	= (Total Damages Per Sector / Total Community Damages); ratio between the total damage value and the total damage value for all planning areas.

VULNERABILITY ASSESSMENT FOR 100-YEAR WIND EVENT - CITY OF CHESAPEAKE, VA

PLANNING AREA	TOTAL NO. OF UNITS	APPROXIMATE TOTAL VALUE	ESTIMATED 100-YEAR WIND DAMAGES PER PLANNING AREA	PERCENT OF TOTAL COMMUNITY DAMAGED	TOTAL PLANNING AREA POPULATION	PERCENT POPULATION DISTRIBUTION	ESTIMATED PER CAPITA PLANNING AREA DAMAGE	VULNERABILITY INDEX
Camelot	**2,581**	**$308,503,000**	**$33,657,878**	**3.2%**	**7,702**	**3.9%**	**$4,370**	**Low**
Deep Creek	**9,147**	**$1,084,217,300**	**$112,821,811**	**10.6%**	**23,800**	**12.0%**	**$4,740**	**Medium**
Great Bridge	**16,776**	**$2,664,397,300**	**$267,155,976**	**25.1%**	**43,918**	**22.1%**	**$6,083**	**Medium**
Southern Chesapeake	**5,218**	**$871,784,500**	**$96,386,246**	**9.1%**	**11,987**	**6.0%**	**$8,041**	**High**
Greenbrier	**7,345**	**$1,482,459,900**	**$150,687,727**	**14.2%**	**23,864**	**12.0%**	**$6,314**	**High**
Rivercrest	**6,217**	**$1,011,927,700**	**$103,942,081**	**9.8%**	**17,019**	**8.5%**	**$6,107**	**High**
South Norfolk	**7,335**	**$622,006,400**	**$64,661,510**	**6.1%**	**22,797**	**11.5%**	**$2,836**	**Low**
Indian River	**6,320**	**$785,496,100**	**$78,186,704**	**7.4%**	**19,444**	**9.8%**	**$4,021**	**Low**
Western Branch	**10,525**	**$1,558,717,249**	**$155,524,682**	**14.6%**	**28,558**	**14.3%**	**$5,446**	**Medium**
ESTIMATED TOTALS	**71,464**	**$10,389,509,449**	**$1,063,024,617**	**100.0%**	**199,089**	**100.0%**	**$5,339**	

Vulnerability Index Determination

Avg. Sector Damages Per Person Range		Vulnerability Index	Distribution
0	$4,589	Low	3
$4,590	$6,089	Medium	3
$6,090	$10,339	High	3

NOTE: Damage ($/Person) values assume a margin of error of ± 10 percent.

APPENDIX D — FREQUENTLY USED MITIGATION TERMS AND ACRONYM LIST

Frequently Used Mitigation Terms

Acquisition of Hazard-Prone Structures	Local governments can acquire lands in high hazard areas through conservation easements, purchase of development rights, or outright purchase of property.
Base Flood Elevation (BFE)	Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The Base Flood Elevation is used as a standard for the National Flood Insurance Program.
Benefit	Net project outcomes, usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of conducting a benefit cost analysis of proposed mitigation measures, benefits are limited to specific, measurable risk reduction factors, including a reduction in expected property losses (building, contents, and function) and protection of human life.
Benefit-Cost Analysis (BCA)	A systematic, quantitative method of comparing the projected benefits to projected costs of a project or policy. It is used as a measure of cost-effectiveness.
Capability Assessment	An assessment that provides a description and analysis of a community or state's current capacity to address the threats associated with hazards. The capability assessment attempts to identify and evaluate existing policies, regulations, programs, and practices that positively or negatively affect the community or state's vulnerability to hazards or specific threats.
Community Rating System (CRS)	CRS is a program that provides incentives for National Flood Insurance Program communities to complete activities that reduce flood hazard risk. When the community completes specified activities, the insurance premiums of these policyholders in

	communities are reduced.
Cost-Effectiveness	Cost-effectiveness is a key evaluation criterion for federal grant programs. Cost- effectiveness has several possible definitions, although for grant making purposes FEMA defines a cost-effective project as one whose long-term benefits exceed its costs. That is, a project should prevent more expected damages than it costs initially to fund the effort. This is done to ensure that limited public funds are used in the most efficient manner possible. Benefit-cost analysis is one way to illustrate that a project is cost-effective.
Critical Facilities	Facilities vital to the health, safety, and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to, shelters, police and fire stations, and hospitals.
Debris	The scattered remains of assets broken or destroyed in a hazard event. Debris transported by a wind or water hazard event can cause additional damage to other assets.
Disaster Mitigation Act of 2000 (DMA 2000)	DMA 2000 (Public Law 106-390) is the latest legislation to improve the planning process. Signed into law on October 30, 2000, this legislation reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur.
Displacement Time	The average time (in days) which the building's occupants typically must operate from a temporary location while repairs are made to the original building due to damages resulting from a hazard event.
Elevation of Structures	Raising structures above the base flood elevation to protect structures located in areas prone to flooding.
Erosion	Wearing away of the land surface by detachment and movement of soil and rock fragments, during a flood or storm or over a period of years, through the action of wind, water, or other geologic processes.
Essential Facility	Elements that are important to ensure a full recovery of a community

	or state following a hazard event. These would include government functions, major employers, banks, schools, and certain commercial establishments, such as grocery stores, hardware stores, and gas stations.
Federal Emergency Management Agency (FEMA)	Agency created in 1979 to provide a single point of accountability for all Agency created in 1979 to provide a single point of accountability for all federal activities related to disaster mitigation and emergency preparedness, response, and recovery. FEMA is now part of the Department of Homeland Security.
Flash Flood	A flood event occurring with little or no warning where water levels rise at an extremely fast rate.
Flood	A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.
Flood Depth	Height of the flood water surface above the ground surface.
Flood Elevation	Elevation of the water surface above an established datum, e.g. National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or Mean Sea Level.
Flood Hazard Area	The area on a map shown to be inundated by a flood of a given magnitude.
Flood Insurance Rate Map (FIRM)	Map of a community, prepared by the Federal Emergency Management Agency that shows both the special flood hazard areas and the risk premium zones applicable to the community.
Flood Insurance Study (FIS)	A study that provides an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations in a community or communities.
Flood Mitigation Assistance	A program created as part of the National Flood Insurance Reform

(FMA) Program	Act of 1994. FMA provides funding to assist communities and states in implementing actions that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other NFIP insurable structures, with a focus on repetitive loss properties.
Floodplain	Any land area, including watercourse, susceptible to partial or complete inundation by water from any source.
Floodproofing	Actions that prevent or minimize future flood damage. Making the areas below the anticipated flood level watertight (dry floodproofing) or intentionally allowing floodwaters to enter the interior to equalize flood pressures are examples of flood-proofing (wet floodproofing).
Flood Zone	A geographical area shown on a Flood Insurance Rate Map (FIRM) that reflects the severity or type of flooding in the area.
Frequency	A measure of how often events of a particular magnitude are expected to occur. Frequency describes how often a hazard of a specific magnitude, duration, and/or extent typically occurs, on average. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average, and would have a 1 percent chance – its probability – of happening in any given year. The reliability of this information varies depending on the kind of hazard being considered.
Functional Downtime	The average time (in days) during which a function (business or service) is unable to provide its services due to a hazard event.
Geographic Information Systems (GIS)	A computer software application that relates physical features on the earth to a database to be used for mapping and analysis.
Goals	General guidelines that explain what you want to achieve. They are usually broad policy-type statements, long term in nature, and represent global visions.
Hazard	A source of potential danger or adverse condition. Hazards include naturally occurring events such as floods, earthquakes, tornadoes,

	tsunami, coastal storms, landslides, and wildfires that strike populated areas and has the potential to harm people or property.
Hazard Event	A specific occurrence of a particular type of hazard.
Hazard Identification	The process of identifying hazards that threaten an area.
Hazard Information Center	Information booth, publication kiosk, exhibit, etc. that displays information to educate the public about hazards that affect the jurisdiction and hazard mitigation activities people can undertake.
Hazard Mitigation	Sustained actions taken to reduce or eliminate long-term risk from hazards and their effects.
Hazard Mitigation Grant Program (HMGP)	Authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster.
Hazard Profile	A description of the physical characteristics of hazards and a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.
Hurricane	An intense tropical cyclone, formed in the atmosphere over warm ocean seas, in which wind speeds reach 74-miles-per-hour or more and blow in large spiral around a relatively calm center or "eye". Hurricanes develop over the north Atlantic Ocean, northeast Pacific Ocean, or the south Pacific Ocean east of 160°E longitude. Hurricane circulation is counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.
Hydrology	The science of dealing with the waters of the earth. A flood discharge

	is developed by a hydrologic study.
Infrastructure	Refers to the public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer treatment facilities, and transportation systems such as airports, heliports; highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots; and waterways, canals, locks, seaports, ferries, harbors, dry docks, piers and regional dams.
Landslide	Downward movement of a slope and materials under the force of gravity.
Loss Estimation	Forecasts of human and economic impacts and property damage from future hazard events, based on current scientific and engineering knowledge.
Lowest Floor	Under the NFIP, the lowest floor of the lowest enclosed area (including basement) of a structure.
Magnitude	A measure of the strength of a hazard event. The magnitude (also referred to as severity) of a given hazard event is usually determined using technical measures specific to the hazard.
Mitigate	To cause something to become less harsh or hostile: to make less severe or painful.
Mitigation Actions	Activities or projects that help achieve the goals and objectives of a mitigation plan.
Mitigation Plan	The document that articulates results from the systematic process of identifying hazards and evaluating vulnerability, identifying goals, objectives, and actions to reduce or eliminate the effects of identified hazards, and an implementation plan for carrying out the actions.
National Flood Insurance	Federal program created by Congress in 1968 that makes flood insurance available in communities that enact minimum floodplain

Program (NFIP)	management regulations in 44 CFR §60.3.
National Weather Service (NWS)	Prepares and issues flood, severe weather, and coastal storm warnings and can provide technical assistance to Federal and state entities in preparing weather and flood warning plans.
Nor'easter	An extra-tropical cyclone producing gale-force winds and precipitation in the form of heavy snow or rain.
Objectives	Objectives define strategies or implementation steps to attain the identified goals. Unlike goals, objectives are specific and measurable.
Open Space Preservation	Preserving undeveloped areas from development through any number of methods, including low-density zoning, open space zoning, easements, or public or private acquisition. Open space preservation is a technique that can be used to prevent flood damage in flood-prone areas, land failures on steep slopes or liquefaction-prone soils, and can enhance the natural and beneficial functions of floodplains.
Post-Disaster Recovery Planning	The process of planning those steps the jurisdiction will take to implement long-term reconstruction with a primary goal of mitigating its exposure to future hazards. The post-disaster recovery planning process can also involve coordination with other types of plans and agencies, but it is distinct from planning for emergency operations.
Probability	A statistical measure of the likelihood that a hazard event will occur.
Public Education and Outreach Programs	Any campaign to make the public more aware of hazard mitigation and mitigation programs, including hazard information centers, mailings, public meetings, etc.
Regulation	Most states have granted local jurisdictions broad regulatory powers to enable the enactment and enforcement of ordinances that deal with public health, safety, and welfare. These include building codes, building inspections, zoning, floodplain and subdivision ordinances,

	and growth management initiatives.
Recurrence Interval	The time between hazard events of similar size in a given location. It is based on the probability that the given event will be equaled or exceeded in any given year.
Relocation Out of Hazard Areas	A mitigation technique that features the process of demolishing or moving a building to a new location outside the hazard area.
Repetitive Loss Property	A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1,000 each have been paid within any 10-year period since 1978.
Replacement Value	The cost of rebuilding a structure. This is usually expressed in terms of cost per square foot, and reflects the present-day cost of labor and materials to construct a building of a particular size, type and quality. This is not the same as market value.
Resources	Resources include the people, materials, technologies, money, etc., required to implement strategies or processes. The costs of these resources are often included in a budget.
Risk	The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood of sustaining damage above a particular threshold due to a specific type of hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.
Special Flood Hazard Area (SFHA)	An area within a floodplain having a 1 percent or greater chance of flood occurrence in any given year (100-year floodplain); represented on Flood Insurance Rate Maps by darkly shaded areas with zone designations hat include the letter A or V.

Stafford Act	The Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-107 was signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, PL 93-288. The Stafford Act is the statutory authority for most Federal disaster response activities, especially as they pertain to FEMA and its programs.
Stakeholders	Individuals or groups, including businesses, private organizations, and citizens, that will be affected in any way by an action or policy.
State Hazard Mitigation Officer (SHMO)	The representative of state government who is the primary point of contact with FEMA, other state and Federal agencies, and local units of government in the planning and implementation of pre- and post disaster mitigation activities.
Storm Surge	Rise in the water surface above normal water level on the open coast due to the action of wind stress and atmospheric pressure on the water surface.
Structural Retrofitting	Modifying existing buildings and infrastructure to protect them from hazards.
Subdivision and Development Regulations	Regulations and standards governing the division of land for development or sale. Subdivision regulations can control the configuration of parcels, set standards for developer-built infrastructure, and set standards for minimizing runoff, impervious surfaces, and sediment during development. They can be used to minimize exposure of buildings and infrastructure to hazards.
Tornado	A violently rotating column of air extending from a thunderstorm to the ground.
Tropical Cyclone	A generic term for a cyclonic, low-pressure system over tropical or subtropical waters.
Tropical Depression	A tropical cyclone with maximum sustained winds of less than 39 mph.

Tropical Storm	A tropical cyclone with maximum sustained winds greater than 39 mph and less than 74 mph.
Vulnerability	Describes how exposed or susceptible to damage an asset is. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power – if an electric substation is flooded, it will affect not only the substation itself, but a number of businesses as well. Often, indirect effects can be much more widespread and damaging than direct ones.
Vulnerability Assessment	The extent of injury and damage that may result from a hazard event of a given intensity in a given area. The vulnerability assessment should address impacts of hazard events on the existing and future built environment.
Zoning Ordinance	Designation of allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

Acronym List

BFE – Base Flood Elevation

BRV – Building Replacement Value

BZA – Board of Zoning Appeals

CBPA – Chesapeake Bay Preservation Area

CRS – Community Rating System

CRV – Contents Replacement Value

DDF – Depth Damage Function

DMA 2000 – Disaster Mitigation Act of 2000

DOF – Virginia Department of Forestry

DPW – Department of Public Works

EMI – Emergency Management Institute

FEMA – Federal Emergency Management Agency

FIA – Flood Insurance Administration

FIRM – Flood Insurance Rate Map

FIS – Flood Insurance Study

GIS – Geographical Information System

HAZMAT – Hazardous Materials

HIRA – Hazard Identification Risk Assessment

HMGP – Hazard Mitigation Grant Program

HRPDC – Hampton-Roads Planning District Commission

HVA – Hazard Vulnerability Assessment

IBC – International Building Code

IFPC – International Fire Protection Codes

IRC – International Residential Code

ISO – Insurance Services Office

LEPC – Local Emergency Planning Committee

LOF – Loss of Function

MAC – Mitigation Advisory Committee

MLW – Mean Low Water

MSA – Metropolitan Statistical Area

NAS – Naval Air Station

NATO – North Atlantic Treaty Organization

NEMAC – National Event Mitigation Advisory Committee

NFIP – National Flood Insurance Program

NHC – National Hurricane Center

NOAA – National Oceanic Atmospheric Administration

NPDES – National Pollutant Discharge Elimination System

NWS – National Weather Service

PFM – Public Facilities Manual

RMA – Resource Management Area

RPA – Resource Protection Area

SFHA's – Special Flood Hazard Areas

SLOSH – Sea, Lake and Overland Surges from Hurricanes

STAPLE/E – Social, Technical, Administrative, Political, Legal, Economic and Environmental

TBA – Tidewater Builders Association

USDA – United States Department of Agriculture

USGS – United States Geological Survey

VDEM – Virginia Department of Emergency Management

VDEQ – Virginia Department of Environmental Quality

WDF – Wind Damage Function