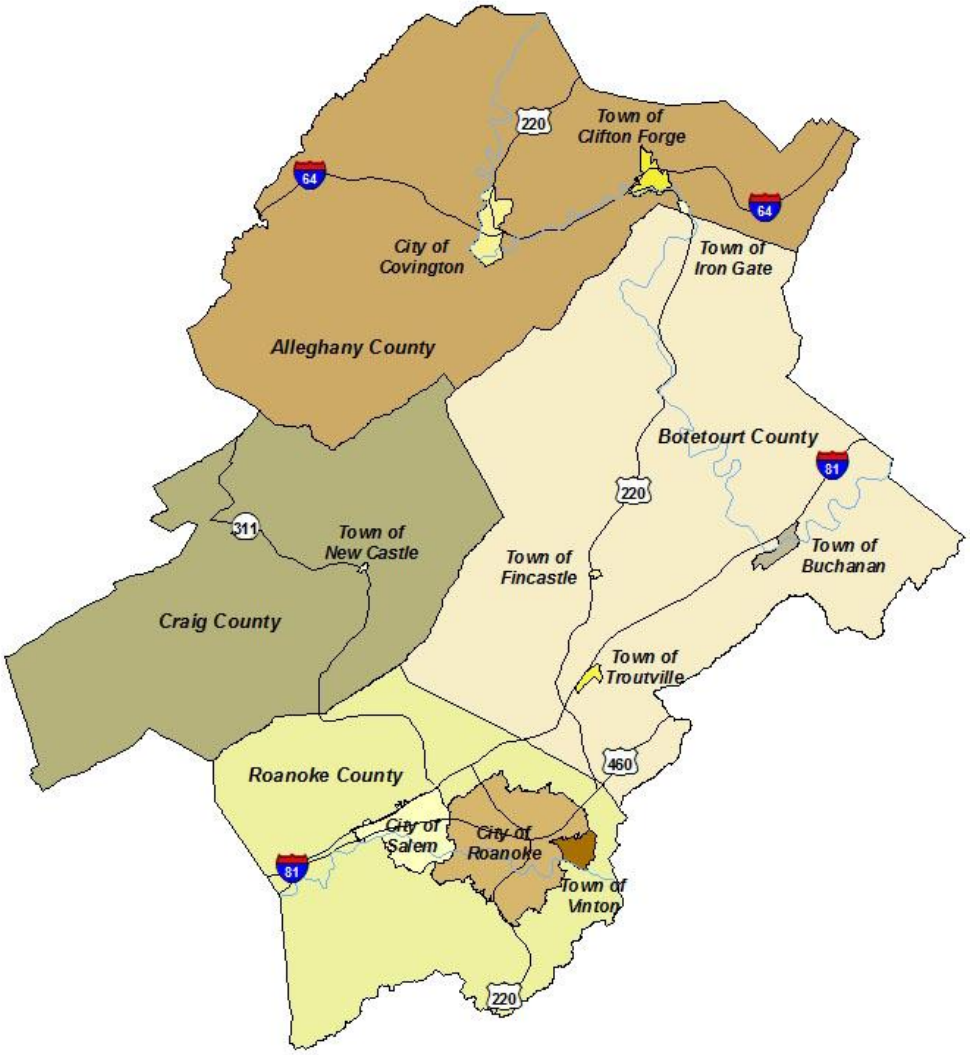
Roanoke Valley-Alleghany Regional Commission

Regional Pre-Disaster Mitigation Plan



Roanoke Valley-Alleghany
REGIONAL
commission

Prepared by:

Roanoke Valley - Alleghany Regional Commission

June 2013

Roanoke Valley-Alleghany Regional Commission
Pre-Disaster Mitigation Plan Committee

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EXECUTIVE SUMMARY

The Disaster Mitigation Act of 2000 requires that local governments, as a condition of receiving federal disaster mitigation funds for Presidential Disaster Declarations, have a mitigation plan that describes the process for identifying hazards, risks and vulnerabilities, identifies and prioritizes mitigation actions, encourage the development of local mitigation and provide technical support for those efforts. The Roanoke Valley-Alleghany region has had twenty (20) Presidential Disaster Declarations since 1969.

The Federal Emergency Management Agency (FEMA) defines Mitigation as any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event. Mitigation, also known as prevention, encourages long-term reduction of hazard vulnerability. The goal of mitigation is to save lives and reduce property damage. Mitigation can accomplish this, and should be cost-effective and environmentally sound. This, in turn, can reduce the enormous cost of disasters to property owners and all levels of government. In addition, mitigation can protect critical community facilities, reduce exposure to liability, and minimize community disruption. Examples include land use planning, adoption of building codes, and elevation of homes, or acquisition and relocation of homes away from floodplains.

It has been demonstrated time after time that hazard mitigation is most effective when based on an inclusive, comprehensive, long-term plan that is developed before a disaster actually occurs. However, in the past, many communities have undertaken mitigation actions with good intentions but with little advance planning. In some of these cases, decisions have been made "on the fly" in the wake of a disaster. In other cases, decisions may have been made in advance but without careful consideration of all options, effects, and/or contributing factors. The results have been mixed at best, leading to less than optimal use of limited resources.

In 2002 VDEM requested that PDCs take the lead in developing regional pre-disaster mitigation plans. This document is an update of the previous plan that was approved by FEMA in 2006. The purpose of this plan is to fulfill local Pre-Disaster Mitigation Plan requirements. While the plan does not establish any legal requirements for the localities, it does provide a framework for planning for natural hazards. The plan identifies hazards; establishes individual locality goals and objectives and select mitigation activities that are appropriate for the Roanoke Valley-Alleghany Region.

Planning Area

The Regional Pre-Disaster Mitigation Plan affects unincorporated areas, towns, cities and counties within the Roanoke Valley-Alleghany Regional Commission service area except Franklin County and the towns of Boones Mill and Rocky Mount which are covered by the West Piedmont PDC's plan. The localities addressed in this plan include: the counties of Alleghany, Botetourt, Craig and Roanoke; the cities of Covington, Roanoke and Salem; and the towns of Buchanan, Clifton Forge, Fincastle, Iron Gate, New Castle, Troutville and Vinton.

The Regional Mitigation Plan

The purpose of this planning initiative is to develop a Plan that meets all State and Federal requirements. The Plan will help localities maintain their eligibility for certain future Federal funding, especially the Hazard Mitigation Grant Program. A FEMA-approved Mitigation Plan is also required to participate in the Emergency Management Performance Grant Program and in projects under the Pre- Disaster Mitigation Grant Program.

The plan outlines general actions designed to address and reduce the impact of a full range of natural hazards facing region, including such natural hazards as floods, hurricanes, winter storms and wildfires. A multi-jurisdictional planning approach was utilized. By having multiple jurisdictions work together on common hazards/risks, the planning process eliminated the need for each local jurisdiction to devise its own approach and prepare its own separate document. Further, this type of planning effort resulted in a common plan format and loss estimation technique that will help the State Department of Emergency Management and FEMA understand the area's vulnerabilities when evaluating future policies and projects.

While a single, regional plan was developed, please note that each local jurisdiction has its own separate section outlining goals, objectives and projects as part of the overall plan.

Hazard Identification

The RVARC worked with the Regional Pre-Disaster Mitigation Plan Committee to compile data on natural hazards. Information was compiled on the occurrence of natural hazard events in the region. Hazards that affect the area were identified based on historical and other available data. Each local jurisdiction has been given an opportunity to review the hazard events data and make amendments as appropriate.

The region has experienced nearly all types of natural disasters, the major ones being flooding, straight-line winds, winter storms, and wildfires. Other disasters that might occur in the region include earthquakes, hurricanes, landslides and tornados. Based on past occurrences and probability, the Pre-Disaster Mitigation Plan Committee selected the following disasters for inclusion in this Plan: earthquakes, flooding, hurricanes, straight line wind, karst, landslides, tornados, wildfires, and winter storms.

Risk Assessment and Loss Estimates

RVARC assessed potential impacts from each hazard using available geographic information system (GIS) layers and local government tax parcel databases. Loss estimates were performed only for flooding. Other disasters are too variable and widespread to determine any useful loss estimates.

Mitigation Strategy Development

Based on the findings of the risk assessment, RVARC, working with local governments, drafted an overall mitigation strategy for the region and each individual locality. During this step, goals, objectives and actions to reduce the damage from each hazard were identified for the planning area.

Committee Meetings

Committee meetings were held on an as needed basis at critical times in the document's development and for review of the draft and final versions of the Plan. Committee meeting agendas and attendance sheets are included in Appendix A.

Localities, state and federal agencies, and other local groups were invited to serve on the Roanoke Valley-Alleghany Regional Commission Pre-Disaster Mitigation Plan Committee. Local governments were asked to appoint the staff and/or citizens that would be the most appropriate representative(s) to the Committee and responded with a wide range of appointees: Elected Officials, Emergency Service Coordinators, Engineers, Planners, City and Town Managers, and fire and rescue personnel. Locality representatives attended the Committee meetings on a regular basis. RVARC staff also worked directly with localities (Clifton Forge, Iron Gate) during development of local goals/projects.

Additional groups that the Committee felt would be of assistance were also invited to participate. These included Virginia Department of Forestry, U.S. Forest Service, and the National Weather Service. Chambers of Commerce were asked to notify their members, through newsletters or web sites, about the mitigation plan.

Public Participation

The public was invited to attend one or more of three meetings that were held to seek input about hazards that have impacted the area. Participants were given the opportunity to review maps, historical hazard data, damage estimates, and information about the Disaster Mitigation Act and the pre-disaster planning requirements. Information gathered at the meetings was used in developing strategies to mitigate natural hazards in the region.

Three public input meetings were held in the early evening at 6 p.m. the week of June 20, 2011 in Clifton Forge, Fincastle and Roanoke. The meetings were advertised as display ads in two daily and four weekly local newspapers as well as through email and Facebook postings. Meeting announcements, sign-in sheets, news articles, brochures, and handout materials were available at the meetings. Documentation is included in Appendix A.

Plan Review, Adoption and Maintenance

In accordance with Federal and State requirements, the governing bodies of each participating jurisdiction must review and approve that portion of the overall plan that affects their jurisdiction. FEMA has requested that each locality review the final version of the plan and adopt it by resolution. The plan will then be sent to the Virginia Department of Emergency Management and FEMA for review and approval.

Following FEMA approval, the plan may then be officially adopted by each locality. No changes to the plan should be made following FEMA's approval of the document. If changes are necessary, they should be noted in the resolution and addressed in the next plan update.

The Plan Maintenance section of this document, Chapter 7, details the process that will ensure that the Mitigation Plan remains an active and relevant document. The process includes a schedule for monitoring the Plan on an annual basis and producing the required plan revision every five years and describes how the localities will integrate public participation throughout the plan maintenance process.

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Introduction

Natural Hazards Mitigation Planning Process

The Disaster Mitigation Act of 2000 (DMA 2000) requires that local governments, as a condition of receiving federal disaster mitigation funds, have a mitigation plan that describes the process for identifying hazards, risks and vulnerabilities, identifies and prioritizes mitigation actions, encourages the development of local mitigation and provide technical support for those efforts.

The Federal Emergency Management Agency (FEMA) defines *Mitigation* as any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event. Mitigation, also known as prevention, encourages long-term reduction of hazard vulnerability. The goal of mitigation is to save lives and reduce property damage. Mitigation can accomplish this, and should be cost-effective and environmentally sound. This, in turn, can reduce the enormous cost of disasters to property owners and all levels of government. In addition, mitigation can protect critical community facilities, reduce exposure to liability, and minimize community disruption resulting from natural disasters. Examples include land use planning, adoption of building codes, elevation of homes, or acquisition and relocation of homes away from floodplains.

It has been demonstrated time after time that hazard mitigation is most effective when based on an inclusive, comprehensive, long-term plan that is developed before a disaster actually occurs. However, in the past, many communities have undertaken mitigation actions with good intentions but with little advance planning. In some of these cases, decisions have been made "on the fly" in the wake of a disaster. In other cases, decisions may have been made in advance but without careful consideration of all options, effects, and/or contributing factors. The results have been mixed at best, leading to less than optimal use of limited resources.

Purpose of the Plan

The purpose of this plan is to fulfill the Federal requirements for the Disaster Mitigation Act of 2000. The plan identifies hazards; establishes community goals and objectives and mitigation activities that are appropriate for the Roanoke Valley-Alleghany region.

Planning Region

The 2013 Regional Pre-Disaster Mitigation Plan affects unincorporated areas, towns, cities and counties within the Roanoke Valley-Alleghany Regional Commission service area except the localities of Franklin County and towns of Boones Mill and Rocky mount which are covered by the West Piedmont PDC Plan. These are the same localities that participated in the 2006 plan. While the plan does not establish any legal requirements for the localities, it does provide a framework for natural hazard mitigation planning.

Plan Update Process

The plan update process is similar to the process used to develop the original 2006 plan. Local governments and Pre-Disaster Mitigation Plan Committee members felt that following a similar process would be the most efficient method for gathering information, reviewing priorities and updating the plan.

The Mitigation Plan was evaluated to review progress that has been made on implementing the projects and to identify new or updated information that could affect mitigation priorities. The convener, Roanoke Valley-Alleghany Regional Commission, was responsible for contacting the Pre-Disaster Mitigation Plan Committee members and organizing meetings to review the plan. Committee members representing their respective local governments and agencies provided guidance for the plan update.

The committee reviewed the hazard information, risk and loss data, goals and strategies and proposed mitigation projects to determine if they are addressing current and expected conditions. The review also considered state and Federal legislation that could affect the implementation of the plan.

Several towns in the region requested that their interests in the planning process be represented by the county in which they are located. The towns of Fincastle and Troutville were represented on the Committee by the Botetourt County Assistant to the County Administrator. The Town of New Castle was represented by Craig County Director of Emergency Services. These representatives served as the liaison between the Committee and the town staff and/or elected officials.

Plan Review

In addition to the local government participants, adjoining regional planning organizations were asked to comment on the plan. The planning process included an opportunity for adjacent localities and regional

commissions to review the draft plan. The New River Valley Planning District Commission, Central Shenandoah Planning District Commission, Region 2000 Regional Commission, and West Piedmont Planning District Commission were notified of the availability of the draft plan and given an opportunity to comment. The West Virginia regional commissions adjacent to the planning area - Region 1–Planning and Development Council (Princeton, WV) and Region 4–Planning and Development Council (Summersville, WV) – were notified of the availability of the draft plan and given an opportunity to comment.

Committee Meetings

Committee meetings were held on an as needed basis at critical times in the document's development and for review of the draft and final versions of the Plan. Committee meeting agendas and attendance sheets are included in Appendix A.

Localities, state and federal agencies, and other local groups were invited to serve on the Roanoke Valley-Alleghany Regional Commission Pre-Disaster Mitigation Plan Committee. Local governments were asked to appoint the staff and/or citizens that would be the most appropriate representative(s) to the Committee and responded with a wide range of appointees: Mayors, Emergency Service Coordinators, engineers, planners, city and town managers, law enforcement officers, and fire and rescue personnel. Locality representatives attended the Committee meetings on a regular basis. RVARC staff also worked directly with local governments (Clifton Forge, Iron Gate) during development of local goals/projects.

Additional groups that the Committee felt would be of assistance were also invited to participate. These included the Virginia Department of Forestry, U.S. Forest Service, and the National Weather Service. Chambers of Commerce were asked to notify their members, through newsletters or web sites, about the mitigation plan.

Public Participation

The public was invited to attend one or more of three meetings that were held to seek input about hazards that have impacted the area. Participants were given the opportunity to review maps, historical hazard data, damage estimates, and information about the Disaster Mitigation Act and the pre-disaster planning requirements. Information gathered at the meetings was used in developing strategies to mitigate natural hazards in the region.

Three public input meetings were held in the early evening (6 p.m.) the week of June 20, 2011. The meetings were advertised as display ads in one regional daily (Roanoke Times reaching 19 counties in southwest Virginia and 200,000 readers), one local daily and four weekly local newspapers with a combined circulation of over 99,000 as well as through Facebook postings and direct emails. Meeting announcements, sign-in sheets, news articles, brochures, and handout materials were available at the meetings. Documentation is included in Appendix A.

Table 1
Pre-Disaster Mitigation Plan Meetings

Date	Group	Location
11/03/10	Kickoff Meeting	Roanoke Valley-Alleghany Regional Commission, Roanoke, VA
01/12/11	Regional Committee	Roanoke Valley-Alleghany Regional Commission, Roanoke, VA
02/09/11	Regional Committee	Roanoke Valley-Alleghany Regional Commission, Roanoke, VA
04/13/11	Regional Committee	Roanoke Valley-Alleghany Regional Commission, Roanoke, VA
05/11/11	Regional Committee	Roanoke Valley-Alleghany Regional Commission, Roanoke, VA
06/15/11	Regional Committee	Roanoke Valley-Alleghany Regional Commission, Roanoke, VA
6/20/11	Public Meeting	Fincastle Public Library, Fincastle, VA
6/22/11	Public Meeting	Clifton Forge Public Library, Clifton Forge, VA
6/23/11	Public Meeting	Roanoke Valley-Alleghany Regional Commission, Roanoke, VA
01/10/12	Regional Committee	Roanoke Valley-Alleghany Regional Commission, Roanoke, VA

Regional Profile

The Roanoke Valley-Alleghany Regional Commission service area lies in western Virginia and includes the counties of Alleghany, Botetourt, Craig, Franklin and Roanoke; the cities of Covington, Roanoke and Salem; and the towns of Boones Mill, Buchanan, Clifton Forge, Fincastle, Iron Gate, New Castle, Rocky Mount, Troutville, and Vinton.

The planning area for the Pre-Disaster Mitigation Plan includes only the counties of Alleghany, Botetourt, Craig, and Roanoke; the cities of Covington, Roanoke and Salem; and the towns of Buchanan, Clifton Forge, Fincastle, Iron Gate, New Castle, Troutville, and Vinton. The localities of Franklin County and towns of Boones Mill and Rocky Mount are covered by the West Piedmont PDC Regional Hazard Mitigation Plan.

Location

The region is on the eastern border of the Appalachian Plateau and the western slope of the Blue Ridge Mountains. The James River flowing east through Botetourt County ultimately reaches the Chesapeake Bay and Atlantic Ocean. The Roanoke River flows through the district in a southeasterly direction to North Carolina before reaching the Atlantic. Both river basins serve as development corridors. Although the planning area includes the Roanoke metropolitan area, much of the region is rural. Approximately 212,039 acres of Federal land lies within the National Forest and Blue Ridge Parkway system.

Physiography

The predominant physical characteristic of the region is the mountainous terrain. Forty-eight percent of the land area has slopes of 25 percent or greater. Within the region mountain ridges run southwest to northeast. There are large concentrations of steep land in northern Botetourt County and Alleghany County. A broken ring of steep lands surrounds the Roanoke metropolitan area. Past development has been influenced greatly by topographic characteristics. The higher elevations have remained in open or forest use while the more moderate foothills and river valleys have been developed.

Flood plains impose considerable restraints on land development activities. In the past, heavy flooding has caused considerable property damage to existing development in flood plains. The region has several

major flood plain areas along the Roanoke, James and Jackson Rivers, Peters, Mason, Carvin, Tinker, Glade, Mud Lick and Smith Creeks.

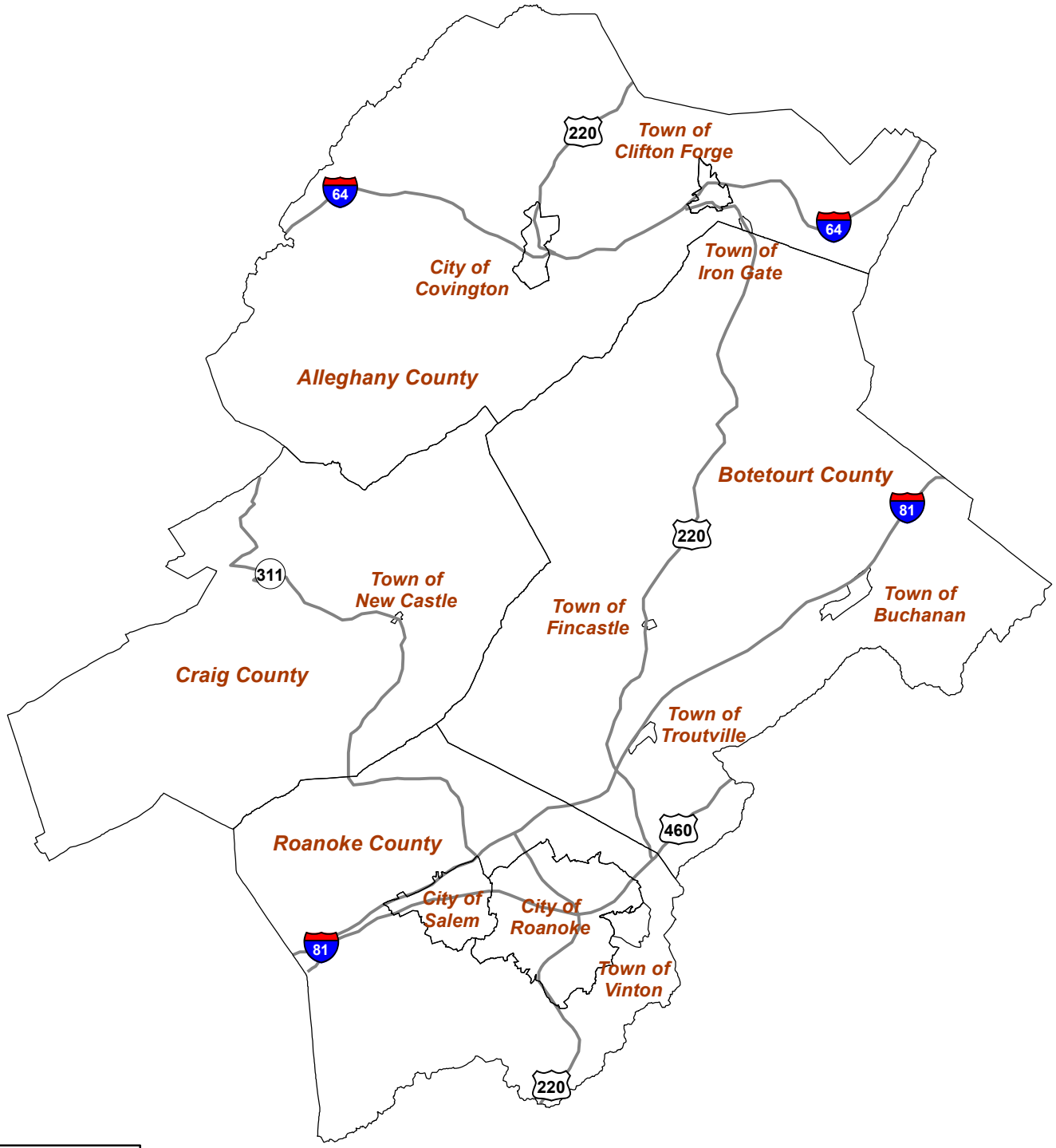
Transportation

Interstate 64 bisects Alleghany County in an east-west direction while passing through the City of Covington and Town of Clifton Forge. Interstate 81 crosses Botetourt and Roanoke counties in a northeast-southwest direction and includes an urban connector I-581 that links I-81 to the central business district of the City of Roanoke. Other arterial routes in the area include US 11 in Botetourt and Roanoke counties; US 60 in Alleghany County; US 220 passing through Alleghany, Botetourt, and Roanoke counties; US 221 and 460 in Roanoke County; and State Primary Route 311 in Alleghany and Craig counties. Air service is available at the Roanoke Regional Airport that provides nonstop service from Roanoke, Virginia to nine major cities. Rail service is provided by the Buckingham Branch Railroad, CSX Transportation and Norfolk Southern Railway.

Climate

The climate of the region is mild and characterized by warm summers and moderately cool winters. Average monthly temperatures range from a low of 36°F in January to a high of 73°F in July. The average annual temperature is 54°F. Annual precipitation is 43 inches and proportionate throughout the year. The highest monthly rainfalls occur between May and September. Snowfall amounts average 20 inches per year.

Firgure 1: Planning Area



Scale 1:500,000

Source: Roanoke Valley-Alleghany Regional Commission, 2013.

Population

The planning area has an area of 1,636 square miles and a 2010 population of 268,169 according to the US Census Bureau. The region's population is projected to increase to 274,564 by 2020 based on estimates from the Virginia Employment Commission. There are 114,040 occupied residences in the planning area. The existing population of the region is concentrated within the Roanoke Valley. The two population centers in the region are the Roanoke Valley area and the Covington/Clifton Forge area.

Table 2
Population Trends

Locality	1990	2000	2010
Alleghany County	13,176	17,215	16,250
Town of Clifton Forge [1]	4,679	4,289	3,884
Town of Iron Gate	417	404	388
Botetourt County	24,992	30,496	33,148
Town of Buchanan	1,222	1,233	1,178
Town of Fincastle	236	359	353
Town of Troutville	455	432	431
City of Covington	6,991	6,303	5,961
Craig County	4,372	5,091	5,190
Town of New Castle	152	179	153
City of Roanoke	96,509	94,911	97,032
Roanoke County	79,294	85,778	92,376
Town of Vinton	7,643	7,782	8,098
City of Salem	23,797	24,747	24,802
Plan Area [2]	253,810	264,541	274,759

Source: Census of Population, U.S. Census Bureau, 1990, 2000 and 2010.

1. Clifton Forge reverted from a city to a town in 2001.
2. Town populations are included in county totals.

Development Trends

It is important to examine new development that has occurred in the area and how this could influence the impact of future natural hazard events. While localities are preventing new construction in floodplains through local ordinances, development occurring in the rest of the region remains at risk from other natural disaster such as hurricanes, straight line winds, wildfires and winter storms. Each additional residential unit constructed or commercial investment made is another potential loss. The plan looks at residential development trends and major new investments in commercial, mixed-use, and industrial sites.

Residential Building Permits

Residential building permit data is compiled by the Weldon Cooper Center for Public Service at the University of Virginia. The data is collected from local governments statewide on a monthly basis.

The building permit data shows residential construction activity for each county and city in the state by month or year. Building permits are categorized by type of building (single-family, duplex, 3-4 unit structures, and 5+ unit structures) and by builder-estimated value of the construction. The information excludes permits issued for mobile homes, garages and other out-buildings, additions and renovations, and commercial construction.

The building permit data was used to show trends in residential development including the number of units, value of construction, and growth/decline in the residential sector.

Examining building permits trends at the local level reveals which areas of the region have experienced the most residential growth since the adoption of the previous plan. The trends are what is to be expected with high growth in the urban area and low to moderate numbers in the rural area.

Table 3
Average Annual Total Residential Building Permits Issued
Since Adoption of the 2006 Plan (2007-2011)

	Number of Units	Total Value	Average Number of Units Permitted Annually	Average Annual Value of Units Permitted
Alleghany County	84	$10,921,905	17	$2,184,381
Botetourt County	425	$82,385,176	85	$16,477,035
Craig County	165	$9,821,566	33	$1,964,313
Roanoke County	1,140	$197,763,607	228	$39,552,721
City of Covington	9	$1,009,221	2	$201,844
City of Roanoke	440	$64,084,342	88	$12,816,868
City of Salem	169	$21,189,101	34	$4,237,820
Region	2,432	$387,174,918	486	$77,434,984

Source: Weldon Cooper Center for Public Service, 2013.

The Roanoke Valley-Alleghany planning area has added almost 10,000 residential units and in excess of $1 billon in residential development since 2000. This equates to approximately 825 units at a value of almost $92 million per year. Since the previous Pre-Disaster Mitigation Plan was approved in 2006, over 2,400 residential units were added at a total value of approximately $387 million.

Growth in the region has mirrored that of the nation in that residential growth has dramatically slowed. The average annual number of permitted residential units since the previous plan has dropped to 486 (a decrease of 41%) at a total value of $77.4 million (a decrease of 16%). It is expected that the region's economy will slowly recovery over the next decade however it is unknown at this time if residential construction will ever return to its previous level.

Table 4
Residential Building Permits Issued, 2000 to 2011

Year	Number of Units	Cost
2000	1,238	$90,363,622
2001	1,251	$97,681,070
2002	1,179	$97,511,690
2003	1,187	$111,002,772
2004	1,316	$134,298,728
2005	958	$120,431,782
2006	341	$62,055,148
2007	705	$112,175,146
2008	639	$94,463,691
2009	343	$57,930,625
2010	338	$58,054,053
2011	407	$64,551,403
Total	9,902	$1,100,519,730
Average Permits Issued 2000-11	825	$91,709,978
Average Permits Issued 2007-11	486	77,434,984
Percent Change in Permits 2000-11	-67.1%	-28.6%
Percent Change in Permits 2007-11	-42.3%	-42.5%
Numeric Change in Permits 2000-11	9,902	$1,100,519,730
Numeric Change in Permits 2007-11	2,432	$387,174,918

Source: Weldon Cooper Center for Public Service, 2013.

Major New Commercial, Mixed-Use, and Industrial Development

In addition to reviewing new residential development, major new commercial and industrial development was also examined. New commercial and industrial development increases the potential for loss of life and property caused by natural disasters. Localities have been managing growth by encouraging redevelopment of existing properties or expansion of existing sites which helps to prevent sprawl and expansion of development into "greenfield" areas. This practice also tends to create a higher concentrate of development, and therefore potential losses.

Since adoption of the previous plan, several major commercial, mixed-use, and industrial developments have occurred or are currently underway in the region. Some are single use sites while others are mixed use developments that include residential and commercial properties.

Carilion Clinic has established the Carilion Biomedical Institute in Roanoke in association with Virginia Tech. The partnership, announced in 2007, has a campus that includes the Virginia Tech Carilion School of Medicine, Research Institute, and Riverside Center office complex. The Research Institute, comprised of 21 major research teams with more than 150 faculty and staff, is a business incubator designed to introduce advanced medical devices into the marketplace. The Virginia Tech Carilion School of Medicine is located on the campus, adjacent to Carilion Roanoke Memorial Hospital and the Carilion Clinic on South Jefferson Street in Roanoke. The assessed value of the parcels and buildings (excluding equipment) is approximately $93 million. The site was designed to mitigate any flooding impact from the nearby Roanoke River by elevating the buildings out of the floodplain and the incorporation of berms and other floodproofing and stormwater management BMPS into the site. A hotel was constructed adjacent to the campus in 2011 at a value of more than $10 million and utilized a similar floodproofing strategy.

The Bridges mixed use redevelopment is a planned $100 million, 20-year effort to develop apartments, offices, stores and restaurants across from the Virginia Tech Carilion School of Medicine and Research Institute in the City of Roanoke. The first phase of the project set to begin in 2013 is a $12 million, 150-unit apartment building on the site.

Downtown housing in the City of Roanoke has grown at a rapid pace since adoption of the previous plan increasing the number of residents that could be impacted by a natural disaster in the central urban area. Several hundred new condo/apartment units are available in downtown Roanoke. According to Downtown Roanoke, Inc., there has been an increase in the number of people living downtown from 50 to

1,300 in the past five years (2008-13). Demand for downtown housing remains strong and renovation of two additional buildings for apartments is underway in 2013.

Planning for the Countryside site redevelopment in the City of Roanoke located near Hershberger Road and Interstate 581, just west of the Roanoke Regional Airport, took place from 2010 to 2012. The City of Roanoke purchased the Countryside Golf Course property in November 2005. The golf course was closed in winter 2010 and City planning staff initiated a public participation process to identify potential reuse options. This plan recommends the property be developed as a new mixed use neighborhood. The challenge was to plan an infill development within an existing neighborhood context, street patterns, and environmental constraints. Over half of the property's 139 acres will be dedicated to open space uses such as recreation, preservation, and natural areas. An additional 71 acres owned by the Roanoke Regional Airport Commission, though not publicly-accessible, will be open space. The Central area features a cluster of mixed residential development with a wide variety of housing types bracketed by a neighborhood park, a community park, and preservation areas.

The Evans Spring Area land comprises approximately 130 acres of vacant land along the southern side of Interstate 581 opposite Valley View Mall. It is the largest assembly of privately owned developable vacant land left in the City. In 2011 the General Assembly provided funding for completion of the interchange at this site. Construction is expected to be complete in 2016. The City's plan for the area addresses these anticipated changes by establishing standards and guidelines that will enable this land to be a productive and mutually beneficial part of the City. This plan recommends Evans Spring be developed as a mixed use neighborhood a framework for development within the context of surrounding neighborhoods, a regional commercial shopping corridor, a major interstate highway frontage and a significant environmental feature: the Lick Run and its floodplain. Proposed development would include residential, commercial, mixed-use and environmental preservation.

The Valley View area in the northern part of the City of Roanoke continues to expand and has had several new hotels and restaurants constructed since adoption of the previous plan. Expansion of the mall property itself has occurred with the opening of "The District" adding two new restaurants and several retail properties. Outparcels also continue to be developed with new restaurants and retailers.

The South Peak community in Roanoke County is developing additional dense residential condominiums (34 units in Phase I) along with commercial buildings, a restaurant, and a proposed hotel on a hilltop near

the intersection of Route 220 and Franklin Road. Residential properties became available in 2013. Commercial development is ongoing.

The Daleville Town Center, a new pedestrian-friendly and lifestyle-oriented community in the Botetourt County community of Daleville, is under development. The town center consists of commercial, medical, restaurants, single family homes and apartments as well as recreation spaces. The town center has a projected build-out of 10 years and will be comprised of 300 residences around the town center. There will be a total of 120 single-family homes. The rest will be town homes and apartment homes.

A new medical clinic was constructed in 2008 in the downtown New Castle. The Craig County Health Center is the only medical facility in the county. The center is a critical facility and has been outfitted with a generator for emergency power.

MeadWestvaco in Covington has made a $285 million investment to construct a new, state-of-the-art biomass boiler and upgrade associated power infrastructure at its Covington facility. Announced in June 2007, the boiler is expected to be online in late 2013. The new boiler and related 75 megawatt steam turbine generator system will replace two older and less efficient units allowing the mill to become self-sufficient in electrical power.

Ongoing downtown revitalization efforts in the City of Covington, and towns of Buchanan, Fincastle, Clifton Forge and Vinton are bringing new businesses and development to these communities. The revitalization of the downtowns focuses primarily on improving the conditions of existing buildings and repairs to infrastructure in an effort to improve the local economy by attracting investment to the localities. While the efforts are to be applauded, however when looking at the work from the point of view of natural disaster risk this leads to increased concentrations of people and higher property values which could result in greater losses. Each of the downtowns, expect Fincastle, is susceptible to flooding.

Chapter 2
Hazard Specific Information

Regional Hazards

The region has experienced nearly all types of natural disasters, the major ones being flooding, straight-line winds, winter storms, and wildfires. Other disasters that might occur in the region include earthquakes, hurricanes, landslides and tornados. Based on past occurrences and probability, the Pre-Disaster Mitigation Plan Committee selected the following disasters for inclusion in this Plan: earthquakes, flooding, hurricanes, straight line wind, karst, landslides, tornados, wildfires, and winter storms. There were no locality specific unique hazards identified during the planning process.

Widespread ***flooding*** or flash flooding impacts a large portion of the region. Watersheds in the region are typical of the Blue Ridge region in which smaller streams collect water which then flows through steep terrain, picking up velocity, and into the valleys and flatlands along major rivers where development has occurred. Sudden downpours can cause stormwater systems in urbanized areas to overflow and cause localized flooding.

In the Roanoke Valley ***wildfires*** are a recurring natural hazard. In 1999, Fort Lewis Mountain in the western part of Roanoke County burned out of control for a week, destroying land and endangering homes before it was brought under control. Other fires have occurred on Brushy Mountain, Poor Mountain, Twelve O'clock Knob, Yellow Mountain, and even portions of Mill Mountain that lies within the heart of the City of Roanoke. The Purgatory Mountain fire in Botetourt County burned 1,285 acres and cost over $166,000 to contain.

Floods are not the only weather related disasters the region faces. The area is frequently subjected to weather events such as ***winter storms***, heavy thunderstorms, tropical storms, ***hurricane*** remnants, ***straight line winds*** and rare ***tornados***. Meteorological events have the potential to impact all communities and structures in the region. In addition, geologic hazards including **karst**, **landslides** and **earthquakes** can impact the region.

Hurricanes or tropical storms occur when their track inland from the Atlantic or Gulf Coast brings them into the surrounding Blue Ridge Mountains. The long periods of rain result in mountain streams overflowing and urban stormwater facilities exceeding their capacities. Thunderstorms often can create

flash flooding in the area. Several neighborhoods throughout the region experience flash flooding every year due to runoff resulting from strong thunderstorms. These flash floods can damage homes, washout roads and overflow stormwater systems.

Thunderstorms bring large amounts of rain, lightning and damaging straight line winds. Thunderstorm season in the region is spring to late fall. ***Straight-line winds*** and flooding are responsible for most thunderstorm damage. Severe thunderstorms have produced tornados in the region. The last verified tornado in the region occurred in 2008 and had winds of 80 miles per hour.

Landslides and sinkholes can occur during or following intense thunderstorms or prolonged rain events such as hurricanes. Landslides can damage buildings located on steep slopes and block roadways.

Winter Storms are the most likely natural hazard to occur in the region. Arctic blasts and Gulf moisture have historically combined to deliver serious winter weather to the region. There is potential for dangerous winter weather from November to May. The regions greatest snowfalls occur from January to March. In 1966, the Roanoke Valley received 41.2 inches of snow. When heavy snowfalls occur, highway crews, emergency personnel and citizens can quickly become overwhelmed - roads close, rescue personnel are pushed to the limit, and citizens can be stranded at work or at home. Heavy snow and ice accumulation can knock down trees, power and telephone lines, and collapse roofs. Winter ice storms are frequent in the region. Even modest accumulations of ice can knock down trees, power lines, and communication towers that are critical for emergency services.

Earthquake

An earthquake is a sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the Earth's surface. Ground shaking from earthquakes can collapse buildings and bridges; disrupt gas, electric, and phone service; and sometimes trigger landslides, avalanches, flash floods, fires, and huge, destructive ocean waves (tsunamis). Buildings with foundations resting on unconsolidated landfill and other unstable soil, trailers and homes not tied to their foundations are at risk because they can be shaken off their mountings during an earthquake. When an earthquake occurs in a populated area, it may cause deaths and injuries and extensive property damage.

Ground movement during an earthquake is seldom the direct cause of death or injury. Most earthquake-related injuries result from collapsing walls, flying glass, and falling objects as a result of the ground shaking, or people trying to move more than a few feet during the shaking. Much of the damage in earthquakes is predictable and preventable. We must all work together in our communities to apply our knowledge to building codes, retrofitting programs, hazard hunts, and neighborhood and family emergency plans.

Past Events

Virginia, like most states on the eastern seaboard, has a moderate level of risk from earthquakes. The largest earthquake known to have impacted the region was the 1886 Charleston, South Carolina, earthquake (estimated magnitude 6.6-6.9). That quake was felt as far north as Canada, as far west as Missouri, and as far south as Cuba. Although earthquakes outside Virginia have caused damage in the Commonwealth in the past, the most likely sources for future damaging shaking in Virginia are the local active areas within the state like Central Virginia and Giles County.

Since 1774, the year of the earliest documented Virginia earthquake, there have been over 300 earthquakes in or near the Commonwealth. Of those, 18 earthquakes had reports of intensity VI or higher. The largest earthquake in Virginia was the 1897 Giles County shock. The maximum intensity was VIII in Giles County, and it was felt over 11 states (approximately 280,000 square miles). The estimated magnitude for this event was 5.8, making it the third largest earthquake in the eastern United States in the last 200 years (second largest in the southeastern U.S.). From 1978 through 1993, over 160 earthquakes were detected in and around the Commonwealth. On May 16, 2009 a magnitude 3.0 earthquake, with an epicenter located in the Cave Spring area of Roanoke County, shook buildings from Salem to Vinton but

did not cause any significant property damage. A magnitude 2.8 earthquake occurred on February 20, 2011 approximately one mile northwest of Potts Creek near the Alleghany and Craig County line. On August 23, 2011, a magnitude 5.8 earthquake occurred 5 miles south-southwest of Mineral, Va. (150 miles northeast of Roanoke). The Mineral event was Virginia's strongest earthquake in over a century.

There has not been a Presidential or State Disaster Declaration in the planning region for earthquakes.

Although numerous intensity scales have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently recommended for use in the United States is the Modified Mercalli (MM) Intensity Scale. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced at that place.

The lower numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The higher numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above.

Table 5

Modified Mercalli Intensity Levels

I. Not felt except by a very few under especially favorable conditions.

II. Felt only by a few persons at rest, especially on upper floors of buildings.

III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.

IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.

VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.

VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.

VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.

XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Current mitigation in the region consists of monitoring for seismic activity by several agencies. In 1963, as part of the Worldwide Standard Seismograph Network program, seismographs were installed at

Georgetown University in Washington, DC, and at Blacksburg, Virginia. In 1977, several more seismographs were installed and operated by Virginia Tech and the Virginia Department of Mines, Minerals, and Energy - Division of Mineral Resources. Initially, the recording was purely analog, but in 1985 digital recording was added. In 1995, a US National Seismic Network broadband, high dynamic range seismograph was installed in Blacksburg. In 1997 the Giles County network was upgraded to digital telemetry.

The Virginia Tech Seismological Observatory (VTSO) operates a digital seismic network with stations in Virginia and southern West Virginia. Along with other southeastern regional seismic networks and the U.S. National Seismic Network (USNSN), VTSO contributes to earthquake monitoring, information dissemination and seismic hazard assessment objectives in the southeastern United States. In 1991, Virginia Tech combined with other institutions in North Carolina and Tennessee to form the Southern Appalachian Cooperative Seismic Network to coordinate earthquake monitoring and data exchange.

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Flood

Widespread flooding or flash flooding impacts a large portion of the region. Watersheds in the Roanoke Valley-Alleghany region are typical of the Blue Ridge region in which smaller streams collect water which then flows through steep terrain, picking up velocity, and into the valleys and flatlands along major rivers where development has occurred. The flood plains throughout these mountainous areas are narrow, averaging less than 250 feet in most areas. These are also the only flat areas where development could take place in this mountainous region. Most flood-producing storms generally occur in the winter and spring. However, flooding due to intense local thunderstorms or from tropical disturbances can occur in any season.

Flood hazard areas for each jurisdiction participating in the plan are shown on the maps in **Appendix B**.

Review of Past Events and Studies

A review of past flood related research and documentation indicates that there are an estimated 5,400 structures that could be impacted by flooding in the Roanoke Valley Alleghany Region. The following documents chronicle flood events in the Roanoke Valley-Alleghany Regional Commission region: Flood Plain Information reports developed by the U.S. Army Corps of Engineers (COE) in the 1968-1971 covering the Roanoke River (City of Roanoke, Roanoke County and City of Salem), Mason Creek (Salem), James River (Alleghany County, Covington, Clifton Forge, and Botetourt County), Jackson River (Alleghany County, Covington and Clifton Forge), Smith Creek (Alleghany County and Clifton Forge); Flood Control Study for Covington, U.S. Army Corps of Engineers 1987; Flood Insurance Study, Alleghany County, Virginia, unincorporated areas, FEMA, 1992; Flood Insurance Study, Botetourt County, Virginia unincorporated areas, 1977; Roanoke Valley Regional Stormwater Management Plan, 1977; and Hazard Analysis, Project Impact Roanoke Valley, 2000; Preliminary Flood Insurance Study, Alleghany County, Virginia, unincorporated areas, FEMA, 2009; and Preliminary Flood Insurance Study, Botetourt County, Virginia unincorporated areas, 2009.

Alleghany County has experienced floods since its original settlement. Large floods occurred in 1877, 1913, 1936, 1969, 1972, 1973 and 1985. Hurricane Jeanne caused severe storms and flooding in October 2004. Flood damage in the area is typically concentrated in and near Covington and Clifton Forge. Because of the rural nature of the county, damages from flooding are widespread. Damage occurs to roads and bridges and public facilities such as schools.

The Jackson River flows through the City of Covington, towns of Clifton Forge and Iron Gate and the communities of Low Moor and Selma. Gathright Dam, constructed in 1974, partially controls flooding along the Jackson River. However, many structures will continue to be in harms way in the event of a US Army Corps of Engineers projected Standard Project Flood. The water and sewer treatment plants located adjacent to the Jackson could be damaged as well as most of the river's bridges.

Covington has experienced large floods on November 1877, March 1913, March 1936, March 1967, August 1969 (Hurricane Camille), 1972 (Tropical Storm Agnes), March and December 1973, and November 1985. Tropical Storm Agnes was the most severe of the events with as much as one-third of the city under water. In all, one church, three public buildings, two industrial plants, 8 commercial buildings, and 490 private residences were damaged. In November 1985, a 100-year frequency rainstorm caused a reported $17 million in damages in the City of Covington. This indicates that even with flood control provided by the dam, the city is still vulnerable to flooding.

The US Army Corps of Engineers, 1986 report titled Flood Control Study, Jackson River, Lower Jackson Street Residential Area, Covington, provides information about the major flood that occurred in November 1985. An approximate 90-year flood event resulted in residential, commercial, and municipal damage in the lower Jackson Street / Rayon Terrace neighborhood. Residential losses included yard, basement, and first floor damage in sixty-four (64) homes and four (4) businesses. Municipal damage included debris in the city park, a sewage pump station and damage to a storm sewer. Total residential, commercial and municipal damage were estimated at $544,000. *Structural and non-structural alternatives for this section of the city were explored in a cost-benefit analysis and found to be infeasible.*

The Army Corps of Engineers 1986 Flood Control Study, Harmon's Run at Industrial Park, Covington, Virginia, reports that the 1985 flood caused inundation of the industrial park's southern edge and affected nothing of value at the site. *The study concluded that no benefits would be realized for a flood-proofing project due to the lack of damage from the flood.*

Floods used in the 1978 Federal Insurance Administration study to describe the impact on the town of Clifton Forge include the Flood of 1950 and Flood of 1969 - both of which occurred prior to construction of Gathright Dam. The 1950 flood brought on the flooding of basements, a lumberyard and the armory, and the town's water supply was cut off when two water mains were washed away.

Smith Creek flows north to south though the residential and commercial center of the Town of Clifton Forge. In Clifton Forge, residential, public, and commercial development are concentrated on both sides of Smith Creek. A number of large commercial buildings in the downtown area have been constructed directly over Smith Creek. Floods have inundated portions of this land in the past, and a substantially greater area is within reach of larger floods in the future. The 1969 Smith Creek flooding caused evacuation of 40 families; a water main was broken, damaged the Matthews Woodworking Mill and caused over $200,000 in damage to town owned property.

A water supply dam is located on Smith Creek about 3.4 miles above the mouth (approximately 1,500 feet above the corporate limits of the Town of Clifton Forge). Built in 1949, the dam is a concrete gravity type structure and is the source of raw water for the Town of Clifton Forge's water treatment plant. The dam's reservoir receives runoff from approximately 12.6 square miles of drainage area and can store approximately 57 million gallons of water below the spillway crest. However, the amount of water that can be stored in back of the dam is small compared to the total volume of runoff which would occur during a large flood. Therefore, the reservoir has no significant effects on floods at the City of Clifton Forge. Little data is available to document the flood events along Smith Creek. Because of the watersheds steep slopes with the town, flood velocities could be dangerously high and cause substantial damage.

Numerous flood events have been recorded in the Upper James River Basin in the counties of Alleghany, Botetourt and Craig. The following water bodies in the basin have flooded: Dunlap Creek, Potts Creek, Cowpasture River, Johns Creek, Craig Creek, and Catawba Creek. Records show a history of major and frequent flooding. One of the worst floods to occur in Tinker Creek in Botetourt County was in 1940. Another large flood occurred in 1961 along Buffalo Creek and is considered to be one of the worst storms of record. The unincorporated communities of Eagle Rock, Glen Wilton, and Gala located in Botetourt County along the James River have all experienced flooding. Glen Wilton was isolated in 1972 due to floodwaters covering the only road access to the community. The Botetourt Communities of Strom, Lithia, Cloverdale, and Coyner have also been victims of floodwaters.

A lack of flood plain information studies for Craig County prevents damages within this locality from being quantified at this time. The county should work with the Corps of Engineers, Virginia Department of Emergency Management, and FEMA to develop a Flood Insurance Study for the major watersheds of Johns Creek, Craig Creek, Potts Creek, Sinking Creek and Barbours Creek.

The Flood Insurance Study, Botetourt County, Virginia Unincorporated Areas, was performed by the US Department of Housing and Urban Development and Federal Insurance Administration in 1977 and updated in 2009. This flood insurance study covers the unincorporated area of Botetourt County, areas within the incorporated towns of Buchanan, Fincastle, and Troutville were not included. The report studied Back Creek, Buffalo Creek, Craig Creek, Eagle Rock Creek, Ellis Run, Glade Creek, Jackson River, James River, Laurel Run, Laymantown Creek, Long Run, Looney Mill Creek, Mill Creek, Roaring Run, Sinking Creek, and Tinker Creek. One of the worst floods for the James River occurred as a result of Tropical Storm Agnes in 1972. A 1940 event caused severe damage in the Tinker Creek basin. Buffalo Creek was impacted by a flood in 1961. The communities of Eagle Rock, Glen Wilton, and Gala have been in the paths of flood waters associated with both intense summer rainfall and frontal system storms during the winter months. Glen Wilton was isolated in June 1972 due to floodwaters overtopping Route 663. The communities of Strom, Lithia, Cloverdale and Coyner Springs have also been victims of damaging floodwaters.

The updated 2009 Flood Insurance Study briefly describes flooding that has taken place in the towns. In the Town of Buchanan, several businesses, and many homes within the study area would be flooded by both the 1-percent annual chance and 0.2-percent annual chance floods. U.S. Highway 11 crosses the James River in Buchanan. The bridge, itself, does not produce any major backwater effects for the 1-percent annual chance flood; however, the approaches would be inundated causing delays and detours.

The Town of Fincastle has experienced flooding. Two of the most severe floods occurred in 1969 and 1972, with the most extensive occurring as a result of tropical storm Agnes in 1972. Town Branch overflowed its banks and, due largely to insufficient bridge capacity at Highway 606, flooded the area between U.S. Highway 220 and Factory Street. Neither discharges nor frequencies are currently available. The bridge on Highway 630 is of sufficient capacity to pass all floods studied except for the 0.2-percent annual chance event.

The Town of Troutville has been damaged by flooding from Buffalo Creek several times in the past. One of the worst floods occurred during August 1961 when “after two hours of intense downpour, Buffalo Creek overflowed its banks. Several homes and basements were flooded and travel on Highway 11 was hazardous due to excessive water. Also, there was about 2 feet of water around Rader Funeral Chapel in the major commercial area of the town” (Roanoke Times, 1961).

The James River in Botetourt County has experienced large floods in 1877, 1913, 1936, and 1969. The remains of hurricane Camille in 1969 caused flooding that destroyed homes, roads, railroads, and bridges along the James River.

River stages and discharges on the James River at Buchanan have been recorded since 1895 by the USGS. Since 1877, the bank at full stage of 15 feet has been exceeded at least 60 times. The greatest flood known to have occurred in Buchanan was in November 1877 and measured 34.9 feet at the USGS gage. Other large floods occurred in April 1886, March 1889, March 1902, March 1913, January 1935, March 1936, March 1963, and August 1969. Tropical Storm Agnes in 1972 was the second highest storm of record. Few flood related problems have occurred on Purgatory Creek in the Town of Buchanan because of lack of development in its watershed.

The Town of Buchanan has a primary sewage treatment plant on the James River. The plant is subject to flooding and during the November 1985 flood was out of operation for 6 months. The historic flood of record in Buchanan occurred in November 1985 (after completion of Gathright Dam). The Town of Buchanan was devastated during the November 1985 storm which produced the Flood of Record with an exceedance of 600 years. The river caused water damage and structural damage to numerous buildings. Some buildings were completely washed away. The railroad station was washed off its foundation and the historic footbridge was washed downstream. People who expected their basements to be flooded had water up to their ceilings.

Historic floods in the community of Eagle Rock occurred in November 1985, November 1877, March 1913, June 1972, March 1936, and August 1969. The November 1985 and April 1987 floods were the only two significant flood events to affect the Eagle Rock area since the completion of Gathright Dam. The community of Eagle Rock was severely flooded during the November 1985 storm causing substantial damage to the commercial district and to many residences. The 1985 storm was the storm of record with an exceedence frequency of 460 years. Seventeen commercial properties and about 16 residences were damaged during the November 1985 flood.

The history of flooding in the Roanoke Valley has been well documented since records were kept. Since 1877 over 17 large floods have occurred in the Roanoke Valley with four of the largest in the past 20 years. Dates of significant floods include the following: 1877, August 1892, October 1893, October 1906, Spring 1913, August 1928, October 1932, January 1935, August 1939, August 1940, July 1947, August

1961, July 1962, June 1972, April 1978, November 1985, April 1992, and June 1995. The flood of record was the November 1985 event.

In the past 20 years, four of the largest floods on record have occurred including June 1972, April 1978, November 1985, and April 1992. Based on rainfall amounts and durations which resulted in these events, the June 1972, April 1978, and November 1985 flood events have recurrence intervals, respectively of approximately 50-, 130-, and 10-years. In this period of flood activity, damages have been estimated exceeding $200 million with over 12,000 impacted residential structures and over 1,000 businesses.

In November of 1985 when rains from Hurricane Juan caused the Roanoke River to rise and crest at a level of 23.4 feet from the bottom of the River, as measured from Walnut Street. The result of that single weather event created floodwaters in downtown Roanoke that rose over five feet inside some businesses. Ten lives were lost and damage to property cost $520,000,000 (source: The Roanoke Times, November, 1985). While this was the Flood of Record, is not the only significant flood the Roanoke Valley has experienced over the past 100 years. On August 16th, 1928, the Roanoke River crested at 18.1 feet; twelve years later, on August 14th, 1940, the Valley's river crested at 18.3 feet. On June 21st, 1972, the Roanoke Valley was hit with the effects of Hurricane Agnes, causing the Roanoke River to crest at 19.6 feet. On April 22nd, 1992, the river once again exceeded its banks and spread floodwaters in the Valley when it crested at 18.1 for the second time during the century.

The most severe flooding on the Roanoke River is usually the result of heavy rains associated with tropical storms, while tributary stream flooding is usually the result of local thunderstorms or frontal systems. Flooding along tributaries is compounded when the streams in lower elevations back-up into feeder streams.

Major floods in the area have occurred in 1940 and 1972 with discharges of 24,400 and 28,800 cfs, respectively, as measured at the USGS gage on the Roanoke River at Niagara Dam. On Tinker Creek at Dale Avenue, the August 1940 storm produced a discharge of 9,000 cfs. The flood damage from the August 1940 event was extensive and resulted in major damage to buildings, roads, bridges, and agricultural crops. The 1972 flood on the Roanoke River, which was the result of Tropical Storm Agnes, was estimated as a 50-year flood. Approximately 400 homes were damaged by flooding from Hurricane Agnes in the Roanoke-Salem area.

On November 5, 1985 a 130-year flood event inundated the study area. This flood was caused by the remnants of Hurricane Juan. The flooding inundated much of the downtown area of Roanoke and resulted in 10 deaths. A total of 11 inches of rain fell between Thursday October 31 and the following Monday. The last six inches fell during the last 24 hours of that five-day period.

Flood Plain Information Glade Creek, Vinton, Virginia, U.S. Army Corps of Engineers, 1971. Glade Creek flows through the northern corporate limits of the Town of Vinton. The report covers the areas subject to flooding by Glade Creek from the Botetourt County line to its confluence with Tinker Creek. The width of the flood plain within the study limits of Glade Creek ranges from 300 feet in width to 1,400 feet. Past floods have occurred at an estimated rate of nearly one every three years.

According to the Flood Plain Management Study, Roanoke River, Roanoke County, Cities of Roanoke and Salem, performed by the US Army Corps of Engineers in 1978, the most severe flooding on the Roanoke River usually results from heavy rains associated with tropical storms. The flood of June 1972, resulting from rains associated with Hurricane Agnes, produced the highest stage of record and approximated the 50-year flood level. This floodplain encompasses about 2,000 acres of flat land where more than 40 industrial plants, along with approximately 2,630 homes and 1,260 businesses are subject to flooding according to the 1978 report. The report states that although severe flash floods have occurred on the Roanoke River in the past, it is reasonable to assume that even greater floods can occur. Studies show that the 100-year frequency flood would inundate most of the floodplain to a depth of 5 to 7 feet, with some areas covered by as much as 12 feet of water.

The main flood season for the creeks is spring and summer, with most of the higher floods resulting from intense thunderstorms. Floods above bankfull level have occurred in August 1940, September 1960, August 1961, August 1962, August 1964, July 1965, February 1966 and March 1967.

The 1985 FEMA Flood Insurance Study, Roanoke County, Virginia, Unincorporated Areas, covers the unincorporated areas of Roanoke County. In all, selected segments of 19 streams were studied in detail, these include the Roanoke River, Back Creek, Tinker Creek, Glade Creek, Carvin Creek, Mason Creek, Mudlick Creek, West Fork Carvin Creek, Jumping Run, Dry Branch, Cook Creek, Stypes Branch, Barnhardt Creek, Peters Creek, Ore Branch, Glade Creek, Murray Run, Mudlick Creek Tributary 1 and Mudlick Creek Tributary 2. Low lying areas adjacent to the streams are subject to periodic flooding. The most severe flooding is usually the result of heavy rains associated with tropical storms, while creek

flooding is the result of local thunder storms or frontal systems. Major floods have occurred several times in the study area including the 1972 50-year flood event and the 1985 flood of record.

Flood Plain Information, Mud Lick Creek at Roanoke, Virginia, U.S. Army Corps of Engineers, 1971. Mud Lick Creek flows along the western corporate limits of the City of Roanoke. Past floods have occurred at an estimated rate of nearly one every three years.

Special Flood Plain Information, Upper Mason Creek at Roanoke County, Virginia, by the U.S. Army Corps of Engineers and Hayes, Seay, Mattern and Mattern, addresses the flood situation along Mason Creek upstream from the Virginia Route 116 bridge northward and includes the communities of Bennett Springs, Mason Cove and Hanging Rock. The properties along the creek are primarily residential and agricultural and have been inundated by the flood of 1942, 1972 and 1988.

Flood Plain Information, Peters Creek and Lick Run, Roanoke, Virginia, (U.S. Army Corps of Engineers, 1968) addresses flooding along Peters Creek. Peters Creek flows along the western corporate limits of the City of Roanoke and empties into the Roanoke River. Lick Run flows parallel to Interstate 581 through the downtown and empties into Tinker Creek at the eastern corporate limits. The study addresses only the "rural" portion of Lick Run north of the downtown area. Past floods have occurred at an estimated rate of nearly one every three years.

Updated Flood Insurance Studies and FIRM

All localities within the planning region have been issued new flood insurance studies along with new FIRMs since the previous plan was adopted.

In 2009 the Flood Insurance Study for Alleghany County was updated along with the Flood Insurance Rate maps (FIRM). The new FIRMs went into effect in December 2010. This study was prepared to include all Alleghany County and unincorporated areas, the independent City of Covington, and the Towns of Clifton Forge and Iron Gate into a countywide format.

In 2009 the Flood Insurance Study for Botetourt County was updated along with the Flood Insurance Rate maps (FIRM). The new FIRMs went into effect in December 2010. This study was prepared to include all of Botetourt County and unincorporated areas and the Towns of Buchanan, Fincastle and Troutville into a countywide format.

In 2009 the Flood Insurance Study for Craig County was updated along with the Flood Insurance Rate maps (FIRM). The new FIRMs went into effect in December 2010. This study does not include all of Craig County.

In 2007 the Flood Insurance Study for Roanoke County was updated along with the Flood Insurance Rate maps (FIRM). The new FIRMs went into effect in December 2010. This study was prepared to include all of Roanoke County and unincorporated areas, the cities of Roanoke and Salem, and the Town of Vinton into a countywide format.

Repetitive Flood Claims

The Repetitive Flood Claims (RFC) grant program was authorized by the Flood Insurance Reform Act of 2004, which amended the National Flood Insurance Act of 1968. Funding is authorized up to $10 million annually at this time. The purpose of the program is to reduce flood damages to insured properties that have had one or more claims to the National Flood Insurance Program. Eligible mitigation activities include: acquisition of properties, and either demolition or relocation of flood-prone structures, where the property is deed restricted for open space uses in perpetuity.

The Severe Repetitive Loss (SRL) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004, which amended the National Flood Insurance Act of 1968 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP). The purpose of the SRL program is to reduce or eliminate claims under the NFIP through project activities that will result in the greatest savings to the National Flood Insurance Fund (NFIF).

The definition of severe repetitive loss as applied to this program was established in section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a. An SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

a) That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or

b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart.

The region has had $29,709,122 in repetitive loss claims with an average claim of $33,569 (see tables 4 to 14). A map showing the general location of repetitive loss properties in each locality is in Appendix B.

Repetitive Loss Strategy

A repetitive loss strategy to verify the geographic location of each repetitive loss property and determine if that property has been mitigated and by what means was developed during the 2011 update of this plan. The strategy was developed in part to meet a FEMA requirement, qualifying the State as having a FEMA approved repetitive loss strategy. Putting this strategy in place allows the State (and sub-grantees such as local governments) to qualify for the 90/10 federal-nonfederal share allocation instead of the 75/25 for funding from the Severe Repetitive Loss grant program and in the Flood Mitigation Assistance grant program (when used for SRL property mitigation). This reduced nonfederal share requirement can help in implementing mitigation projects for repetitive loss and severe repetitive loss properties. The strategy also provides local governments and citizens with information about repetitive loss "hot spots" in the region that should be targeted for mitigation.

The activities to maintain an accurate database and map of repetitive loss properties are outlined below:

A. Localities will work with VDEM and FEMA to update list of repetitive loss properties annually.
B. Localities will obtain updated list of repetitive loss properties annually from VDEM/FEMA.
C. Localities will review property addresses for accuracy and make necessary corrections.
D. Localities will determine if and by what means each property has been mitigated.
E. Localities will map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).
F. Localities will determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

Repetitive Loss Statistics for the Roanoke Valley - Alleghany Region

Table 6
Repetitive Loss Statistics Alleghany County (unincorporated area)

Number of Properties	24
Residential	23
Non-Residential	1
Number of Claims	59
Total Losses	$780,541.47
Total Building	$482,190.53
Total Contents	$298,350.94
Average Claim	$13,229.52

Source: Virginia Department of Emergency Management, 2011.

Table 7
Repetitive Loss Statistics Botetourt County

Number of Properties	29
Residential	24
Non-Residential	5
Number of Claims	73
Total Losses	$975,765.00
Total Building	$757,627.00
Total Contents	$218,138.00
Average Claim	$13,366.66

Source: Virginia Department of Emergency Management, 2011.

Table 8
Repetitive Loss Statistics Town of Buchanan

Number of Properties	6
Residential	2
Non-Residential	4
Number of Claims	19
Total Losses	$1,189,972.00
Total Building	$364,265.00
Total Contents	$825,708.00
Average Claim	$62,630.13

Source: Virginia Department of Emergency Management, 2011.

Table 9
Repetitive Loss Statistics Town of Clifton Forge

Number of Properties	3
Residential	2
Non-Residential	1
Number of Claims	7
Total Losses	$102,073.97
Total Building	$69,203.62
Total Contents	$32,870.35
Average Claim	$14,581.99

Source: Virginia Department of Emergency Management, 2011.

Table 10
Repetitive Loss Statistics City of Covington

Number of Properties	5
Residential	4
Non-Residential	1
Number of Claims	13
Total Losses	$145,264.00
Total Building	$82,116.00
Total Contents	$63,148.00
Average Claim	$11,174.15

Source: Virginia Department of Emergency Management, 2011.

Table 11
Repetitive Loss Statistics Craig County

Number of Properties	6
Residential	5
Non-Residential	1
Number of Claims	13
Total Losses	$433,257.00
Total Building	$265,211.00
Total Contents	$168,046.00
Average Claim	$33,327.44

Source: Virginia Department of Emergency Management, 2011.

Table 12
Repetitive Loss Statistics City of Roanoke

Number of Properties	90
Residential	64
Non-Residential	26
Number of Claims	279
Total Losses	$10,558,322.00
Total Building	$6,260,128.00
Total Contents	$4,298,193.00
Average Claim	$37,843.00

Source: Virginia Department of Emergency Management, 2011.

Table 13
Repetitive Loss Statistics Roanoke County (unincorporated area)

Number of Properties	26
Residential	26
Non-Residential	0
Number of Claims	76
Total Losses	$734,905.00
Total Building	$597,108.00
Total Contents	$137,797.00
Average Claim	$9,669.80

Source: Virginia Department of Emergency Management, 2011.

Table 14
Repetitive Loss Statistics City of Salem

Number of Properties	83
Residential	76
Non-Residential	7
Number of Claims	333
Total Losses	$14,279,639.00
Total Building	$12,731,639.00
Total Contents	$1,548,000.00
Average Claim	$42,881.00

Source: Virginia Department of Emergency Management, 2011.

Table 15
Repetitive Loss Statistics Town of Vinton

Number of Properties	5
Residential	3
Non-Residential	2
Number of Claims	13
Total Losses	$509,383.00
Total Building	$284,262.00
Total Contents	$225,121.00
Average Claim	$39,183.00

Source: Virginia Department of Emergency Management, 2011.

Table 16
Repetitive Loss Statistics Region Total

Number of Properties	277
Residential	229
Non-Residential	48
Number of Claims	885
Total Losses	$29,709,122.44
Total Building	$21,893,750.15
Total Contents	$7,815,372.29
Average Claim	$33,569.63

Source: Virginia Department of Emergency Management, 2011.

Disaster Declarations for Flooding

The Governor of Virginia declares a state of emergency when he believes a disaster has occurred or may be imminent that is severe enough to require state aid to supplement local resources in preventing or alleviating damages, loss, hardship or suffering. Once a local state of emergency has been declared, the Governor may then ask for an emergency declaration, which makes federal resources available for immediate response missions. In the event of a Presidential Disaster Declaration, Virginia Department of Emergency Management (VDEM) is further empowered to coordinate federal agency assets that become available. An emergency declaration preempts generally approved administrative purchasing and procurement procedures to make resources immediately available to rescue, evacuate, shelter, provide essential commodities (i.e., heating fuel, food, etc.) and quell disturbances in affected localities.

There have been nine (9) Presidential Disaster Declarations related to flooding in the region since 1969. All of the declarations impacted multiple localities in the region.

Table 17
Presidential Disaster Declarations for Flooding, 1969 to 2010

Locality	Declaration Number	Designation Date	Disaster Description
Alleghany County Botetourt County	274	08/23/1969	Severe storms and flooding
Alleghany County Botetourt County Clifton Forge City of Covington Craig County Roanoke County City of Roanoke City of Salem	755	11/09/1985	Severe storms and flooding
Botetourt County Craig County Roanoke County City of Roanoke City of Salem	944	05/19/1992	Severe storms and flooding
Alleghany County Botetourt County Craig County Roanoke County City of Roanoke	1014	03/10/1994	Severe ice storms, flooding
Roanoke County City of Roanoke	1059	07/31/1995	Severe storms and flooding
Alleghany County Botetourt County Clifton Forge City of Covington	1098	02/02/1996	Flooding, high winds, and wind driven rain
Craig County Roanoke County City of Roanoke City of Salem	1458	04/28/2003	Severe winter storm, record/near record snowfall, heavy rain, flooding, and mudslide
Alleghany County Botetourt County Craig County Roanoke County City of Roanoke City of Salem	1570	10/18/2004	Hurricane Jeanne caused severe storms and flooding
Alleghany County Botetourt County Craig County	1655	07/13/2006	Severe storms, tornados and flooding

Source: Virginia Department of Emergency Management, 2003 and FEMA 2010.

There have been seven (7) State Emergency Declarations for flooding in the Region since 1985.

Table 18
State Emergency Declarations for Flooding, 1985 to 2010

Type of Disaster	Localities Affected	Declaration Date	Type	Description
Flash Flooding, Landslides	Entire State		Continuing Declaration	Executive Order 65 (85)
Flash Flooding, Landslides	Entire State		Continuing Declaration	Executive Order 15 (86)
Flooding	Roanoke River Basin	9/18/87	Declaration of State of Emergency	Unusually heavy rains
Flash Flooding	Western Virginia	4/24/92	Declaration of State of Emergency	Heavy rains occurred in southwest Virginia and continued up the Roanoke Valley and then to the Shenandoah Valley and other affected parts of the state, at least one life was lost, National Guard was called out
Storm	Entire State	6/23/93	Declaration of State of Emergency	Summer storm system crossed the Commonwealth with hail, high winds, and torrential rains, the City of Lynchburg, City of Bedford, Appomattox County and Campbell County were particularly affected
Flash Flooding, Landslides, Dam Failure	Western, Central, Northern, South central Virginia	6/23/95 with extension of area on 6/26/95	Declaration of State of Emergency	Heavy rains resulted in flash floods, mudslides and dam failure in the western and central portions of the state, later other portions of the state, northern and south central) were added, the Virginia National Guard was called out
Tropical Storm	Entire State	11/11/2009	Declaration of State of Emergency	Severe weather from prolonged periods of wet and windy weather from the remnants of Tropical Storm Ida and a coastal Nor'easter causing widespread power outages, flooding and transportation difficulties throughout the State.

Note: All disaster declarations in Virginia are Executive Orders issued by the Governor. Disasters without a description in the Virginia Department of Emergency Management file are described by Executive Order number only.
Source: Virginia Department of Emergency Management, 2003, Library of Virginia, 2010.

Hurricane

A hurricane is a tropical storm with winds that have reached a constant speed of 74 miles per hour or more. Hurricane winds blow in a large spiral around a relative calm center known as the "eye." The eye is generally 20 to 30 miles wide, and the storm may extend outward 400 miles. As a hurricane approaches, the skies will begin to darken and winds will grow in strength. As a hurricane nears land, it can bring torrential rains, high winds, and storm surges. A single hurricane can last for more than two weeks over open waters and can run a path across the entire length of the eastern seaboard. August and September are the peak months during the hurricane season that lasts from June 1 through November 30.

Some of the greatest rainfall amounts associated with tropical systems occurs from weaker Tropical Storms that have a slow forward speed (one to 10 mph) or stall over an area. Due to the amount of rainfall a Tropical Storm can produce, they are capable of causing as much damage as a Category 2 hurricane.

Widespread rainfall of six to 12 inches or more is common during landfall, frequently producing deadly and destructive floods. Such floods have been the primary cause for tropical cyclone-related fatalities over the past 30 years. The risk from flooding depends on a number of factors: the speed of the storm, its interactions with other weather systems, the terrain it encounters, and ground saturation.

Large amounts of rain can occur more than 100 miles inland where flash floods are typically the major threat along with mudslides in mountainous regions. Tornadoes and high winds generally become less of a threat the farther inland a hurricane moves (although there have been several exceptions), but the heavy rains frequently continue and even intensify as the dying, but still powerful, hurricane is forced up higher terrain or merges with other storm systems in the area. For example, Hurricane Camille (1969) devastated the Gulf Coast, but weakened quickly as it moved northeast. The storm combined with a cold front in the mountains of central Virginia to produce an unexpected 30 inches of rain. As a result, 109 people died.

The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures. In the western North Pacific, the term "super typhoon" is used for tropical cyclones with sustained winds exceeding 150 mph.

Table 19
Saffir-Simpson Hurricane Damage Scale

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3(major)	111-129 mph 96-112 kt 178-208 km/h	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4(major)	130-156 mph 113-136 kt 209-251 km/h	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5(major)	157 mph or higher137 kt or higher252 km/h or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: Saffir-Simpson hurricane Wind Scale, National Hurricane Center, National Weather Service, http://www.nhc.noaa.gov/aboutsshws.php, 2013.

Review of Past Events and Reports

Virginia has been struck by 14 hurricanes from 1900 to 1996 according to records from the National Hurricane Center. These include two Category 1 hurricanes, one Category 2 and one Category 3. The Roanoke Valley – Alleghany region has not experienced a direct hurricane in over 100 years. The region is impacted by the remnants of the hurricanes as tropical depressions and subtropical storms bringing heavy rains and winds.

August 12-16, 1928: Two tropical storms moved across the Florida panhandle and then turned northeast and moved up the Appalachians weakening into depressions. The depressions passed over Virginia just four days apart bringing heavy rain, flash flooding and significant rises on the larger rivers. Major

flooding occurred on the Roanoke River through Roanoke and Brookneal. The river crested on the 16th at 18.1 ft (8 ft above flood stage) in Roanoke.

October 18, 1932: Tropical storm made landfall on the Gulf Coast moved northeast weakening to a depression. The center passed over the Virginia-Kentucky border into West Virginia. Heavy rains to the east of the storm impacted the Appalachians. It caused major flooding on the Roanoke River through Alta Vista where it crested at 29 feet (11 feet over flood stage) and moderate flooding in South Boston on the Dan River.

August 19, 1939: A hurricane made landfall on the Florida coast and then again on the Gulf Coast. The storm turned northeast and moved up across Virginia as a tropical depression on the 19th. The storm produced heavy rains and flash flooding particularly along the eastern slopes of the southern Blue Ridge. Major flooding occurred on the Roanoke River through Alta Vista (11.5 feet over flood stage).

October 15, 1954, Hurricane Hazel: Hazel maintained hurricane force winds up the East Coast and produced a number of record wind gusts. Lynchburg, Roanoke, and Danville recorded five to six inches of rain causing flooding of small streams.

August 17, 1955, Hurricane Diane. Hurricane Diane made landfall near Wilmington, NC as a Category 1 storm on August 17 and moved north across central Virginia. Rain spread north up to 250 miles ahead of the storm's eye. On the evening of the 17th, the Blue Ridge saw rainfall amounts of five to 10 inches along the southern and eastern slopes. The Skyline Drive area was hardest hit. Severe flooding followed on the Rappahannock River with some flooding also on the James, Potomac and Shenandoah Rivers. Roanoke saw winds gusts to 62 mph and Lynchburg 56 mph out of the north.

August 20, 1969, Hurricane Camille: Camille made landfall as a Category 5 hurricane smashing the Mississippi Coast with 200 mph winds on August 17. Camille was the strongest hurricane to make landfall on the U.S. this century. The hurricane maintained force for 10 hours as it moved 150 miles inland. The storm tracked northward weakening and becoming less defined. It moved toward Virginia on the 19th and was only a tropical depression. Moisture from the warm Gulf Stream waters moved northwest toward the storm and new feeder bands formed. These thunderstorms "trained" (one followed the other), into the Blue Ridge south of Charlottesville. In just 12 hours, up to 31 inches of rain fell with devastating results (153 killed, most in Nelson County).. Major flooding followed as the bulge of water moved down the James River into Richmond. Waynesboro on the South River saw eight feet of water in its downtown

and Buena Vista had five and one-half feet in its business section. Damage was estimated at 113 million dollars (1969 dollars).

June 21, 1972, Hurricane Agnes. Agnes originated in the Gulf of Mexico and was downgraded to a tropical storm by the time it reached Virginia, yet still caused 13 deaths in the Commonwealth. The storm impacted the entire region. Tropical Storm Agnes was a severe event an resulted in as much as one-third of the City of Covington under water where one church, three public buildings, two industrial plants, 8 commercial buildings, and 490 private residences were damaged. During the event, Glen Wilton was isolated due to floodwaters covering the only road access to the community. The storm impacted communities along the James and Roanoke rivers. Tropical Storm Agnes was the second highest storm of record along the James River in Buchanan. The storm caused a 50-year flood. The Roanoke Valley was hit with the effects of Agnes, causing the Roanoke River to crest at 19.6 feet and approximately 400 homes were damaged by flooding in the Roanoke-Salem area.

September 18, 2003, Hurricane Isabel. Hurricane Isabel struck the North Carolina coast at midday and moved north-northeast through the evening hours and following day. Hurricane Isabel's 29 hours of tropical storm force winds carved a wide swath of damage and left behind major flooding across the commonwealth. The Roanoke Valley-Alleghany area received rain amounts varying from 0.5 to 5.5 inches and 50 mph winds causing light damage.

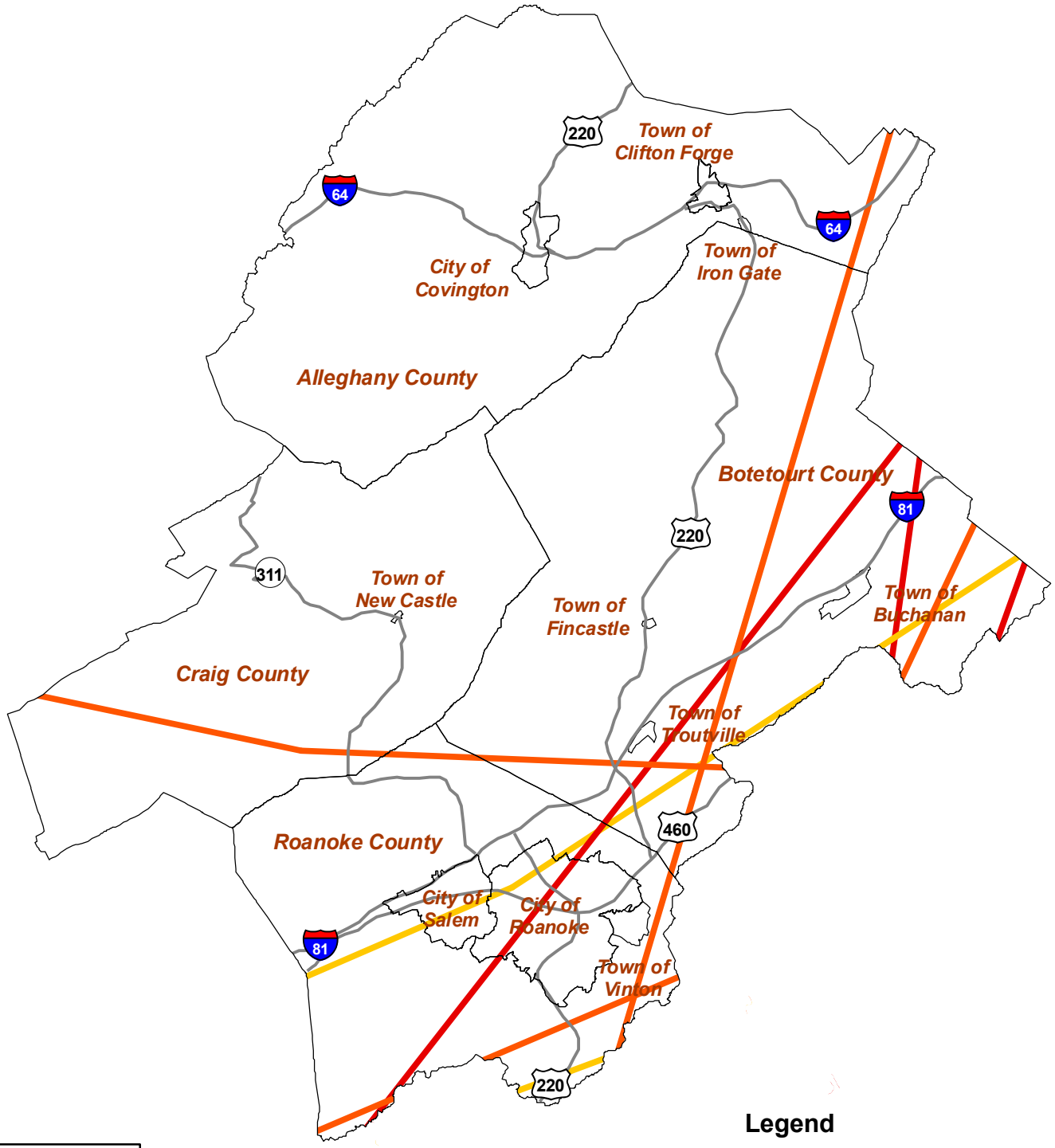
Sept. 8, 2004, Hurricane Frances. The hurricane made landfall over east central Florida as a Category 2 hurricane. It then moved northeast into the northern Gulf of Mexico, eventually turning north, making a second landfall in the panhandle of Florida, and then weakening into a tropical depression. It tracked through western Virginia, then northeast and offshore the mid-Atlantic coast. A total of six tornadoes were observed in central and eastern Virginia, the strongest producing F1 damage.

Sept. 17, 2004, Hurricane Ivan. The hurricane made landfall near the Florida/Alabama border as a Category 3 hurricane. It weakened to a tropical depression and moved northeast, tracking along the Appalachian Mountains through western Virginia, then northeast and offshore the mid-Atlantic coast. A total of 40 tornadoes were produced in Virginia, most in central and northern Virginia. This was a record single day outbreak for Virginia, and exceeded the previous annual tornado record of 31. Most of these tornadoes were F0 or F1 in intensity, although 10 F2 tornadoes and one F3 tornado touched down in south central, west central and northern Virginia.

Sept. 28, 2004, Hurricane Jeanne. The remnants of Hurricane Jeanne, in the form of a tropical depression, moved through the vicinities of Greenville, SC, Roanoke, VA and Washington, DC and finally to the New Jersey coast on Tuesday, Sept. 28. Maximum sustained wind speeds ranged from 25 mph to 30 mph near the storm's center. The primary impact on the Commonwealth was flooding, although one F1 tornado touched down in Pittsylvania County. The heaviest rainfall occurred from the New River Valley to the Southern Shenandoah Valley. Rainfall in this region ranged from 3 inches to 7 inches, with the highest amounts falling in Patrick, eastern Floyd, eastern Montgomery, Giles, Roanoke, Botetourt and Rockbridge counties.

Roanoke Valley-Alleghany Regional Hazard Mitigation Plan

Hurricane Tracks



Legend

Hurricane Tracks, 1851-2009

Category

- Extratropical Storm
- Tropical Depression
- Tropical Storm

Scale 1:500,000

Source: Roanoke Valley-Alleghany Regional Commission, 2013.

There have been three (3) Presidential Disaster Declarations related to hurricanes in the region. There have been ten (10) State Emergency Declarations for hurricanes in the Region since 1987.

Table 20
Presidential Disaster Declarations for Hurricanes, 1972 to 2010

Locality	Declaration Number	Designation Date	Disaster Description
Alleghany County Botetourt County Clifton Forge City of Covington Craig County Roanoke County City of Salem	339	06/29/1972	Tropical storm Agnes
Alleghany County Botetourt County Roanoke County	1135	09/16/1996	Hurricane Fran and associated severe storm conditions
Alleghany County Botetourt County City of Covington Craig County Roanoke County City of Salem	3240	09/10/2005	Hurricane Katrina; evacuation, emergency protective measures

Source: Virginia Department of Emergency Management, 2003 and FEMA 2010.

Table 21
State Emergency Declarations for Hurricanes, 1987 to 2010

Type of Disaster	Localities Affected	Declaration Date	Type	Description
Hurricane	Entire State	9/22/89	Declaration of State of Emergency	Hurricane Hugo, on September 21, 1989 Hugo made landfall on the Carolinas and flooding was expected, the Virginia National Guard was called out
Hurricane	Entire State	8/15/95	Declaration of State of Emergency	Hurricane Felix, predictions that this storm could cause storm surge, heavy rains, flooding, high winds and tornadoes should the storm make landfall in the cities and counties east of I-95, inland areas could also be impacted, the Virginia National Guard was called out
Hurricane	Entire State	7/11/96	Declaration of State of Emergency	Hurricane Bertha, predictions of storm surge, heavy rains, flooding and high winds in localities east of I-95, inland areas could also be impacted, the Virginia National Guard was called out
Hurricane	Entire State	9/6/96	Declaration of State of Emergency	Hurricane Fran, predictions of heavy rains that could cause flash and riverine flooding, predicted landfall is between North and South Carolina, the Virginia National Guard was called out
Hurricane	Entire State	8/25/98	Declaration of State of Emergency	Hurricane Bonnie, predictions of storm surge, heavy rains and high winds, predicted landfall south of the Virginia coast in North Carolina, the Virginia National Guard was called out
Hurricane	Entire State	9/14/99	Declaration of State of Emergency	Hurricane Floyd, predictions of storm surge, heavy rains, high winds and tornadoes, predicted, the Virginia National Guard was called out
Hurricane	Entire State	8/29/2008	Declaration of State of Emergency	Declared in support of the Emergency Management Assistance Compact to assist the Gulf Coast States respond to and recover from the impact of Hurricane Gustav.
Hurricane	Entire State	9/04/2008	Declaration of State of Emergency	Declared based on forecasts that indicate that Hurricane Hanna could cause damaging high winds, flash flooding, and possible tornadoes throughout the eastern and southeastern portion of the state.
Hurricane	Entire State	9/10/2008	Declaration of State of Emergency	Declared in support of the Emergency Management Assistance Compact (EMAC), of which the Commonwealth of Virginia is a member, to assist the Gulf Coast States respond to and recover from the impact of hurricanes Gustav and Ike.

Type of Disaster	Localities Affected	Declaration Date	Type	Description
Hurricane	Entire State	9/01/2010	Declaration of State of Emergency	Based on National Hurricane Center and National Weather Service forecasts projecting impacts from Hurricane Earl that could cause damaging high winds, coastal and lowland flooding throughout the eastern portion of the Commonwealth.

Note: All disaster declarations in Virginia are Executive Orders issued by the Governor. Disasters without a description in the Virginia Department of Emergency Management file are described by Executive Order number only.
Source: Virginia Department of Emergency Management, 2003 and Library of Virginia, 2010.

References:

Inland Flooding, National Weather Service, http://www.nws.noaa.gov/oh/hurricane/inland_flooding.html, 2001.

Hurricane Basics, NOAA, http://www.nws.noaa.gov/oh/hurricane, 2002.

StormReady, National Weather Service, http://www.nws.noaa.gov/stormready.

Virginia Hurricanes, National Weather Service, http://165.176.249.147/library/vahurr/va-hurr.htm.

U.S. Mainland Hurricane Strikes by State, 1900-1996, National Hurricane Center, http:/www.nhc.noaa.gov/paststate.html.

Hurricane Isabel Situation Reports #1 through #7, Virginia Emergency Operations Center, 2003.

Preliminary Local Storm Report, September 19, 2003, National Weather Service Blacksburg, Virginia, 2003.

Virginia's Weather History, Virginia Hurricanes, Virginia Department of Emergency Management, http://www.vaemergency.com/newsroom/history/hurricane.cfm

Karst

Karst is defined as a landscape with sinkholes, springs, and streams that sink into subsurface caverns. In karst areas, the fractured limestone rock formations have been dissolved by flowing groundwater to form cavities, pipes, and conduits. Sinkholes, caves, sinking streams, and springs signal the presence of underground drainage systems in karst areas.

Sinkholes are natural depressions on the land surface that are shaped like a bowl or cone. They are common in regions of *karst*, where mildly acidic groundwater has dissolved rock such as limestone, dolostone, marble, or gypsum. Sinkholes are subsidence or collapse features that form at points of local instability. Their presence indicates that additional sinkholes may develop in the future. The probability for karst hazards cannot be determined as easily as other hazards due to lack of accurate mapping and historical data.

References

Living on Karst: A Reference Guide for Landowners in Limestone Regions, Cave Conservancy of the Virginias, 1997.

Living With Sinkholes, Virginia Cave Board, Virginia Department of Conservation and Recreation.

State Hazard Mitigation Plan, Hazard Identification and Risk Assessment, Virginia Department of Emergency Management, 2010.

Landslide

The term "landslide" describes many types of downhill earth movements, ranging from rapidly moving catastrophic rock avalanches and debris flows in mountainous regions to more slowly moving earth slides and other ground failures.

Though most landslide losses in the United States accrue from many widely distributed events, landslides can be triggered by severe storms and earthquakes, causing spectacular damage in a short time over a wide area. Some landslides move slowly and cause gradual damage, whereas others move so rapidly that they can destroy property and take lives. Debris flows are a common type of fast-moving landslide that generally occurs during intense rainfall on saturated soil. Their consistency ranges from watery mud to thick, rocky mud (like wet cement) which is dense enough to carry boulders, trees, and cars. Debris flows from many different sources can combine in channels, where their destructive power may be greatly increased. (Debris Flow Hazards in the Blue Ridge of Virginia, USGS Fact Sheet 159-96P. L. Gori and W. C. Burton, 1996).

Landslides can be triggered by both natural changes in the environment and human activities. Inherent weaknesses in the rock or soil often combine with one or more triggering events, such as heavy rain, snowmelt, and changes in groundwater level, or seismic activity. Erosion may remove the toe and lateral slope support of potential landslides. Human activities triggering landslides are usually associated with construction and changes in slope and surface water and groundwater levels. Changes in irrigation, runoff and drainage can increase erosion and change groundwater levels and ground saturation.

Review of Past Events and Reports

Historical records tell us that destructive landslides and debris flows in the Appalachian Mountains occur when unusually heavy rain from hurricanes and intense storms soaks the ground, reducing the ability of steep slopes to resist the downslope pull of gravity. For example, during Hurricane Camille in 1969, such conditions generated debris flows in Nelson County, Virginia. The storm caused 150 deaths, mostly attributed to debris flows, and more than $100 million in property damage. Likewise, 72 hours of storms in Virginia and West Virginia during early November 1985 caused debris flows and flooding in the Potomac and Cheat River basins that were responsible for 70 deaths and $1.3 billion in damage to homes, businesses, roads, and farmlands.

Most localities of the RVARC region have experienced small localized landslide events, especially areas in the valleys. The mountain slopes are characterized by the USGS as having a high susceptibility but a low incidence, indicating that few events have occurred on the higher slopes.

The only documented concentration of landslides in the planning region has been along Smith Creek in the Town of Clifton Forge. A State Emergency Declaration was issued in November of 1987 for the area. Heavy rains caused landslides along Smith Creek in Clifton Forge, the third occurrence in the past decade. The area is landslide prone and structures are at risk from further landslides. A study is warranted to determine scope of the problem and a method to stabilize the area.

There has been only one Presidential Disaster Declaration related to landslides in the region. The declaration impacted multiple localities in the region. There have been three (3) State Emergency Declarations for landslides in the Region since 1987.

Table 22
Presidential Disaster Declarations for Landslides, 1965 to 2010

Locality	Declaration Number	Designation Date	Disaster Description
Craig County Roanoke County City of Roanoke City of Salem	1458	04/28/2003	Severe winter storm, record/near record snowfall, heavy rain, flooding, and mudslide

Source: Virginia Department of Emergency Management, 2003 and FEMA 2010.

Table 23
State Emergency Declarations for Landslides, 1987 to 2010

Type of Disaster	Localities Affected	Declaration Date	Type	Description	Noted Damage
Landslides	Town of Clifton Forge	11/30/87	Declaration of State of Emergency	Heavy rains caused landslides along Smith Creek in Clifton Forge, third occurrence in the past decade, area is landslide prone and structures are at risk from further landslides, study is warranted to determine scope of the problem and stabilize the area	Property damage, residences at risk
Flash Flooding, Landslides, Dam Failure	Western, Central, Northern, South central Virginia	6/23/95 with extension of area on 6/26/95	Declaration of State of Emergency	Heavy rains resulted in flash floods, mudslides and dam failure in the western and central portions of the state.	Dam failure
Winter Emergency, Landslide	Entire State	2/11/94	Declaration of State of Emergency	Severe winter storm across the Commonwealth, large accumulations of ice, sleet and snow and moderate rain throughout the state, the southwestern portion of the state had heavy rains, mudslides and flooding occurred, 28 localities opened shelters, Virginia National Guard called out	More than 235,000 homes had no power, trees were down and some roads were blocked by mudslides

Source: Virginia Department of Emergency Management, 2003 and Library of Virginia 2010.

References:

National Landslide Hazards Mitigation Strategy: A Framework For Loss Reduction, USGS Open-File Report 00-450, E. C. Spiker and P. L. Gori, 2000.

Debris Flow Hazards in the Blue Ridge of Virginia, USGS Fact Sheet 159-96P. L. Gori and W. C. Burton, 1996.

Straight Line Winds

Straight line wind is a term used to define any thunderstorm wind that is not associated with rotation, and is used mainly to differentiate from tornadic winds. Most straight-line winds are a result of outflow generated by a thunderstorm downdraft. Half of all severe reports in the lower 48 states are due to damaging winds. Since most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft, anyone living in thunderstorm-prone areas is at risk for experiencing straight line winds.

According to the National Climatic Data Center, there have been over 350 events reported in the planning region for high winds and thunderstorm winds 1950 and 2011. The most recent large scale event was the derecho on June 29, 2012 that arrived with 80 mph winds and left over a million people without power and caused extensive wind damage throughout Virginia. The event was caused by a series of days with high temperatures in excess of 100 degrees created by a heat dome over the central and eastern US followed by a line of strong thunderstorms that moved quickly from the Chicago area to the east on the afternoon of June 29th. Emergency services personnel dealt with fires caused by downed powerlines, collapsed roofs, and wrecked vehicles. Many businesses in the area remained closed for an extended time and lost revenue due to the power outages while hardware stores experienced a run on generators and propane fueled grills. It took more than two weeks for utility companies to restore power to all residents in the region. Recovery, including the clean-up of hundreds of downed trees, roofs and building repairs lasted throughout July and August.

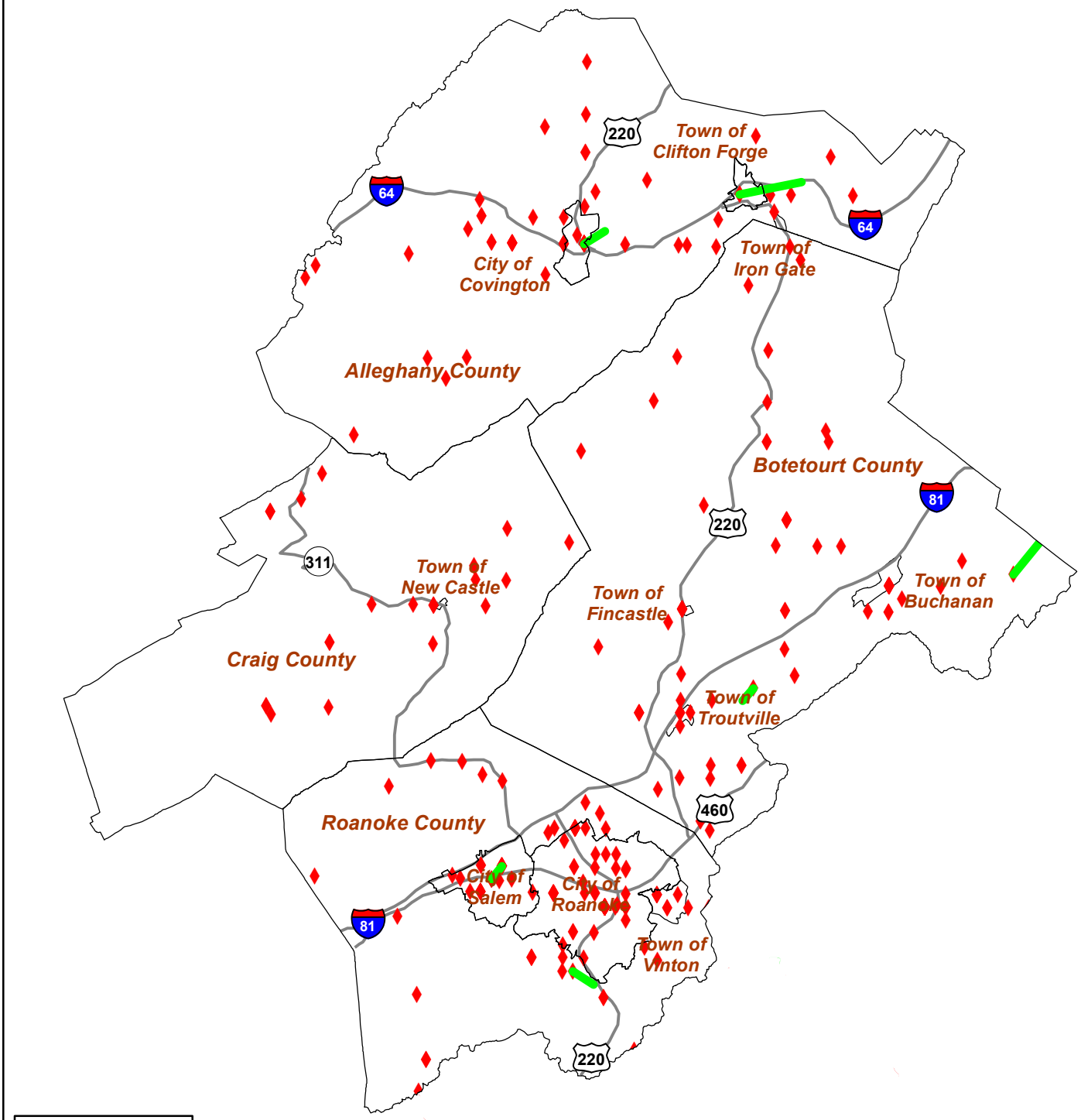
Straight line wind events can occur anywhere in the planning region and have the potential to impact all types of buildings, power and telecommunication transmission lines, and transportation services.

References:

Damaging Winds Basics, NOAA National Severe Storms Laboratory, http://www.nssl.noaa.gov/primer/wind/wind_basics.html, 2011.

Storm Events 2011, NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/oa/ncdc.html, 2011.

Figure 3: High Wind Event



Legend

Wind Swaths

High Wind Event

Scale 1:500,000

Source: Roanoke Valley-Alleghany Regional Commission, 2012.

Tornados

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. It is spawned by a thunderstorm (or sometimes as a result of a hurricane) and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. The damage from a tornado is a result of the high wind velocity and wind-blown debris. Tornado season is generally March through August, although tornadoes can occur at any time of year.

At this time NOAA, the National Weather Service and other agencies are unable to predict the occurrence and location of future tornadoes. Based on past events it is likely that tornados will continue to impact the Roanoke Valley – Alleghany Region.

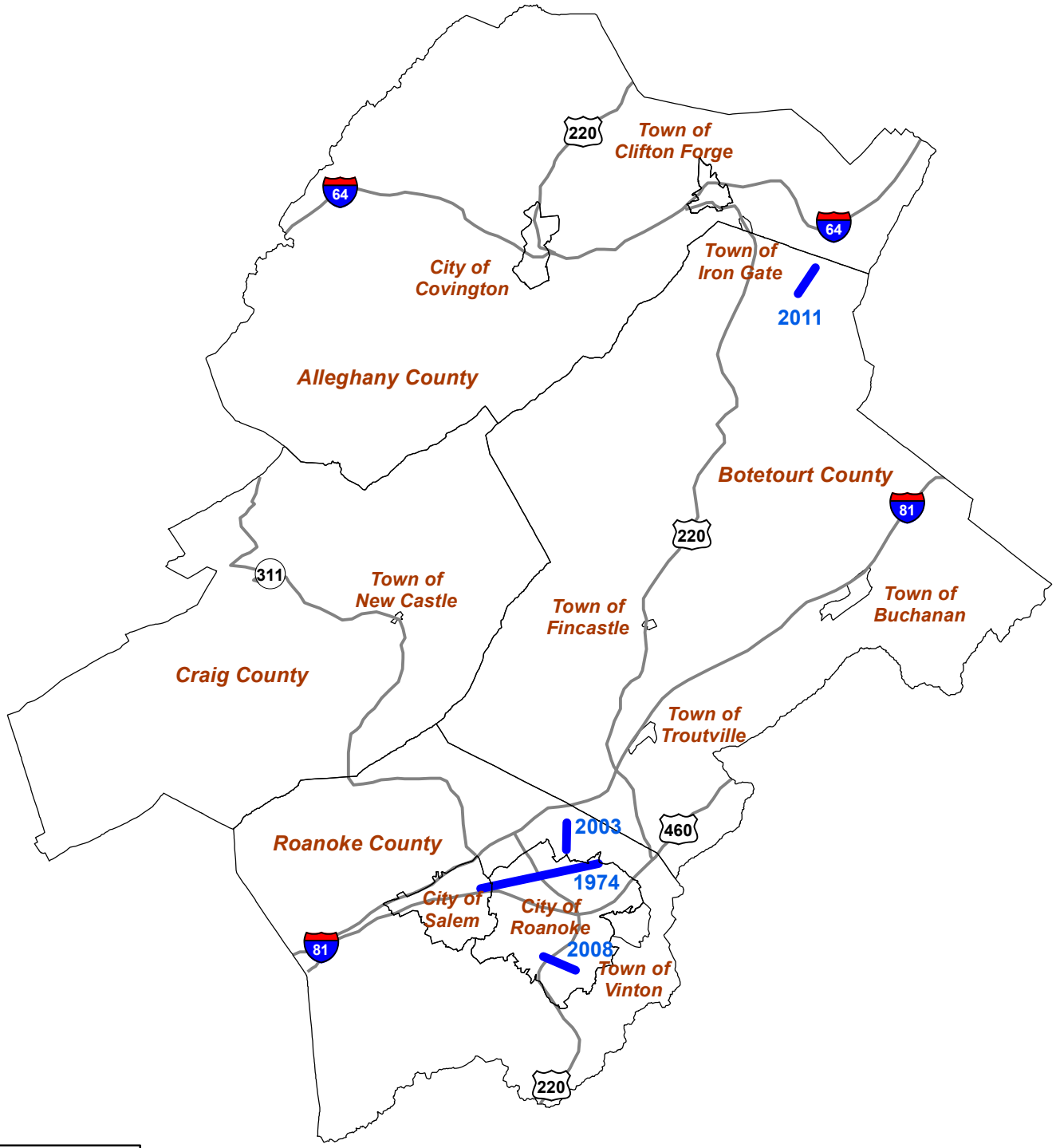
In February 2007, the National Weather Service adopted the Enhanced Fujita scale to measure tornadoes. The EF scale replaces the original Fujita scale that led to inconsistent tornado ratings due to a lack of damage indicators, no account of construction quality and variability, and no definitive correlation between damage and wind speed. For example, a weak structure combined with a slow-moving storm could lead to a tornado's rating being higher than it should be. The EF scale accounts for these and other variables for a more accurate measurement.

Table 24
Fujita Scale of Tornado Winds and Damage: Statistics from 1950-2007;
Enhanced Fujita (EF) scale definition 2007

F Scale	Class	MPH	Damage	EF Scale	Class	MPH
F0	Weak	40-72	Light damage. Tree branches snapped; antennas and signs damaged.	EF0	Weak	65-85
F1	Moderate	73-112	Moderate damage. Roofs off; trees snapped; trailers moved or overturned.	EF1	Moderate	86-110
F2	Strong	113-157	Considerable damage. Weak structures and trailers demolished; cars blown off road.	EF2	Strong	111-135
F3	Severe	158-206	Roofs and some walls torn off well constructed buildings; some rural buildings demolished; cars lifted and tumbled.	EF3	Severe	136-165
F4	Devastating	207-260	Houses leveled leaving piles of debris; cars thrown some distance.	EF4	Devastating	166-200
F5	Incredible	261-318	Well built houses lifted off foundation and disintegrated with debris carried some distance.	EF5	Incredible	>200

Source: Virginia Department of Emergency Management, 2010.

Figure 4: Tornado Events



Scale 1:500,000

Source: Roanoke Valley-Alleghany Regional Commission, 2012.

Legend

Tornado Tracks

Review of Past Events and Reports

April 24, 1896: Around 4:30 pm, a tornado moved northeast from Salem into Roanoke destroying a bowling alley and several other buildings. A framed home near the bowling alley was leveled, killing three of the eight-member family in the house. The five others were injured.

May 2, 1929, "Virginia's Deadliest Tornado Outbreak": It has been said that tornadoes do not occur in mountainous areas. This is false. In Bath and Alleghany counties, the Cowpasture Valley is at an elevation of 1,500 feet and lies between two ridges that rise 1,000 feet above the valley. On May 2, 1929 a tornado struck around 6 pm. Property losses in the communities of Coronation and Sitlington were great. At least 10 people were injured, but none were killed. There were five tornadoes reported on that day. More may have struck remote areas. Twenty-two people were killed and over 150 injured with at least a half a million dollars in damages.

April 4, 1974, "Super Outbreak": It was before sunrise when the severe thunderstorms rolled into southwest Virginia. The storms were part of a squall line ahead of a cold front, and they had a history of being deadly. It was the worst tornado outbreak in U.S. history. April 3-4, 1974 is known as the "*Super Outbreak*" with 148 tornadoes, 315 people killed and 5,484 injured. It was the most tornadoes ever in recorded in a 24-hour period and it was the worst tornado outbreak since February 19, 1884. In Virginia, eight tornadoes hit. One person was killed and 15 injured, all in mobile homes. Over 200 homes and barns and over 40 mobile homes and trailers were damaged or destroyed. The Saltville area and Roanoke were the hardest hit. An F3 tornado touched down on the west edge of Roanoke, near Salem around 5 a.m., and moved through the north part of Roanoke to Bonsack and into Botetourt County to the Blue Ridge area. The path was initially a mile wide, but it continued to narrow to 75 yards across near the end of its track of damage. It hit four schools (two lost portions of their roof and two had windows broken out) and two apartment complexes, Grandview Village Apartments (18 buildings damaged) and Ferncliff Apartments (lost roof). The Red Cross reported 120 homes damaged or destroyed in the Roanoke area. Trees were down on buildings and cars. Carports, garages, and porches were flattened. Roofs were partly blown off several houses in Botetourt.

August 5, 2003: A small tornado struck northern Roanoke County. The storm had winds of 110-113 miles per hour and caused damage to ITT Industries and Sunnybrook Garage on Plantation Road in addition to damaging roofs, fences and a car in the area. No injuries were reported as a result of the tornado.

June 4, 2008: A small tornado touched down in the City of Roanoke. The tornado was rated EF-0 on the Enhanced Fujita Scale of tornado intensity. The National Weather Service reported that the storm knocked down power lines and trees, including on houses along a 1.4 mile path. Appalachian Power stated that the storm knocked out power to 4,000 customers.

There have not been any Presidential Disaster Declarations or State Emergency Declarations related to tornados in the planning area.

References:

Yes, Roanoke was Hit by a Tornado, Roanoke Times, http://www.roanoke.com/news/wb/164601, 2008.

Tornados, NOAA, http://www.outlook.noaa.gov/tornadoes.

Tornado Facts, NOAA, http://www.outlook.noaa.gov/tornadoes/tornfact.htm

Virginia Tornados, B. M. Watson, NOAA, http://www.vdem.state.va.us/library/vatorn/va-tors.htm, 2002.

Virginia Weather History, Virginia Tornados, Virginia Department of Emergency Management, http://www.vaemergency.com/newsroom/history/tornado.cfm, 2008.

Wildfire

Wildfires are a natural part of the ecosystem in the Roanoke Valley and Alleghany Highlands. However, wildfires can present a substantial hazard to life and property. In 1999, Fort Lewis Mountain in the western part of Roanoke County burned out of control for a week, destroying land and endangering homes before it was brought under control. Other fires have occurred on Brushy Mountain, Purgatory Mountain, Poor Mountain, Twelve O'Clock Knob, Yellow Mountain, and even portions of Mill Mountain that lies within the heart of the City of Roanoke.

Review of Past Events and Reports

According to the Virginia Department of Forestry, Virginia experiences forest fire seasons in the spring and fall. The spring fire season begins in mid February and extends through April. The fall fire season usually covers a period of a few weeks in late October to mid November. Wildfire events are highly dependent on weather conditions and can occur any time of year in the planning region.

Table 25
Regional Wildfire Statistics 1995 - 2008

Locality*	Total Number of Wildfires
Alleghany County	77
Botetourt County	160
Craig County	17
Roanoke County	84

* Data includes cities and towns located within each county.
Source: Virginia Department of Forestry, 2011.

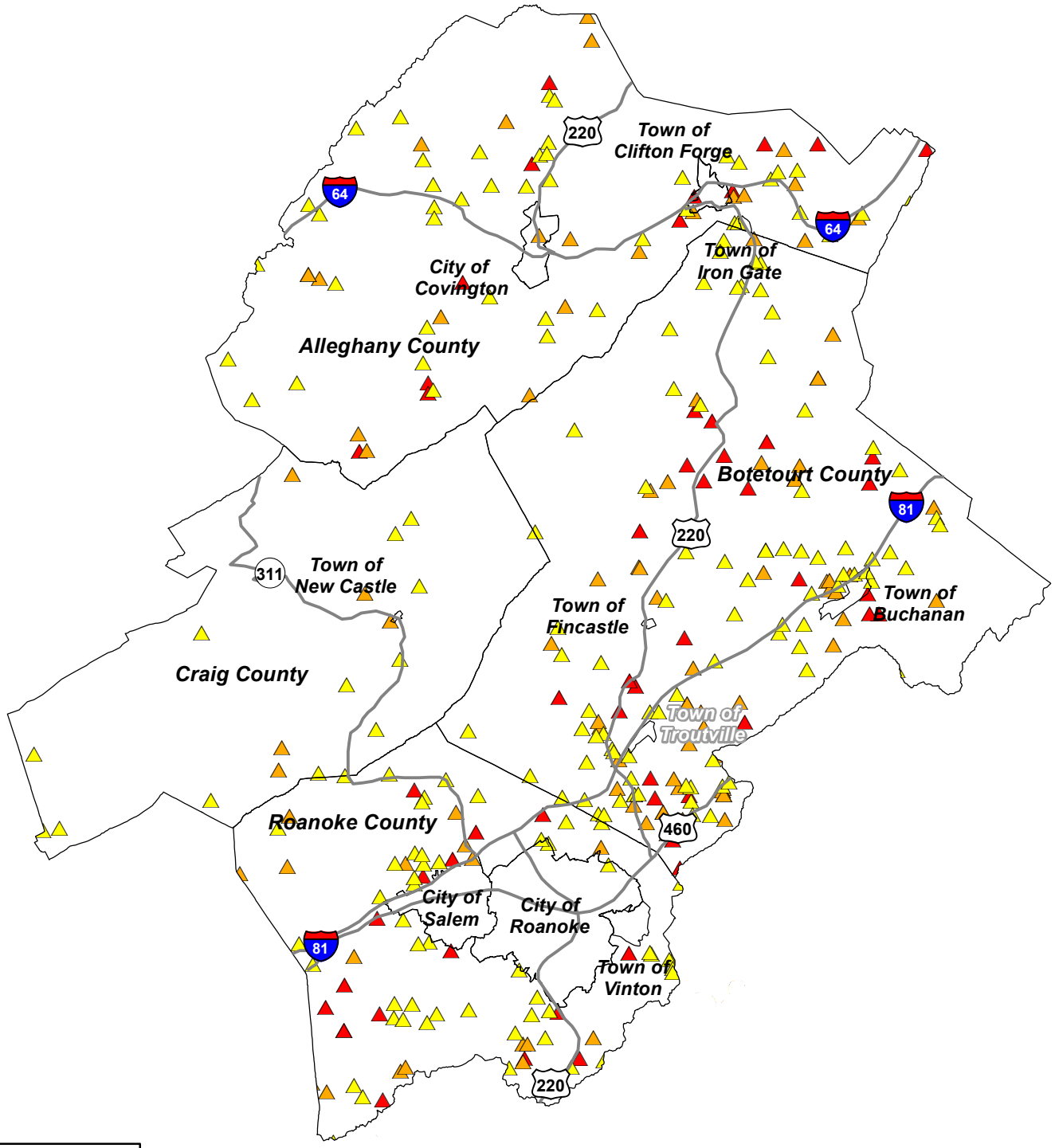
There have not been any Presidential Disaster Declarations related to wildfire in the region. There have been three (3) State Emergency Declarations for wildfire in the Region since 1995.

Table 26
State Emergency Declarations for Wildfires, 1987 to November 2010

Type of Disaster	Localities Affected	Declaration Date	Type	Description
Forest Fires	Entire State	4/9/95	Declaration of State of Emergency	Due to extreme dry conditions in the Commonwealth has forest fires in existence and other potential for forest fires, the Virginia National Guard was called out
Forest Fires, Plant Disease Risk, Insect Infestation	Entire State	9/6/96	Declaration of State of Emergency	Amendment to EO 66 (96), due to damage done to the Commonwealth by Hurricane Fran there was a risk of forest fires, spread of plant diseases and undesirable insect increase
Forest Fires, Drought	Entire State	10/26/01	Declaration of State of Emergency	Existence of drought conditions caused a greater potential for forest fires, the Virginia National Guard was called out, a statewide ban on open burning was announced

Note: All disaster declarations in Virginia are Executive Orders issued by the Governor. Disasters without a description in the Virginia Department of Emergency Management file are described by Executive Order number only.
Source: Virginia Department of Emergency Management, 2003 and Library of Virginia 2010.

Figure 5: Wildfire Incidents



Legend

- VDOF Wildfire 1995-2001
- VDOF Wildfire 2002-06
- VDOF Wildfire 2006-08

Scale 1:500,000

Source: Roanoke Valley-Alleghany Regional Commission, 2012.

Winter Storms

Winter Storms have the greatest chance of impacting the region. Virginia's biggest winter storms are the great Nor'easters. At times, nor'easters have become so strong that they have been labeled the "White Hurricane". In order for these storms to form, several things need to occur. High pressure builds over New England. Arctic air flows south from the high center into Virginia. The colder and drier the air is, the denser and heavier it becomes. This cold, dry air is unable to move west over the Appalachian Mountains. Instead, it remains trapped to the east side, funneling down the valleys and along the coastal plain toward North Carolina. To the east of the arctic air is the warm water of the Gulf Stream. The contrast of cold air sinking into the Carolinas and the warm air sitting over the Gulf Stream creates a breeding ground for storms. Combine this with the right meteorological conditions such as the position of the jet stream and storm development may become "explosive" (sudden, rapid intensification; dramatic drop in the central pressure of the storm).

Review of Past Events and Reports

The region's greatest snowfall totals have occurred in January, February, and March. In January of 1966, the area received a total of 41.2 inches of snow. February of 1960 found the area blanketed with 27.6 inches and March delivered 30.3 inches that same year. The second greatest official snow accumulation in a single 24-hour period occurred on February 11th and 12th of 1983 when 18.6 inches covered the region. The storm resulted in snowdrifts of up to three feet in height. This was the third heaviest snowfall in over 100 years.

The "Storm of the Century" hit the valley in March 1993. With blizzard-like conditions and nearly 30 inches of snow, this was the biggest winter storm in 10 years. Localities in the region received a Presidential Declaration of Emergency and the National Guard was mobilized to help with emergency transportation needs. Shelters were open for those without electricity.

A devastating storm struck the region and surrounding jurisdictions in February 1994, with one to three inches of solid ice from freezing rain and sleet. Roads were blocked, electric and phone lines were lost and a large portion of the valley was without electricity.

The "Blizzard of '96" dropped 22.2 inches officially in 24 hours in early January of 1996 that is the current record 24-hour snowfall. Many areas of the region received more than 36 inches during the same period.

In March 2009 snowfall reports in the region ranged from 6 to 9 inches, and were the largest snow event since 2005.

The Winter of 2009-2010 brought three major winter storms to the area. On December 18th, with areas of Craig and Alleghany County reporting up to 23 inches, snow continued to fall for the next 11 days. The first week of February 2010 saw another 8-10 inches fall on top of an event in late January that had already dropped 10-12 inches causing power outages, and dangerous driving conditions.

There have been seven (7) Presidential Disaster Declarations related to winter storms in the region. The declarations impacted multiple localities in the region. There have been sixteen (16) State Emergency Declarations for winter storms in the Region since 1993

Table 27
Presidential Disaster Declarations for Winter Storms, 1965 to June 2003

Locality	Declaration Number	Designation Date	Disaster Description
Alleghany County Botetourt County Craig County Roanoke County City of Roanoke	1014	03/10/1994	Severe ice storms, flooding
Craig County Roanoke County	1021	04/11/1994	Severe winter ice storm
Alleghany County Botetourt County Clifton Forge City of Covington Craig County Roanoke County City of Roanoke City of Salem	1086	02/02/1996	Blizzard of 96 (severe snow storm)
Alleghany County Botetourt County Craig County Roanoke County	1318	02/28/2000	Severe winter storms
Craig County Roanoke County City of Roanoke City of Salem	1458	04/28/2003	Severe winter storm, record/near record snowfall, heavy rain, flooding, and mudslide
Alleghany County Botetourt County Clifton Forge City of Covington Craig County Roanoke County City of Roanoke City of Salem	1874	02/16/2010	Severe winter storms
Craig County	1905	04/27/2010	Severe winter storms

Source: Virginia Department of Emergency Management, 2003 and FEMA, 2010.

Table 28
State Emergency Declarations for Winter Storms, 1987 to February 2003

Type of Disaster	Localities Affected	Declaration Date	Type	Description
Winter Emergency	Entire State	3/12/93	Declaration of State of Emergency	Extremely low temperatures and heavy snowfall accompanied by high velocity winds, sleet and freezing rain fell over the Commonwealth, hundreds of motorists were stranded, thousands of people were without power or heat, shelters were opened, the Virginia National Guard was called out.
Winter Emergency	Western Virginia	1/3/94	Declaration of State of Emergency	An unusually severe winter storm was expected to impact the western portion of Virginia shortly after January 3, 1994, the conditions did not materialize although two feet of snow had been predicted, the Virginia National Guard was called out.
Winter Emergency	Entire State	1/19/94	Declaration of State of Emergency	Due to severe winter weather (extremely low temperatures, heavy snowfall, high winds, sleet and freezing rains) winter fuel was being used faster than homes and agribusiness could be supplied, exemptions were granted to haulers delivering heating fuels.
Winter Emergency, Landslide	Entire State	2/11/94	Declaration of State of Emergency	Severe winter storm across the Commonwealth, large accumulations of ice, sleet and snow and moderate rain throughout the state, the southwestern portion of the state had heavy rains, mudslides and flooding occurred, 28 localities opened shelters, Virginia National Guard was called out .
Winter Emergency	Entire State	3/2/94	Declaration of State of Emergency	Severe winter weather buried the Commonwealth with snow to depths of 1 and one-half to two feet of snow, drifts occurred in the Shenandoah Valley and Northern Virginia due to 25 mile per hour winds, ice condition existed on the roads and torrential rains caused flooding in the coastal and western regions of the state, the ground was saturated by previous winter storms and this exacerbated the storm's effects, Virginia National Guard was called out.
Winter Emergency	Entire State	1/6/96	Declaration of State of Emergency	Predicted winter storm with blizzard conditions, snowfall of 12-24 inches expected throughout the Commonwealth

Type of Disaster	Localities Affected	Declaration Date	Type	Description
Winter Emergency	Entire State	2/2/96	Declaration of State of Emergency	A storm system moved through Virginia February 1-4, 1996, an Arctic air mass from Canada moved across the state, it had the potential to cause widespread power outages, and fuel and other resource shortages, it had the potential to cause severe economic losses including the agricultural community and livestock operations, the Virginia National Guard was called out .
Winter Emergency	Entire State	1/28/98	Declaration of State of Emergency	Severe winter storm causing heavy snowfall in the western section of the state causing riverine flooding, coastal flooding and high winds on the coast, the Virginia National Guard, EO was extended for second storm predicted shortly after.
Winter Emergency	Entire State	1/25/00	Declaration of State of Emergency	Winter storm with high winds dumped up to 18 inches of snow across much of the state, there were drifting and blizzard conditions, the Virginia National Guard was called out, the EO was extended to cover a predicted storm on January 28-31, 2000.
Winter Emergency	Entire State	12/11/02	Declaration of State of Emergency	Icy conditions caused massive power outage.
Winter Emergency	Entire State	2/17/03	Declaration of State of Emergency	SW Virginia received more than 4 inches of rain that caused flooding and mudslides.
Winter Emergency	Entire State	3/02/2009	Declaration of State of Emergency	Severe weather from a winter weather event causing widespread power outages and transportation difficulties throughout the State.
Winter Emergency	Entire State	12/18/2009	Declaration of State of Emergency	Severe winter storm from prolonged periods of snow and windy weather from the remnants of a winter storm causing widespread power outages, flooding and transportation difficulties throughout the State.
Winter Emergency	Entire State	1/28/2010	Declaration of State of Emergency	Severe winter storm with significant snow accumulations ranging from 4 to 12 inches and temperatures below freezing that could cause transportation difficulties and power outages.
Winter Emergency	Entire State	2/03/2010	Declaration of State of Emergency	Severe winter storms with significant snow and ice accumulations and excessive rain that could impact the Commonwealth between February 5 and 10, 2010, creating the potential for transportation difficulties and power outages.

Type of Disaster	Localities Affected	Declaration Date	Type	Description
Winter Emergency	Entire State	2/26/2010	Declaration of State of Emergency	Winter storm with damaging high winds, continuous snow showers and blowing snow that reduced visibility to near zero creating the potential for transportation difficulties and power outages.

Source: Virginia Department of Emergency Management, 2003 and Library of Virginia, 2010.

Regional Snowfall Index (RSI)

NOAA's National Climatic Data Center is now producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two thirds of the U.S. The RSI ranks snowstorm impacts on a scale from 1 to 5, similar to the Fujita scale for tornadoes or the Saffir-Simpson scale for hurricanes.

Table 29
Regional Snowfall Index

Category	RSI Value	Description
1	1–3	Notable
2	3–6	Significant
3	6–10	Major
4	10–18	Crippling
5	18.0+	Extreme

Source: Regional Snowfall Index, National Climatic Data Center, NOAA, http://www.ncdc.noaa.gov/snow-and-ice/rsi/, 2013.

The RSI differs from these other indices because it includes population. RSI is based on the spatial extent of the storm, the amount of snowfall, and the juxtaposition of these elements with population. Including population information ties the index to societal impacts. Currently, the index uses population based on the 2000 Census.

The RSI is an evolution of the Northeast Snowfall Impact Scale (NESIS) which NCDC began producing in 2005. While NESIS was developed for storms that had a major impact in the Northeast, it includes the

impact of snow on other regions as well. The RSI is important because of the need to place snowstorms and their societal impacts into a historical perspective on a regional scale.

NCDC has analyzed and assigned RSI values to over 500 storms going as far back as 1900. New storms are added on an ongoing basis as they occur. As such, RSI puts the regional impacts of snowstorms into a century-scale historical perspective. The index is useful for the media, emergency managers, the public and others who wish to compare regional impacts between different snowstorms. The RSI website also includes an interactive map that shows historic and recent data which would be useful for planning purposes.

The RSI and Societal Impacts Section of the website allows users to see the regional RSI values for particular storms as well as the area and population of snowfall for those storms.

References:

Hazard Analysis, Project Impact Roanoke Valley, (no date).

StormReady, National Weather Service, http://www.stormready.noaa.gov, 2003.

Source: Regional Snowfall Index, National Climatic Data Center, NOAA, http://www.ncdc.noaa.gov/snow-and-ice/rsi/, 2013

Chapter 3
Vulnerability Assessment

The vulnerability assessment of the region's localities to specific hazards is based on a combination of the probability, extent and past occurrences of hazard events. Probability is based on the number of past documented occurrences of a hazard. A higher number of occurrences resulted in the disaster being given a higher ranking. Extent is based on the hazards area of impact- either localized or jurisdiction wide. Hazards with a wider area of impact were given a higher ranking. Past occurrences is based on whether or not a specific hazard has occurred in a locality. Disasters that have actually occurred in a locality were given a higher ranking.

Based on past probability, extent and past occurrences, the Pre-Disaster Mitigation Plan Committee selected the following disasters for inclusion in this Plan: earthquakes, flooding, hurricanes, landslides, tornados, straight-line winds, wildfires, and winter storms.

Tables 27 to 30 show rankings for disasters in each locality based on: probability of occurrence; extent of disaster; past occurrence; and overall vulnerability. The ranking system is similar to the one used by VDEM in the State HIRA. a semi-quantitative scoring system was used to compare all of the hazards. This method prioritizes hazard risk based on a blend of quantitative factors from the available data.

Probability of Occurrence is the probability that a specific type of disaster will occur in a jurisdiction. Some of the hazards assessed in this plan did not have precisely quantifiable probability or impact data, therefore a qualitative ranking based on local knowledge and historical record was used.

Probable Extent of Disaster is the probable geographic extent of the disasters impact. The available data sources vary widely in their depiction of hazard geography. As a result, one uniform ranking system could not be accomplished. Each hazard has been assigned a category of localized such as the path of a tornado or jurisdiction-wide such as a winter storm.

Past Occurrence is simply whether or not the disaster has occurred in a locality.

Overall Vulnerability is a combination of the rankings of the other three matrixes to obtain an overall ranking for each type of disaster in each jurisdiction and in the region.

Table 30
Probability of Hazard Occurrence

Locality	Earthquake	Flood	Hurricane	Straight Line Winds	Landslide	Tornado	Wildfire	Winter Storm
Alleghany County	1	3	1	2	1	1	3	3
Botetourt County	1	3	1	2	1	1	3	3
Town of Buchanan	1	3	1	2	1	1	2	3
Town of Clifton Forge	1	3	1	2	1	1	2	3
City of Covington	1	3	1	2	1	1	1	3
Craig County	1	3	1	2	1	1	3	3
Town of Fincastle	1	1	1	2	1	1	1	3
Town of Iron Gate	1	1	1	2	1	1	2	3
Town of New Castle	1	2	1	2	1	1	1	3
City of Roanoke	1	3	1	2	1	1	1	3
Roanoke County	1	3	1	2	1	1	3	3
City of Salem	1	3	1	2	1	1	1	3
Town of Troutville	1	3	1	2	1	1	2	3
Town of Vinton	1	3	1	2	1	1	1	3

Source: Roanoke Valley-Alleghany Regional Hazard Mitigation Plan Committee, 2011.
Note: Rankings are defined as: 1 - Low; 2 - Medium; and 3 - High.

Table 31
Probable Extent of Disaster

Locality	Earthquake	Flood	Hurricane	Straight Line Winds	Landslide	Tornado	Wildfire	Winter Storm
Alleghany County	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
Botetourt County	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
Town of Buchanan	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
Town of Clifton Forge	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
City of Covington	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
Craig County	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
Town of Fincastle	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
Town of Iron Gate	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
Town of New Castle	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
City of Roanoke	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
Roanoke County	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
City of Salem	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
Town of Troutville	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide
Town of Vinton	Localized	Localized	Jurisdiction-wide	Localized	Localized	Localized	Localized	Jurisdiction-wide

Source: Roanoke Valley-Alleghany Regional Hazard Mitigation Plan Committee, 2011.

Table 32
Past Hazard Occurrences

Locality	Earthquake	Flood	Hurricane	Straight Line Winds	Landslide	Tornado	Wildfire	Winter Storm
Alleghany County	No	Yes	Yes	Yes	No	No	Yes	Yes
Botetourt County	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Town of Buchanan	No	Yes	Yes	Yes	No	No	No	Yes
Town of Clifton Forge	No	Yes	Yes	Yes	Yes	No	No	Yes
City of Covington	No	Yes	Yes	Yes	No	No	No	Yes
Craig County	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Town of Fincastle	No	Yes	Yes	Yes	No	No	No	Yes
Town of Iron Gate	No	Yes	Yes	Yes	No	No	Yes	Yes
Town of New Castle	No	Yes	Yes	Yes	No	No	No	Yes
City of Roanoke	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Roanoke County	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City of Salem	No	Yes	Yes	Yes	No	Yes	No	Yes
Town of Troutville	No	Yes	Yes	Yes	No	No	No	Yes
Town of Vinton	No	Yes	Yes	Yes	No	No	No	Yes

Source: Roanoke Valley-Alleghany Regional Hazard Mitigation Plan Committee, 2011.

Table 33
Overall Hazard Vulnerability Rankings

Locality	Earthquake	Flood	Hurricane	Straight Line Winds	Landslide	Tornado	Wildfire	Winter Storm	Total
Alleghany County	2	5	4	4	2	2	5	6	30
Botetourt County	2	5	4	4	3	2	5	6	31
Town of Buchanan	2	5	4	4	2	2	3	6	28
Town of Clifton Forge	2	5	4	4	3	2	3	6	29
City of Covington	2	5	4	4	2	2	2	6	27
Craig County	2	5	4	4	3	2	5	6	31
Town of Fincastle	2	3	4	4	2	2	2	6	25
Town of Iron Gate	2	3	4	4	2	2	4	6	27
Town of New Castle	2	4	4	4	2	2	2	6	26
City of Roanoke	3	5	4	4	2	3	3	6	30
Roanoke County	2	5	4	4	3	3	5	6	32
City of Salem	2	5	4	4	2	3	2	6	28
Town of Troutville	2	5	4	4	2	2	3	6	28
Town of Vinton	2	5	4	4	2	2	2	6	27
Regional Score	**29**	**65**	**56**	**56**	**32**	**31**	**46**	**84**	**-**

Source: Roanoke Valley-Alleghany Regional Hazard Mitigation Plan Committee, 2011.
Note: Rankings are defined as: 1 - Very Low; 2 - Low; 3 - Medium; 4 - Medium High; 5 - High; and 6 - Very High.

Capabilities Assessment

The capabilities assessment reviews the ability of each jurisdiction to implement future mitigation projects. The assessments are ratings of localities in the region for the technical, fiscal, and administrative capacity to implement hazard mitigation strategies. Technical expertise and mitigation experience of staff (engineers, public works technicians), administrative ability (in particular availability of enough staff to manage multiple projects) and financial constraints were key considerations in the assessment. Each locality in the region was considered separately although many of the towns are served by county services.

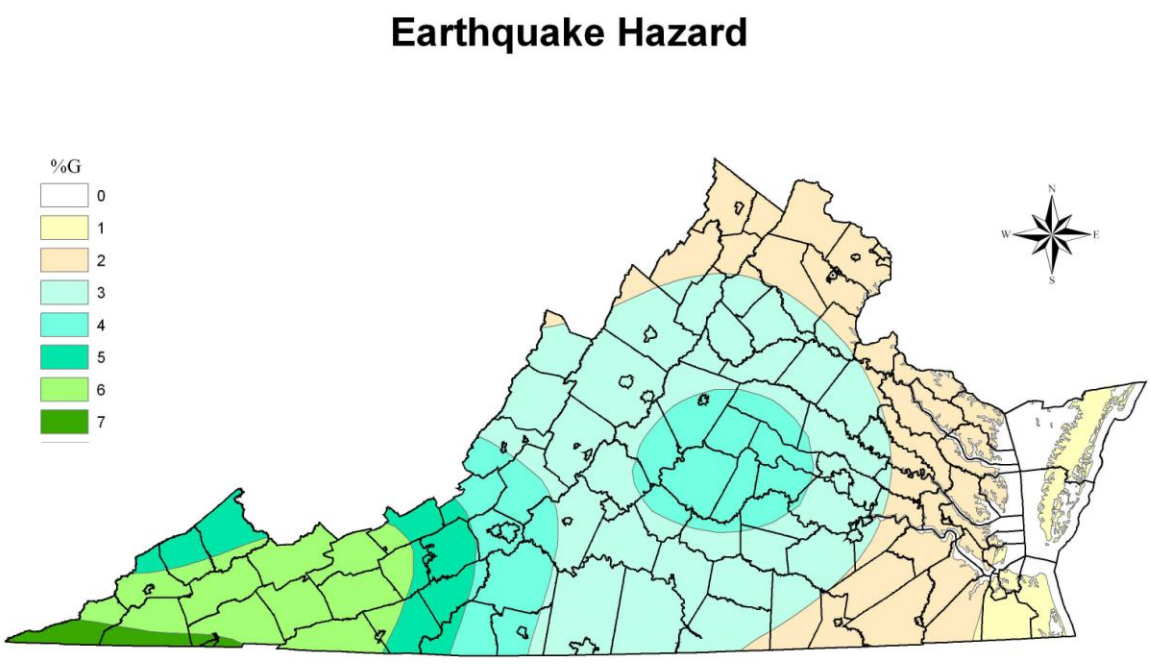
Table 34
Capabilities Assessment

Locality	Technical	Administrative	Financial
Alleghany County	High	High	Low
Town of Clifton Forge	Moderate	Moderate	Low
Town of Iron Gate	Low	Low	Low
Botetourt County	High	High	Moderate
Town of Buchanan	Low	Low	Low
Town of Fincastle	Low	Low	Low
Town of Troutville	Low	Low	Low
City of Covington	Moderate	Moderate	Low
Craig County	Low	Low	Low
Town of New Castle	Low	Low	Low
City of Roanoke	High	High	Moderate
Roanoke County	High	High	Moderate
Town of Vinton	Moderate	Moderate	Low
City of Salem	High	Moderate	Low

Earthquake

While rarely occurring, earthquakes do impact the region. The map below illustrates the severity of horizontal shaking that has a 10% probability of occurring within a 50-year period for the Commonwealth of Virginia. The *%g* value, an index indicating the severity of horizontal shaking that has a 10% chance of occurring within a 50-year period, for the Roanoke Valley-Alleghany region ranges from 4 to 5. An area in southwest Craig County has a %g value of 5, which indicates the likelihood of increased severity in earthquake events. Overall, earthquake events in the region will most likely be minor or, at most, moderate events with little or no structural damage. The probability of an occurrence of a earthquakes has remained unchanged since the adoption of the 2006 Regional Pre-Disaster Mitigation Plan.

Figure 6
Earthquake Hazard



The %g value, an index indicating the severity of horizontal shaking that has 10% chance of occurring within a 50-year period, for the RVARC region ranges from 4 to 5. An area in Southwest Craig County has a %g value of 5, which indicates the likelihood of increased severity in earthquake events.

Source: U.S. Geologic Survey, 2003

Flood

Widespread flooding or isolated flash flooding impact a large portion of the region. The Roanoke Valley has historically proven susceptible to flooding. The main contributing factor to sustained flooding and flash flooding is the intensity of the rainfall and its duration. The mountains surrounding the alley make the region prone to runoff from heavy rain. Much of this rainfall is absorbed into the ground, replenishing groundwater. Pavement, concrete, and buildings limit the amount of ground cover available for the absorption of water. Water runoff in urbanized areas is increased two to six times over what would occur in natural terrain. The result is swollen streams overflowing their banks and ending with dangerous widespread flooding of the Roanoke Valley. *The probability of an occurrence of a flood event has remained unchanged since the adoption of the 2006 Regional Pre-Disaster Mitigation Plan. There have been no significant regional flooding events since the previous edition of the plan.*

National Flood Insurance Program

Many localities participate in, and are in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements. This program allows property owners to purchase flood insurance from NFIP. The number of active flood insurance policies is an indicator of flood risk in the region.

Many residents have purchased flood insurance to help recover from flood losses. Flood insurance covers only the improved land or the actual building structure. Although it is helpful to those who have suffered losses, it may also provide a false sense of security and discourage people and businesses from relocating to a more appropriate site. Many residents that experience flood loss rebuild in the same location, only to be flooded again. These repetitive loss properties expose lives and property to flood hazards. FEMA and local governments recognize this problem and attempt to remove repetitive loss properties through land acquisition, home relocation or by elevating the structure. Continued repetitive loss claims lead to increased damage by floods, higher insurance rates, and increasing amounts of tax dollars being spent on disaster relief.

Table 35
National Flood Insurance Program Communities

Community Name	Date of Entry	Current Effective Map
Alleghany County	07/16/87	02/19/92
Botetourt County	06/15/78	12/17/10
Buchanan, Town of	11/02/77	12/17/10
Clifton Forge, Town of	09/01/78	12/17/10
Covington, City of	01/03/79	12/17/10
Craig County	02/02/90	02/02/90
Fincastle, Town of	05/15/78	12/17/10
Iron Gate, Town of	01/16/87	12/17/10
New Castle, Town of	02/02/90	02/02/90
Roanoke County	10/17/78	09/28/07
Roanoke, City of	11/04/81	09/28/07
Salem, City of	09/02/81	09/28/07
Troutville, Town of	10/14/77	12/17/10
Vinton, Town of	03/15/78	09/28/07

Source: FEMA, Federal Insurance Administration, 2011.

Table 36
NFIP Policy Statistics

Community Name	Policies In-force	Insurance In Force	Written Premium In Force
Alleghany County	172	$26,010,400	$116,674
Botetourt County	158	$25,557,100	$128,208
Buchanan, Town of	35	$5,104,600	$37,924
Clifton, Town of	4	$1,550,000	$3,365
Covington, City of	113	$11,543,800	$67,014
Craig County	57	$6,194,600	$37,003
Fincastle, Town of	4	$580,800	$1,632
Iron Gate, Town of	5	$616,900	$1,392
New Castle, Town of	6	$654,400	$2,588
Roanoke County	450	$86,000,700	$376,214
Roanoke, City of	668	$151,465,000	$916,216
Salem, City of	523	$101,713,200	$690,349
Troutville, Town of	15	$1,599,400	$11,925
Vinton, Town of	52	$14,140,100	$125,461
Region	2,262	$432,731,000	$2,515,965

Source: FEMA, National Flood Insurance Program, 2011.
Note: Policies In Force = Policies in force on the "as of" date of the report, 02/28/2011.
Insurance In Force = The coverage amount for policies in force.
Written Premium In Force = The premium paid for policies in force.

Table 37
NFIP Claims 1978-2011

Community Name	Total Losses	Closed Losses	Open Losses	CWOP Losses	Total Payments
Alleghany County	193	169	0	24	$2,464,681
Botetourt County	216	189	0	27	$2,659,048
Buchanan, Town of	63	60	0	3	$1,777,294
Clifton Forge, Town	9	8	0	1	$74,846
Covington, City of	144	126	0	18	$833,730
Craig County	93	72	0	21	$1,300,627
Fincastle	0	0	0	0	$0
Iron Gate	0	0	0	0	$0
New Castle, Town of	4	4	0	0	$32,441
Roanoke County	406	324	2	80	$3,410,280
Roanoke, City of	1,015	815	0	200	$18,313,284
Salem, City of	679	563	0	116	$15,706,788
Troutville, Town of	9	5	0	4	$9,534
Vinton, Town of	80	60	0	20	$1,252,020
Region	2,911	2,395	2	514	$47,834,574
Total For Virginia	38,420	30,655	122	7,643	$555,656,484

Source: FEMA, National Flood Insurance Program, 2011.
Note: Total losses = All losses submitted regardless of the status; Closed losses = Losses that have been paid; Open losses = Losses that have not been paid in full; CWOP losses = Losses that have been closed without payment; Total Payments = Total amount paid on losses.

Flood Mitigation Assistance (FMA) Program

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FEMA provides FMA funds to assist States and communities implement measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program.

Three types of FMA grants are available to States and communities:

1. Planning Grants to prepare Flood Mitigation Plans. Only NFIP-participating communities with approved Flood Mitigation Plans can apply for FMA Project grants
2. Project Grants to implement measures to reduce flood losses, such as elevation, acquisition, or relocation of NFIP-insured structures. States are encouraged to prioritize FMA funds for applications that include repetitive loss properties; these include structures with 2 or more losses each with a claim of at least $1,000 within any ten-year period since 1978.

3. Management Cost Grants for the State to help administer the FMA program and activities. Up to ten percent (10%) of Project grants may be awarded to States for Management Cost Grants.

Riverine Flooding

Riverine flooding impacts all localities within the region. Rainfall on the steep watersheds floods small streams, raise river levels and overwhelm stormwater systems. The prevention of losses of life and property due to flooding is a priority for the local governments in the region.

Alleghany Highlands Communities

Potentially, the main flooding problem in Alleghany County is along the Jackson River. Gathright Dam is the only dedicated flood protection structure in the County. Since the completion of the dam, there has been widespread belief that flooding should not occur. This belief helps lead to increased pressure for development along the floodplain of the Jackson River. Although the reduction in flood stages provided by the dam is substantial, it does not completely eliminate the flood hazards downstream of Potts Creek and Dunlap Creek. Gathright Dam only controls approximately 38 percent of the Jackson River watershed, and has no control over the watersheds of Potts and Dunlap Creeks.

The USGS has recorded stages of area streams. Records of river stages and discharges on the Jackson River at Falling Spring gage, located approximately 10 miles upstream from Covington, have been maintained since April 1925. To supplement the Falling Springs records, data is recorded from the USGS gauging stations at Dunlap Creek and Potts Creek. The Dunlap gage, located 4.3 miles above its confluence with the Jackson River, has been recording data since October 1928. Records of river stages and discharges on Potts Creek, 7.5 miles upstream of its mouth, have been maintained from October 1928 to September 1956, and October 1965 to present. There is also a USGS stream gage on the Cowpasture River.

In 1986, the Federal Emergency Management Agency (FEMA) completed a Flood Insurance Study for Alleghany County. In 1992, the study was updated and provided detailed data on Wilson Creek and its tributaries. The floodplains along the Jackson River are areas of intensive development and should be noted as possible hazardous areas.

The U.S. Department of Housing and Urban Development (HUD), Federal Insurance Administration (FIA), 1978 Flood Insurance Study of Clifton Forge, Virginia, provides details on the effects of flooding along the Jackson River and Smith Creek. Flooding on the smaller streams Hazel Run, Dry Creek, and East Branch were studied by approximate methods. The Jackson River flows easterly through the town with a relatively well-defined channel and banks covered with vegetation and trees. CSX Railroad parallels the river along its length in town. The steep banks of the river prevent development on the flood plain. Smith Creek flows in a southerly direction from its headwaters in Bath County, through Clifton Forge to the Jackson River. Development, consisting primarily of residences, public buildings and businesses is concentrated along both sides of the stream throughout its entire reach.

Floods have occurred and can be expected to occur on the Jackson River and Smith Creek in Clifton Forge during all seasons of the year. During all major floods, high velocity flood flows and hazardous conditions would exist in the main stream channel and in some parts of the flood plain. Intense rainfall from local thunderstorms or by tropical disturbances will most likely be the source of the more severe floods on the Jackson River. Flooding at the mouth of Smith Creek can be caused by rainfall runoff from the watershed or by backwater from the Jackson River when it floods.

Damage from past floods along the Jackson River has been minor due to the topography and physical characteristics of the floodplain. However this is not true on Smith Creek. At a number of locations, the floodplain is severely restricted by buildings that have been constructed on opposite sides of the stream. Near the center of town, flow is confined for a distance of approximately 400 feet by a maze of culverts of varying sizes and capacities. Due to the numerous buildings that have been constructed over this section of the creek, potential for serious flood losses exists. If the culvert system becomes clogged, floodwaters would travel over the streets and a large portion of the business district would be flooded.

The US Department of Housing and Urban Development and Federal Insurance Administration 1978 Flood Insurance Study of the City of Covington, Virginia details the effects of fluvial flooding from the Jackson River. Mill Branch, Harmon's Run, and Dry Run Branch by approximate methods. The study does take into consideration the storage effects of Gathright Dam. The Jackson River flood plain contains a mixture of residential and commercial development with some light industry located in the area. The flood plains of the tributaries of the Jackson contain a majority of residential development with occasional commercial development. The Jackson River flows in a southerly direction through the City of Covington with a well-defined bank covered with vegetation and trees. Dry Branch flows in a northwesterly direction to the Jackson. Floods have occurred and can be expected to occur on the Jackson River in

Covington during all seasons of the year. During all major floods, high velocity flood flows and hazardous conditions would exist in the main stream channel and in some parts of the flood plain.

In 2009 the Flood Insurance Study for Alleghany County was updated along with the Flood Insurance Rate maps (FIRM). The new FIRMs went into effect in December 2010. This study was prepared to include all Alleghany County and unincorporated areas, the independent City of Covington, and the Towns of Clifton Forge and Iron Gate into a countywide format. For this FIS, the floodplains for all detailed study, unrevised streams and approximately 80 miles of effective Zone A floodplains have been redelineated using updated topographic data provided to FEMA by the Virginia Department of Conservation and Resources (VADCR) on October 2, 2008. All floodplain boundaries were updated, based on new digital topographic data; supplied by the Commonwealth of Virginia, dated Spring 2005. Also, all approximate Zone A Special Flood Hazard Areas were delineated based on the aforementioned elevation data. This work was completed in April 2009. The updated study and maps were used in determining risk and potential loss caused by flooding.

Botetourt County Communities

The Flood Insurance Study, Town of Buchanan, Virginia, performed by the US Department of Housing and Urban Development and Federal Insurance Administration in 1977 documented the impact of the James River and Purgatory Creek on the Town of Buchanan. Purgatory Creek flows into the James River within the corporate limits of Buchanan and forms the eastern town limit. Most of the residential and business areas of the town are above the flood plain. However, there are many residential, commercial, and industrial properties subject to flooding, many of which have been damaged by flooding in the past. The CSX Railroad parallels the James River on the south bank and the Norfolk Southern Railroad parallels the north bank throughout the Buchanan study area. During the 100-year flood portions of both tracks would be flooded according to the Flood Insurance Study. The high school, the sewage treatment plant, several businesses, and many homes would be flooded by the 100-year flood. US Highway 11 crosses the James River at Buchanan. While the bridge does not produce backwater, the approaches to the structure would be flooded.

The 1988 Reconnaissance Report, James River, Buchanan, Virginia, Section 205 Flood Control Study, by the US Army Corps of Engineers provides information about potential flooding along Looney, Purgatory and Bearwallow creeks. Entering the James River from the west of Buchanan is Looney Creek.

Bearwallow Creek flows into the James just east of town. Purgatory Creek flows east into the James River at the eastern corporate limits of Buchanan. The Study did not predict flood losses. The Section 205 Flood Control Study prepared and reviewed two alternatives for reducing flood loss in Buchanan: a 600-year levee and a 100-year levee. Due to the cost involved and low benefits of the alternatives, the Corps of Engineers determined that further study of developing local flood control measures was not appropriate at the time.

The 1989 Reconnaissance Report, James River, Eagle Rock, Virginia, Section 205 Flood Control Study, by the US Army Corps of Engineers, study area included the entire community of Eagle Rock and its immediate vicinity just downstream from the confluence of Craig Creek with the James River. The study estimates that the damages for a 100-year flood would be $605,000 (1989 dollars). Field reconnaissance performed for the Reconnaissance Report indicated that there would be a minimal amount of commercial and residential flooding below the 100-year event. This would be limited to the old mill, railroad station, and railways. Due to the cost involved and low benefits of the alternatives, the Corps determined that further study of developing local flood control measures for the community of Eagle Rock was not appropriate at the time.

In 2009 the Flood Insurance Study for Botetourt County was updated along with the Flood Insurance Rate maps (FIRM). The new FIRMs went into effect in December 2010. This study was prepared to include all of Botetourt County and unincorporated areas and the Towns of Buchanan, Fincastle and Troutville into a countywide format. All detailed streams within Botetourt County and Incorporated Areas were redelineated based on new digital topographic data; supplied by the Commonwealth of Virginia, dated 2006 to 2007. Also, all approximate Zone A floodplains were delineated, based on the aforementioned elevation data. The updated study and maps were used in determining risk and potential loss caused by flooding.

Craig County Communities

A lack of flood plain information studies for Craig County prevents a risk assessment within this locality from being quantified at this time. The county should work with the Corps of Engineers, Virginia Department of Emergency Management, and FEMA to develop a Flood Insurance Study for the major watersheds of Johns Creek, Craig Creek, Potts Creek, Sinking Creek and Barbours Creek.

Roanoke Valley Communities

In 1997, the Roanoke Valley Regional Stormwater Management Plan was prepared by Dewberry & Davis under contract to the Fifth Planning District Commission (now the Roanoke Valley-Alleghany Regional Commission). Localities participating in this study include only the Cities of Roanoke and Salem, the County of Roanoke and the Town of Vinton. The project is funded by the City of Roanoke, the City of Salem, the County of Roanoke, the Town of Vinton, and a stormwater mitigation grant from the Federal Emergency Management Agency (FEMA).

The overall focus of the Regional Stormwater Management Plan was the implementation of policies and procedures for mitigation of floods in the Roanoke Valley. The plan focused on 16 major watersheds. To accomplish this task, the report includes components that are designed to assist jurisdictions in making decisions about stormwater management and related flooding.

Following hydraulic (HEC-2) and hydrologic (HEC-1) analysis of the 16 watersheds, development of flood profiles and floodplains, flood hazards in the study area were identified. Residential structures located in the floodplains were identified and a determination was made as to the cause of the flooding. Possible solutions to reduce or eliminate flooding at residential structures were screened to determine those that would reduce the severity of the flooding. Roads that were inundated by storms with a 10-year or more frequent recurrence interval were also identified.

The following section describes the 16 watersheds and vulnerability to flooding identified in the Roanoke Valley Regional Stormwater Management Plan.

Back Creek

Located in Southeast Roanoke County, the Back Creek watershed encompasses a 58.7 square mile drainage basin that originates in the Blue Ridge Mountains on Poor Mountain at an elevation of 3,600 feet above sea level. It flows in a northeasterly direction for about 25 miles until it joins the Roanoke River near the borders of Roanoke, Bedford, and Franklin Counties.

Flooding problems along Back Creek (running west to east through southern Roanoke County), Martins Creek (southwest Roanoke County along Rt. 696), Little Back Creek (southwest Roanoke County along Rt. 695 and Rt. 221) and Back Creek Tributaries A & B (southern Roanoke County) were identified for

flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads.

On Back Creek, flooding is scattered throughout the length of the stream. Two areas that experience house flooding are between Merriman Road (southern Roanoke County along Rt. 613) and Coleman Road (Rt. 735) and between Cotton Hill Road (Rt. 688) and Old Mill Road (Rt. 752) in southern Roanoke County. The tributaries to Back Creek also experience scattered house flooding.

The Roanoke Valley Regional Stormwater Management Plan estimated that 165 houses in the watershed would be flooded by a 100-year storm event.

Barnhardt Creek

With an origin on Poor Mountain at 2,700 feet above sea level in southwestern Roanoke County, the Barnhardt Creek watershed is a 4.2 square mile drainage basin located in south central Roanoke County, southern Salem, and the southwestern portion of the City of Roanoke.

Flooding problems along Barnhardt Creek for both existing and developed land use conditions, were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads.

The existing conditions 100-year storm floods about 30 homes along Barnhardt Creek including more than 20 that are inundated by a 10-year storm. One of the major flooding problems on Barnhardt Creek is upstream of Cravens Creek Road (located in the westernmost part of Roanoke City at the border with the City of Salem). Another is upstream of Electric Road - State Route 419 in the Farmingdale subdivision (located between Rt. 685 and Rt. 419 at the junction of Roanoke County, the City of Salem and City of Roanoke) along Lakemont Drive. The Meadow Creek subdivision located in southwest Roanoke County, also experiences house flooding both upstream and downstream of Meadow Creek Drive (off of Rt. 686).

The Roanoke Valley Regional Stormwater Management Plan estimated that 36 houses in the watershed would be flooded by a 100-year storm event

Butt Hollow Creek

Located wholly within central Roanoke County and the western portion of the City of Salem, Butt Hollow Creek watershed is a 2.7 square mile fan-shaped drainage basin. Butt Hollow Creek originates on Fort Lewis Mountain at an elevation of 3,260 feet above sea level. It flows southeasterly for about three miles to its confluence with the Roanoke River.

Flooding problems along Butt Hollow Creek for both existing and developed land use conditions were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads.

The existing conditions 100-year storm floods about 30 homes along Butt Hollow Creek including more than 10 that are also inundated by a 10-year storm. The major flooding problems on Butt Hollow Creek are at Routes 11/460 and Butt Hollow Road (Rt. 640) at the western corporate limits of the City of Salem.

The Roanoke Valley Regional Stormwater Management Plan estimated that 29 houses in the watershed would be flooded by a 100-year storm event.

Carvin Creek

The Carvin Creek watershed originates on Tinker Mountain in southeastern Botetourt County at an elevation of 3,200 feet above sea level. It flows in a northeasterly direction for about 3 miles to the Carvin Cove Reservoir, which is a public drinking water supply for the City of Roanoke. Located in northeast Roanoke County, northern City of Roanoke, and the western portion of Botetourt County, the Carvin Creek watershed is a 28 square mile fan-shaped drainage basin.

Flooding problems along Carvin Creek, West Fork Carvin Creek, and Deer Branch, for both existing and developed land use conditions, were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads. Problems with debris blockage were also identified.

The major flooding problem in the Carvin Creek watershed is in the Sun Valley subdivision located on the main stem of Carvin Creek (Verndale Drive and Rt. 623 in northeastern Roanoke County). Approximately 100 houses are located in the 100-year floodplain including more than 25 that are

inundated by a 10-year storm. Another problem in the Carvin Creek watershed is in the Summerdean subdivision in northeastern Roanoke County south of Rt. 11 where debris blockage problems at Plantation Road and Peyton Street increase the flood elevations enough to inundate several more houses. The major flooding problem on West Fork Carvin Creek is in the Captains Grove subdivision in Roanoke County (near the intersection of Rt. 623 and Rt. 11 / 220, just east of the Roanoke Regional Airport) where seven houses are located in the 100-year floodplain. On Deer Branch in northern Roanoke County near the intersection of Peters Creek Road and Williamson Road (Rt. 11), the worst flooding problem is on U.S. Route 11 just upstream of the confluence of Deer Branch with West Fork Carvin Creek. At this location U.S. Route 11 is flooded by the 2-year storm for approximately 1,000 feet of the road.

The Roanoke Valley Regional Stormwater Management Plan estimated that 160 houses in the watershed would be flooded by a 100-year storm event.

Cole Hollow Brook

From 3,020 feet above sea level on Fort Lewis Mountain, Cole Hollow Brook flows southwesterly and then southeasterly for about 4 miles until its confluence with the Roanoke River in Salem. The Cole Hollow Brook watershed is a 5.9 square mile drainage basin. This oblong watershed is located primarily in Roanoke County (paralleling Rt. 618), but the southern portion is in the City of Salem at Rt. 618 and Rt. 11.

Flooding problems along Cole Hollow Brook for both existing and developed land use conditions, were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads.

The existing conditions 100-year storm floods about 45 buildings/homes in west Salem along Cole Hollow Brook including more than 10 that are inundated by a 10-year storm. One of the major flooding problems on Cole Hollow Brook is upstream of West Main Street in the City of Salem at Horner Lane. Another is downstream of Interstate 81 in the Mitchell subdivision in west Salem along Windsor Avenue.

The Roanoke Valley Regional Stormwater Management Plan estimated that 43 houses in the watershed would be flooded by a 100-year storm event.

Dry Branch

Lying within Roanoke County and the City of Salem, the Dry Branch watershed is a 4.5 square mile drainage basin located primarily in north central Roanoke County that parallels Rt. 619 and 733. The southern portion of the watershed is in northern Salem. With a width of about two miles near its center, the watershed is fan shaped and has a length of 4.5 miles.

Flooding problems along Dry Branch for both existing and developed land use conditions, were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads. The major flooding problems on are in the Hockman Subdivision at Dry Branch's crossing of East Main Street (Rt. 11) and Burwell Street and at the Cameron Court subdivision at Dry Branch's crossing of Carrollton Avenue in Salem.

The Roanoke Valley Regional Stormwater Management Plan estimated that 149 houses in the watershed would be flooded by a 100-year storm event.

Gish Branch

Originating on Fort Lewis Mountain in north Roanoke County, the Gish Branch watershed descends from 3,080 feet above sea level. It flows in a southeasterly direction for about 3.5 miles until its confluence with Mason Creek in the City of Salem. Gish Branch lays wholly within north central Roanoke County and the north central portion of the City of Salem.

Flooding problems along Gish Branch for both existing and developed land use conditions were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads.

The existing conditions 100-year storm floods about 11 homes along Gish Branch on North Mill Road (Rt. 631) including more than 8 that are inundated by a 10-year storm. One of the major flooding problems on Gish Branch is upstream of Kessler Mill Road (Rt. 630) in east Salem where several homes and a commercial building are inundated by a 10-year storm.

The Roanoke Valley Regional Stormwater Management Plan estimated that 12 houses in the watershed would be flooded by a 100-year storm event.

Glade Creek

The Glade Creek watershed is a 33 square mile drainage basin located in northeast Roanoke County, northeast City of Roanoke, and northwest Vinton with the northern portion of the watershed located in Botetourt County. Glade Creek originates in the Blue Ridge Mountains near Curry Gap at an elevation of 2,500 feet above sea level. It flows in a southwesterly direction for about 11 miles to its confluence with Tinker Creek at the border of the City of Roanoke and Vinton.

Flooding problems for both existing and developed land use conditions along Glade Creek, Cook Creek, and Glade Creek Tributaries A and B, were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads. Problems with debris blockage were also identified.

The major flooding problem on Glade Creek is in the Town of Vinton upstream of the confluence of Glade Creek with Tinker Creek. From just upstream of Gus W. Nicks Boulevard to the confluence there are approximately 100 houses in the developed conditions (Year 2020) 100-year floodplain and 50 of which are inundated by the 10-year storm in the Town of Vinton. The May 1985, Feasibility Study by Camp Dresser and McKee states that the intersection of Walnut Avenue and Fifth Street located near the confluence of Glade Creek with Tinker Creek is the most severe flooding problem in the Town of Vinton.

The Roanoke Valley Regional Stormwater Management Plan estimated that 122 houses in the watershed would be flooded by a 100-year storm event.

Lick Run

The Lick Run watershed is located primarily in north central City of Roanoke with the northern portion in north central Roanoke County. It is a 7.8 square mile drainage basin that is narrow and has a maximum width of about two miles near its mouth. It is approximately 5.5 miles long. Lick Run originates at the interchange of Interstate 81 and Route 11 at an elevation of approximately 1,200 feet above sea level. Lick Run flows in a southeasterly direction for about 7.5 miles until its confluence with Tinker Creek immediately north of Norfolk Avenue and the Norfolk Southern Railyard.

Much of the central business district of Roanoke is subject to flooding by Lick Run. The Williamson Road area has exhibited some of the most severe and continuing local flooding problems in the City of Roanoke. Areas upstream of Washington Park (Lick Run north of Orange Avenue) have also been subject to flooding. High water marks along Lick Run were used by the consultants to verify the computed flood elevations

Flooding problems along Lick Run and Trout Run, for both existing and developed land use conditions, were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads. Problems with debris blockage were also identified.

The major flooding problem in the Lick Run watershed is overland flooding of residential neighborhoods (10th Street, Norris Drive and Andrews Road) and the central business district along Lick Run and Trout Run in the City of Roanoke where both streams are contained underground in the storm sewer system for the City of Roanoke.

The Roanoke Valley Regional Stormwater Management Plan estimated that 207 houses in the watershed would be flooded by a 100-year storm event.

Mason Creek

Originating at an elevation of 3,260 feet above sea level on Fort Lewis Mountain in northern Roanoke County near Big Bear Rock Gap, the Mason Creek watershed is a 29.6 square mile drainage basin. It includes the Gish Branch watershed and is located in north central Roanoke County, eastern Salem, and western City of Roanoke. The watershed is fan-shaped and has a length of about 8.5 miles and a maximum width of 9 miles near its headwaters. From Fort Lewis Mountain, Mason Creek flows northeasterly for about seven miles to Mason Cove where it turns and flows southeasterly 7.5 miles to its confluence with the Roanoke River in the City of Salem.

Flooding problems along Mason Creek and Jumping Run Creek, for both existing and developed land use conditions, were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads. Problems with debris blockage were also identified.

In the downstream portion of Mason Creek, the major flooding problems are at two trailer parks, the Salem Village Trailer Park (south of the intersection of Rt. 460 and Kessler Mill Road in Salem) and a trailer park located along Schrader Street in eastern Salem, south of the Salem Turnpike (Rt. 460). These trailer parks are subject to flooding in the 2-year storm. Another major problem in the Mason Creek watershed is in the vicinity of East Main Street where several buildings and houses are inundated by a 10-year storm including the Lakeside Plaza Shopping Center. Other areas subject to flooding include North Electric Road to Janee Drive (north of Interstate 81), Janee Drive to Carvins Cove Road, Carvins Cove Road to Catawba Valley Road, and Catawba Valley Road to Plunkett Road (all sections parallel Mason Creek and Kessler Mill Road from the City of Salem and then north along Catawba Road, Rt. 311, into Roanoke County).

The Roanoke Valley Regional Stormwater Management Plan estimated that 519 houses in the watershed would be flooded by a 100-year storm event.

Mud Lick Creek

Mudlick Creek watershed is a 9.6 square mile drainage basin. It is located in east central Roanoke County and southeast City of Roanoke. The watershed is fan shaped with a length of about 4.5 miles and a maximum width of 3.5 miles near its headwaters. Mudlick Creek flows northeasterly for about 4.5 miles until its confluence with the Roanoke River in Roanoke.

Flooding problems along Mudlick Creek for both existing and developed land use conditions, were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval. Buildings located in the floodplain were identified as well as overtopped roads.

There are several areas of house flooding on Mudlick Creek which are scattered along the stream. The major flooding areas on Mudlick Creek are located downstream of Brandon Avenue in the western part of Roanoke City, downstream of Grandin Road (Rt. 11) in the Westhampton/Rosalind Hills subdivisions (Brandon Avenue and Langdon Road in Roanoke City) and along South Park Circle in the Southwoods subdivision (northwest of the intersection of Garst Mill Road and Halevan Road in Roanoke County). There are approximately 60 houses in the 100-year floodplain of Mudlick Creek of which 40 are also inundated by the 10-year storm.

The Roanoke Valley Regional Stormwater Management Plan estimated that 60 houses in the watershed would be flooded by a 100-year storm event.

Murray Run

The Murray Run watershed lies wholly within Roanoke County and the City of Roanoke. It is an oblong shaped watershed consisting of a 2.9 square mile drainage basin located in south central Roanoke County and southeast City of Roanoke. Originating from nearly 1,400 feet above sea level just south of Roanoke and north of Starkey Road, Murray Run flows northeasterly for about four miles to its confluence with the Roanoke River in Roanoke.

Flooding problems along Murray Run for both existing and developed land use conditions were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads.

One of the major flooding problems on Murray Run is upstream of Brandon Avenue in the City of Roanoke along Ross Lane where 17 houses are in the 100-year floodplain including 13 that are inundated by a 10-year storm. Another is located both upstream and downstream of West Road in the Lakewood subdivision in the City of Roanoke where 12 houses are in the 100-year floodplain including 10 that are inundated by a 10-year storm. Several of the Pebble Creek Apartments (Circle Brook Drive in Roanoke County) located upstream of Ogden Road are also located in the 10 and 100-year floodplain. Upstream of Crawford Road near its intersection with Janney Lane in the Green Valley subdivision in Roanoke County, five houses are flooded by a 100-year storm and four of these are also flooded by a 10-year storm.

The Roanoke Valley Regional Stormwater Management Plan estimated that 52 houses in the watershed would be flooded by a 100-year storm event.

Ore Branch

With an origin near Chestnut Ridge south of Roanoke, the Ore Branch watershed begins at an elevation of almost 1,700 feet above sea level. From Chestnut Ridge, it flows northeasterly for about 2.5 miles along Route 220 in Roanoke County and Franklin Road in the City of Roanoke to its confluence with the Roanoke River at Wiley Drive in the City of Roanoke.

Flooding problems along Ore Branch for both existing and developed land use conditions were identified for flood events ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads. The major flooding problem in the Ore Branch watershed is downstream of the Cycle Systems recycling yard near the confluence of Ore Branch with the Roanoke River at Wonju Street and Franklin Road in the City of Roanoke. This area is heavily developed with commercial and industrial buildings.

The Roanoke Valley Regional Stormwater Management Plan estimated that 62 houses in the watershed would be flooded by a 100-year storm event.

Peters Creek

The Peters Creek watershed originates at an elevation of 2,380 feet above sea level on Brushy Mountain in Roanoke County. This nine square mile drainage basin is located in central Roanoke County, northwest City of Roanoke, and northeast Salem. The watershed has a length of about six miles and a maximum width of two miles near the center. From Brushy Mountain, it flows southeasterly for about six miles to its confluence with the Roanoke River in Roanoke.

Flooding problems along Peters Creek and Peters Creek Tributaries A, B and C were identified for flood events. ranging from the 2-year recurrence interval to the 100-year recurrence interval storms. Buildings located in the floodplain were identified as well as overtopped roads. The major flooding problem in the Peters Creek watershed are upstream of Westside Boulevard (near Rolling Hill Avenue), downstream of Westside Boulevard (Laurel Ridge Apartments at Westside and Shenandoah Avenue), upstream of Melrose Avenue (intersection of Melrose and Peters Creek Road in the City of Roanoke) and in the vicinity of Northwood Drive (including Bermuda Road and Laura Road) in the City of Roanoke. All of the Peters Creek watershed streams have adjacent scattered buildings and residences subject to flooding. Several specific areas for concern within the Peters Creek watershed in the City of Roanoke are: Westside Boulevard to Shenandoah Avenue, Shenandoah Avenue to Salem Turnpike in the Washington Heights region, Salem Turnpike to Melrose Avenue, Melrose Avenue to Peters Creek Road, Peters Creek Road to Shenandoah Bible College Access Road, Shenandoah Bible College Access Road to Peach Tree Drive, Peach Tree Drive to Northwood Drive, and Northwood Drive to Green Ridge Road.

The Roanoke Valley Regional Stormwater Management Plan estimated that 214 houses in the watershed would be flooded by a 100-year storm event.

Tinker Creek

Located in northeast Roanoke County, northeast City of Roanoke, northwest Vinton, and southeast Botetourt County, the Tinker Creek watershed is a 112 square mile drainage basin. Tinker Creek watershed originates at an elevation of 2,400 feet above sea level on Tinker Mountain near in Botetourt County, Virginia. It flows in a southerly direction about 11 miles until its confluence with the Roanoke River at the border between the City of Roanoke and Vinton.

Along Tinker Creek, the major flooding problem is located upstream of Dale Avenue (Rt. 24/364) near the confluence of Glade Creek on the boarder of the City of Roanoke and Town of Vinton. A substantial number of houses and buildings lie within the Tinker Creek floodplain. Some areas of specific concern in the City of Roanoke are: Mouth of Tinker Creek to Dale Avenue, Dale Avenue to Wise Avenue, Wise Avenue to Orange Avenue, Orange Avenue to 13th Street, 13th Street to Old Mountain Road, Old Mountain Road to Preston Avenue, Preston Avenue to the City limit. Areas of specific concern in the County of Roanoke are: the Roanoke City limit to Hollins Road, Hollins Road to Clearwater Avenue, Clearwater Avenue to Ardmore Avenue, and Ardmore Avenue to Williamson Road (at this point Tinker Creek is in Botetourt County and outside of the Stormwater Study).

The Roanoke Valley Regional Stormwater Management Plan estimated that 134 houses in the watershed would be flooded by a 100-year storm event.

Wolf Creek

Originating in the Blue Ridge Mountains at Stewart Knob at an elevation above sea level of 2,435 feet, the Wolf Creek watershed is a 4.9 square mile drainage basin. It is located in eastern Roanoke County and east Vinton. The watershed flows in a southeasterly direction for about 4 miles until its confluence with the Roanoke River in Vinton.

No significant areas of flooding were identified on Wolf Creek. Presently, the main risk associated with Wolf Creek is the overtopping of roadways by floodwaters. Three roadways are identified: Niagara Road

is subject to 5-year storms, and Hardy Road and Mountain View Road are overtopped by 10-year storms. Flooding of these roadways prevents access to some residential areas.

The Roanoke Valley Regional Stormwater Management Plan estimated that there would not be any houses in the watershed flooded by a 100-year storm event.

The remaining localities in the Roanoke Valley-Alleghany Region have not performed studies as detailed as that of the Roanoke Valley Regional Stormwater Management Plan. For these areas, past studies performed by the USGS, FEMA and HUD were used in combination with GIS and FIRMs to document vulnerability to flooding.

Flood Prone Roadways

A flood prone roadway is defined as any public road that has a history of being covered by enough water in a manner that the road surface, markings and edges are not visible. Such conditions could be caused by stream/river flooding, poor drainage along roadways or normal surface runoff. Water on the roadway could be either standing or moving, and could also leave debris such as gravel, leaves and branches on the roadway.

About 40 percent of flood related deaths occur to people traveling in motor vehicles. Suddenly changing water depths, water currents and road damage make crossing a flooded roadway very dangerous for both motor vehicles and pedestrians. Rural areas are particularly vulnerable because roads are lightly traveled and often not closed to traffic as quickly as urban roadways.

The 2007 Flood Prone Roadway Study is an update and expansion of the Rural Flood Prone Roadway Study developed by the Fifth Planning District Commission in 1999. The Rural Flood Prone Roadway Study covered the portions of the region outside of the Roanoke Valley Area Metropolitan Planning Organization (RVAMPO) study area. The 2007 Flood Prone Roadway Study includes the entire Roanoke Valley-Alleghany Regional Commission's service area, however, Franklin County is not part of the Roanoke-Valley Alleghany Regional Pre-Disaster Mitigation Plan.

The purpose of this study was to identify, compile, and map flood prone roadways in the region and to provide information on how to mitigate the loss of life and property, especially as associated with flooded

roadways in the region. In this study, a flood prone roadway is defined as any public road that has a history of being covered by enough water to render road surface, markings, and edges not visible to motor vehicle operators, bicyclists, and pedestrians. The flood prone roadways listed in this study include those identified as having a history of being flooded based on information from the Virginia Department of Transportation (VDOT), National Weather Service (NWS), and/or local sources (e.g., local government staff, elected officials).

There is little written documentation on flooded roadways in the region, and often the knowledge is distributed among the employees of several state and local organizations. A central and structured reporting and inventory system would provide better documentation on problem areas. By maintaining an inventory of flood prone roadways, officials will have documentation to help evaluate possible solutions to mitigate the impact of flooded roadways in the future. While some flooding from streams and runoff can be expected, standing water in roadways indicates improper drainage that should be remedied if the problem is reoccurring. While the blockage of regular traffic is mostly an inconvenience, emergency service personnel should have easy access to written documentation on flood prone roadways so that they can research alternate routes before emergencies occur. In some heavily affected areas, evacuation plans could be developed for larger flood events.

Table 38
Flood Prone Roadways
Alleghany County

Road	Route	Description
Douthat Road	629	Just before the Buckhorn Store
Indian Draft Road	600	I-64 bridge
Indian Draft Road	600	Humpback Bridge
Rich Patch Road	616	Just below Rich Patch Union Church near the intersection of Routes 616 and 621(Roaring Run Road)
White Gap Road	623	About 2 miles from Route 616 at the creek intersection just past Bryant Farm
	634	Along the Cowpasture River below Sharon School

Source: Flood Prone Roadway Study, Roanoke Valley – Alleghany Regional Commission, 2007.

Table 39
Flood Prone Roadways
Botetourt County

Road	Route	Description
Ball Park Road	685	South side of Craig Creek
Barger Drive	819	Confluence of Little Patterson Creek & Patterson Creek
Breckinridge Mill Road	600	Two miles west of Fincastle
Nace Road	640	Spec, Lithia, and Pico areas
Country Club Road	665	Intersection of SR 600 Haymakertown
Craig Creek Road	615	Several spots from the James River to Roaring Run
Craig Creek Road	615	Just west of Oriskany near Silent Dell, and at Roaring Run
Ellis Run Lane	644	Spec, Lithia, and Pico areas
Fringer Trail	645	Spec, Lithia, and Pico areas
Goode Lane	643	Spec, Lithia, and Pico areas
Greyledge Road	611	Several spots where Purgatory Creek crosses
Haymakertown Road	600	Intersection of 665 near Haymakertown
Jennings Creek Road	614	From Arcadia to the dead end
Lake Catherine Drive	649	Four miles northwest of Buchanan
Lapsley Run Road	726	James River to the intersection with SR 687
Lee Highway	US 11	Near intersection with Hardbarger Road (Route 636)
Middle Creek Road	618	Middle Creek
Middle Creek Road	620	Middle Creek
Mt. Joy Road	625	Near intersection with Park Vista Drive
Patterson Trail	683	To US 220
Plank Road	610	Near I-81 in the extreme northeast portion of the county
Poor Farm Road	681	Between SR 679 and 630 just northeast of Fincastle
Pulaski Mine Road	689	Spec, Lithia, and Pico areas
Springwood Road	630	Between Timber Ridge Road (635) and Thrasher Road (625)
Sugar Tree Hollow	684	Area adjacent to Little Patterson Creek
Tinker Mill Road	674	Daleville area 0.5 miles west of US 220
Willowbrook Lane	US 460	Glade Creek near Willow Brook Mobile Home Park

Source: Flood Prone Roadway Study, Roanoke Valley – Alleghany Regional Commission, 2007.

Table 40
Flood Prone Roadways
Town of Clifton Forge

Route	Description
Commercial Street	Upper end in an area referred to as "Neddleton Addition"
Rose Street	Small bridge above the 900 Block
Rose Street	Parking lot bordering Dry Creek
West Main Street	Downtown area

Source: Flood Prone Roadway Study, Roanoke Valley – Alleghany Regional Commission, 2007.

Table 41
Flood Prone Roadways
City of Covington

Route	Description
Court Street	Downtown area
Dalton Avenue	Sunnydale area
Dry Run Road	North Alleghany Drive to Hillcrest Drive
Gilliam Street	Rayon View area
Gordon Street	Parrish Court Avenue
Gum Avenue	Rayon View area
Lyman Avenue	Sunnydale area
Maple Avenue	Downtown area
Marshall Street	Idlewilde area
Michigan Avenue	Idlewilde area
North Alleghany Drive	Dry Run to Hillcrest Drive
North Craig Avenue	Downtown area
North Lexington Avenue	Downtown area
Parrish Court Avenue	Parrish Street, Phillip Street, Gordon Street
Parrish Street	Parrish Court Avenue
Phillip Street	Parrish Court Avenue
Plum Street	Rayon View area
Riverside Avenue	Downtown area
Royal Avenue	Downtown area
South Carpenter Drive	Idlewilde area
SR 18	Bridge over Jackson River
Trout Street	Idlewilde area
West Chestnut Street	Downtown area
West Jackson Street	Lower end
Wood Street	Rayon View area

Source: Flood Prone Roadway Study, Roanoke Valley – Alleghany Regional Commission, 2007.

Table 42
Flood Prone Roadways
Craig County

Route	Description
311	Broad Run bridge - confluence of Craig Creek and Broad Run approximately three miles south of New Castle
611	Portions along Craig Creek
612	Craig Creek
614	Low water bridge
614	Intersection of Route 681
618	From about 0.75 miles north of Route 311to 4 miles north.
623	About 4 miles southwest of New Castle
627	One mile southeast of the town of Simmonsville at a low water bridge
647	Near the end of state maintenance
651	About five miles southwest of Abbott
681	Intersection of Route 614

Source: Flood Prone Roadway Study, Roanoke Valley – Alleghany Regional Commission, 2007.

Table 43
Flood Prone Roadways
City of Roanoke

Route	Description
10th Street	Intersection of Shadelawn Avenue
13th Street	Intersection with Eastern Avenue and Tinker Creek
Arbor Avenue	Riverview Area
Arbutus Avenue	Riverview Area
Baldwin Avenue	Intersection with Tuck Street
Bennington Street	Jamestown Area
Boulevard Street	Intersection with Salem Ave. (Shaffers Crossing)
Brambleton Avenue	Crossing of Murray Run Creek
Campbell Avenue	Near intersection of 10th Street
Cravens Creek Road	Intersection with Deyerle Road
Deyerle Road	Intersection with Valentine Road
Edgewood Street	Near intersection with Brandon Road
Franklin Road	Intersection with Brandon Road
Franklin Road	Intersection with Broadway Avenue
Jefferson Street	Intersection with Reserve Avenue
King Street	Intersection of Berkeley Ave and Richards Ave
Piedmont Street	Intersection with Hamilton Terrace
Wiley Drive	Various spots
Wise Avenue	Crossing of Tinker Creek

Source: Flood Prone Roadway Study, Roanoke Valley – Alleghany Regional Commission, 2007.

Table 44
Flood Prone Roadways
Roanoke County

Road	Route	Description
Back Creek Road	676	Between US 220 and 615
Bandy Road	666	Middle Back Creek Bridge
Bandy Road	666	5000 Bandy Road
Barley Drive	646	Various spots near River
Bendermere Road	699	Masons Creek Bridge
Bent Mountain Road	US 221	Intersection of Twelve O'clock Knob Road (694)
Bottom Creek Lane	637	Various spots
Bottom Creek Road	607	1.5 miles west of intersection with Route 711
Bottom Creek Road	607	724 Bottom Creek Road
Bradshaw Road	622	Various spots near Creek
Carson Road	758	Near intersection with Lake Back O Beyond Dr.
Cartwright Road	1726	Near Crystal Creek
Carvins Cove Road	740	Bennet Springs to Carvins Cove
Carvins Cove Road	740	Above Carvins Cove reservoir near Bennett Springs
Clearwater Avenue	1861	Various spots near Creek
Coleman Road	735	Various points
Cotton Hill Road	688	West of Intersection with Route 613
Crawford Road	1736	400 block
Creekwood Drive	1124	Near intersection with Beaverbrook
Cresthill Drive	1658	Garst Mill Bridge
Dent Road	623	From Williamson Road to Brookside
Dutch Oven Road	863	Various spots near Creek
Electric Road	419	Near intersection with Cordell Dr
Electric Road	419	Intersection with McVitty Road
Ferguson Valley Road	721	Various spots along Creek
Five Oaks Road	6512	Intersection with Bent Mountain Road
Florist Road	623	Near intersection with Verndale Drive
Garst Mill Road	682	Near Intersection with Halevan Road
Glade Creek Road	636	Near intersection with Bonsack Road
Grandin Road Extension	686	West of Meadow Creek Drive
Green Ridge Road	628	3000 Block of Green Ridge Road
Halevan Road	1361	At Garst Mill Park Road
Harwick Drive	769	Various spots
Hershberger Road	101	East of intersection with Plantation Road
Indian Head / Bohon Hollow Rd.	734	Various spots
John Richardson Road	743	Near intersection of Hershberger Dr. and Plantation Road
Keagy Road	685	4400 Keagy Road
Kessler Mill Road	630	Various spots
Lakemont Drive	1446	Various locations
LaMarre Drive	1815	Various spots near Creek

Road	Route	Description
Little Bear Road	680	Various spots
Loch Haven Road	1894	2 miles east of Route 419
McVitty Road	1662	Intersection with Castle Rock Rd
McVitty Road	1662	3100 McVitty Road
Merriman Road	613	Near Penn Forest Elementary
Ogden Road	681	At Pebble Creek
Old Mountain Road	864	Various spots near Creek
Palm Valley Road	1897	Sun Valley Subdivision
Plymouth Street	836	Near Brookside
Ran Lyn Drive	745	Near Intersection with South Roselawn
River Road		Various places near river
Rocky Road	744	635 Rocky Road
Shadwell Road	601	Near intersections with Ashton Rd. and Summerview
South Campus Drive	6081	Various spots near Creek
Starkey Road	904	At Back Creek Tributary B
Starlight Lane	615	Between Boones Chapel Rd. and Blue Ridge Parkway
Sugarloaf Mountain Road	692	Near Mud Lick Creek
Texas Hollow Road	641	Various spots
Tinsley Lane	711	Near intersection with Bottom Creek Road
Tree Top Camp Road	871	Various spots
Twelve O'clock Knob Road	694	Various locations
Verndale Drive	1867	Sun Valley Subdivision
West River Road	639	Various places
West Riverside Drive	639	Various spots near River
Willow Branch Road	677	Various spots near Creek
Wood Haven Road	628	Near intersection with Willow Creek Drive
Yellow Mountain Road	668	Near intersection with US 220

Source: Flood Prone Roadway Study, Roanoke Valley – Alleghany Regional Commission, 2007.

Table 45
Flood Prone Roadways
City of Salem

Route	Description
Apperson Drive	Between Orchard Drive and Riverside
Colorado Street	Between Rowan Street and Riverside Dr
East Main Street	Intersection with Kessler Mill
East Riverside Drive	Between Apperson and McVitty
Electric Road	Near intersection with Apperson Drive
Epperly Lane	Kessler Mill Road to Terminus
Front Street	Between Riverside Drive and Riverside Dr
Horner Lane	Near Wildwood Road
Lancing Drive	Salem Ridge Apartments, aka Willow River
Mill Lane	Between W Main Street and Riverside Dr
Pine Bluff	Kessler Mill Road to Sycamore
River Side Drive	Apperson Drive to Colorado Street
Sycamore Drive	Pine Bluff to Terminus
Union Street	Between Fourth Street and Eddy Street
West Main Street	Intersection with Wildwood Road
West Main Street	Between Poplar Street and Turner Street
Wildwood Road	Intersection with West Main Street

Source: Flood Prone Roadway Study, Roanoke Valley – Alleghany Regional Commission, 2007.

Table 46
Flood Prone Roadways
Town of Vinton

Road	Description
Hardy Road	Town of Vinton / Roanoke County CL
Virginia Avenue	Town of Vinton / City of Roanoke CL
Walnut Avenue	From 4th Street to 8th Street

Source: Flood Prone Roadway Study, Roanoke Valley – Alleghany Regional Commission, 2007.

Potential Flooding Due to Dam Failure

Flooding due to dam failure refers to a collapse, overtopping, breaching, or other failure that causes an uncontrolled release of water or sludge from an impoundment, resulting in downstream flooding. Dam or levee failures can occur with little warning. Intense storms may produce a flood in a few hours or even minutes from upstream locations. Dam failure may occur within hours of the first signs of breaching. Other failures and breeches can take much longer to occur, from days to weeks, as a result of debris jams or the accumulation of melting snow.

DCR's Division of Dam Safety and Floodplain Management administers the Virginia Dam Safety Program, under the authority of the Virginia Soil and Water Conservation Board. The dam safety division regulates impounding structures in the Commonwealth to ensure that they are "properly and safely constructed, maintained and operated." The regulations promulgated to achieve these ends are recorded in the Virginia Administrative Code. Ongoing dam inspections and Virginia's participation in the National Dam Safety Program maintained by FEMA and the U.S. Army Corps of Engineers serve as a preventative measure against dam failures. Disaster recovery programs include assistance to dam owners and local officials in assessing the condition of dams following a flood disaster and assuring the repairs and reconstruction of damaged structures are compliant with the National Flood Insurance Program regulations.

In 2001, Virginia's legislature broadened the definitions of "impounding structure" to bring more dams under regulatory oversight. On February 1, 2008, the Virginia Soil and Water Conservation Board approved major revisions to the Impounding Structure Regulations in the Virginia Administrative Code, changing the dam hazard potential classification system, modifying spillway requirements, requiring dam break inundation zone modeling, expanding emergency action plan requirements, and making a variety of other regulatory changes.

Dams are classified with a hazard potential depending on the downstream losses estimated in event of failure. The recent regulatory revisions bring Virginia's classification system into alignment with the system already used in the National Inventory of Dams maintained by the U.S. Army Corps of Engineers. Hazard potential is not related to the structural integrity of a dam but strictly to the potential for adverse downstream effects if the dam were to fail. Regulatory requirements, such as the frequency of dam inspection, the standards for spillway design, and the extent of emergency operations plans, are dependent upon the dam classification.

Table 47
Virginia Dam Classification System

Potential	Description	Inspection
High	Failure will cause probable loss of life or serious economic damage (to buildings, facilities, major roadways, etc.)	Annual, with inspection by a professional engineer every 2 years.
Significant	Failure may cause loss of human life or appreciable economic damage (to buildings, secondary roadways, etc.)	Annual, with inspection by a professional engineer every 3 years.
Low	Failure would result in no expected loss of human life, and cause no more than minimal economic damage	Annual, with inspection by a professional engineer every 6 years.

The owner of each regulated high, significant, or low hazard dam is required to apply to the board for an Operation and Maintenance Certificate. The application must include an assessment of the dam by a licensed professional, an Emergency Action Plan and the appropriate fee(s), submitted under separate cover. An executed copy of the Emergency Action Plan or Emergency Preparedness Plan must be filed with the appropriate local emergency official and the Virginia Department of Emergency Management.

The Virginia Soil and Water Conservation Board (VSWCB) issues Regular Operation and Maintenance Certificates to the dam owner for a period of six years. If a dam has a deficiency but does not pose imminent danger, the board may issue a Conditional Operation and Maintenance Certificate, during which time the dam owner is to correct the deficiency. After a dam is certified by the board, annual inspections are required either by a professional engineer or the dam owner, and the Annual Inspection Report is submitted to the regional dam safety engineer.

There are no comprehensive databases of historical dam failures or flooding following a dam failure in Virginia. Most failures occur due to lack of maintenance of dam facilities in combination with major precipitation events, such as hurricanes and thunderstorms.

Although flood inundation maps are a requirement of the current Impounding Structure Regulations, Virginia DCR does not currently have this information available in a digital form. Were these maps available, they would illustrate the probable area of flooding downstream of a dam in the event of failure. Lacking such data, this plan's risk assessment was based solely on the USACE National Inventory of Dams.

In 1972, Congress authorized the U.S. Army Corps of Engineers to inventory dams located in the United States through the National Dam Inspection Act. The Water Resources Development Act of 1986 authorized USACE to maintain and periodically publish an updated National Inventory of Dams (NID). The Water Resources Development Act of 1996 re-authorized periodic update of the NID by USACE, and continued a funding mechanism. This data set is the source for the general jurisdictional analysis in this plan and is shown in Table 44. There are three classification levels in the National Inventory of Dams classification system – Low, Significant and High – described below and listed in order of increasing adverse consequences:

Low Hazard Potential - Failure or misoperation results in no probable loss of human life and low economic and/or environmental losses, principally limited to the owner's property.

Significant Hazard Potential - Failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.

High Hazard Potential - Failure or misoperation will probably cause loss of human life.

Predicting the probability of flooding due to dam failure requires a detailed, site specific engineering analysis for each dam in question. Failure may result from hydrologic and hydraulic design limitations, or from geotechnical or operational factors. The data and time necessary to perform a probabilistic failure analysis for each dam in Virginia is beyond the scope of this plan.

Identified Dam Deficiencies

Rainbow Forest Recreation Association in Botetourt County was ordered to drain Rainbow Forest Lake by the Virginia Department of Conservation and Recreation in May 2011. The association must comply with required maintenance. RFRA has been working with the state to address concerns about the structure since 1997. Additional development has occurred downstream since the impoundment was built almost 50 years ago. RFRA did not have the funds (estimated at $300,000) to upgrade the dam to meet state standards. The state has designated the dam as high hazard meaning that if the dam failed there could be loss of life and property downstream.

In May 2009, the U.S. Army Corps of Engineers (USACE) inspected the Gathright Dam as part of Screening Portfolio Risk Analysis and routine inspections. Later in the year on September 2, the USACE assigned the dam a Safety Action Classification (DSAC) II which is defined as "Urgent (Unsafe or Potentially Unsafe)". The rating is attributed to concerns about possible increased seepage at the toe of the dam, and an undetermined flow rate at the river spring a quarter mile downstream, and potential flow channels through limestone below the spillway during pool events above 1600 feet. Because of this rating, the USACE has implemented risk reduction measures which include increased monitoring, updating emergency operation plans and reducing the water level in the reservoir. As of early 2010, the USACE has reduced and continues to maintain the reservoir at an elevation of 1,562 ft above sea level compared to the normal level of 1,582 ft.. Throughout 2010, the USACE conducted safety exercises with local/state officials, conduct a series of investigations on the dam, update inundation mapping and reevaluate the DSAC status. In November 2010, Lake Moomaw was restored to a level of 1,582 ft. and the DSAC will be reevaluated in the future.

Table 48
National Inventory of Dams Data, 2006

Dam Name	River	City	Year Completed	Hazard	County	Owner Name	Owner Type [1]
Clifton Forge Dam	Smith Creek	Clifton Forge	1949	H	Alleghany	City of Clifton Forge	L
Gathright Dam	Jackson River	Covington	1978	H	Alleghany	US Army Corps of Engineers	F
Pond Lick Branch Dam	Pond Lick Branch	Blue Spring Run	1962	L	Alleghany	Ralph H. Burroughs, Jr.	
MeadWestvaco #2 Flyash Lagoon Dam	Dunlap Cr.-Off Stream	Covington	1977	S	Alleghany	MeadWestvaco, Bleached Board Division	P
Blue Ridge Estates Dam	Laymantown Creek	Blue Ridge	1950	H	Botetourt	Emerald Lake Property, Inc.	P
Carvin Cove Dam	Carvins Creek	Roanoke	1946	H	Botetourt	City of Roanoke	L
Orchard Lake Dam	Tributary of Tinker Creek	Glebe Mills	1957	S	Botetourt	R. W. Woodson	
Rainbow Forest Dam [2]	Laymantown Creek	Blue Ridge	1960	H	Botetourt	Rainbow Forest Recreational Assoc Inc	P
Johns Creek Dam #1	Johns Creek	Maggie	1967	H	Craig	Mountain Castles SWCD	L
Johns Creek Dam #2	Little Oregon Creek	Maggie	1967	H	Craig	Mountain Castles SWCD	L
Johns Creek Dam #3	Mudlick Branch	Maggie	1968	H	Craig	Mountain Castles SWCD	L
Johns Creek Dam #4	Dicks Creek	Maggie	1966	H	Craig	Mountain Castles SWCD	L
Clifford D. Craig Memorial Dam	Trib. To Roanoke River	Salem	1994	H	Roanoke	Roanoke County	L
Loch Haven Lake Dam	Tributary Deer Branch Creek	Roanoke	1930	S	Roanoke	Sky Preece	P
Niagara	Roanoke	Vinton; U/S	1906	H	Roanoke	Appalachian Power Company	U
Orchard Dam	Trib-Glade Creek	Bonsack	1984	H	Roanoke	F & W Community Development Corp.	P
Woods End Dam	Mud Lick Creek	Roanoke	-	H	Roanoke	Roanoke County	L

Source: *National Inventory of Dams, Water Control Infrastructure*, U.S. Army Corps of Engineers, 2006.
1. Owner Types - L: local government; F: Federal government; P: private; U: utility.
2. Rainbow Forest Lake was ordered by the VA Department of Conservation and Recreation to be drained by July 2011 due to concerns about the dam.

References:

USACE Gathright Dam Action Plan Update, 2010.

Flood Prone Roadway Study, Roanoke Valley – Alleghany Regional Commission, 2007.

Dam Failure, FEMA, http://www.fema.gov/hazard/damfailure/index.shtm

Commonwealth of Virginia Emergency Operations Plan, Standard Hazard Mitigation Plan, Support Annex 3, Virginia Department of Emergency Management, 2010

National Inventory of Dams, Water Control Infrastructure, U.S. Army Corps of Engineers in cooperation with FEMA's National Dam Safety Program, 2003

Hurricane

Since 1871, 123 hurricanes and tropical storms have affected Virginia taking 228 lives and costing the commonwealth over a billion dollars in damages. The eye of 69 tropical cyclones has tracked directly across Virginia. Eleven have made landfall on or close (within 60 miles) to the Virginia Coast. Virginia averages one hurricane a year. Some years go by with no storms while others years threaten the Commonwealth with multiple storms sometimes, just days or weeks apart. The planning region has not experienced any significant damage from hurricanes since the adoption of the previous plan.

The majority of hurricanes (61 percent) and tropical storms that have affected Virginia have originated in the Atlantic Ocean. The storm begins as a disturbance moving off the west coast of Africa near the Cape Verde Islands. It gains strength over the very warm equatorial waters. Twenty-six percent of the tropical cyclones that affect Virginia originate in the Caribbean waters and eight percent in the Gulf of Mexico. Three storms (2.5%) originated in the eastern Pacific. They traversed Central America into the Gulf of Mexico before moving northeast toward Virginia.

Hurricanes often spawn tornadoes across Mid-Atlantic region that have, at times, been strong and deadly. This century, 15 hurricanes, tropical storms or their remnants have spawned tornadoes in Virginia. Hurricane David in 1979 spawned 34 tornadoes, of which, eight were in Virginia. Tornadoes struck five counties and three cities from Norfolk in the southeast to near Leesburg in the far north. One person was killed, 25 were injured and damages were close to $14 million.

At this time NOAA, the National Weather Service and other agencies are unable to predict the occurrence and location of future hurricanes. *Based on past events it is likely that hurricanes will continue to impact the Roanoke Valley - Alleghany Region in the future. The probability of an occurrence of a hurricane event has remained unchanged since the adoption of the 2006 Regional Pre-Disaster Mitigation Plan.*

Karst

Karst and sinkholes were identified as a natural hazard of concern by the localities participating in the regional pre-disaster mitigation plan process due to the localized nature of hazards caused by sinkholes – typically impacting only one structure or a short section of road. Lack of adequate historical data on sinkhole hazard events and lack of complete, detailed mapping of karst/sinkholes also makes it difficult to determine the level of risk for these geologic features.

The areas at risk from karst in Virginia, as shown in Figure 6, are primarily limited to the mountainous regions of the state. Because land subsidence caused by karst is very site-specific and often occurs in undeveloped areas, there is no existing long-term record for Virginia. There have not been any known karst events since the previous plan was adopted. *The probability of an occurrence of a winter storm event has remained unchanged since the adoption of the 2006 Regional Pre-Disaster Mitigation Plan.*

Table 49
Karst Areas in the
Roanoke Valley-Alleghany Region

Locality	Estimated % Karst Terrain	Major Karst Development Areas
Alleghany County (incl. City of Covington, and Towns of Clifton Forge and Iron Gate)	30	Jackson River Valley Potts Creek Valley Warm Springs Valley
Botetourt County (incl. Towns of Buchanan, Fincastle and Troutville)	20	Catawba Creek Valley Timber Ridge
Craig County (incl. Town of New Castle)	30	Sinking Creek Valley Potts Creek Valley
Roanoke County (incl. cities of Roanoke and Salem and Town of Vinton)	20	Roanoke Valley Minor Valleys

Source: Virginia Speleological Survey, http://www.virginiacaves.org, 2005.

Localities should be aware of how environmentally sensitive karstlands can be. Sinkholes, in particular, pose several problems that ultimately affect groundwater in karstic terrain and delicate cave ecosystems. Environmental concerns included: (1) introduction of contaminants and pollutants into the groundwater, (2) catastrophic collapse and gradual subsidence of the land surface, and (3) flooding during or following intense storms.

Karst terrain, particularly that of moderate to high sinkhole density, thus imposes constraints on land use. Mismanagement of karstlands, whether through unsupervised development, poor farming practices,

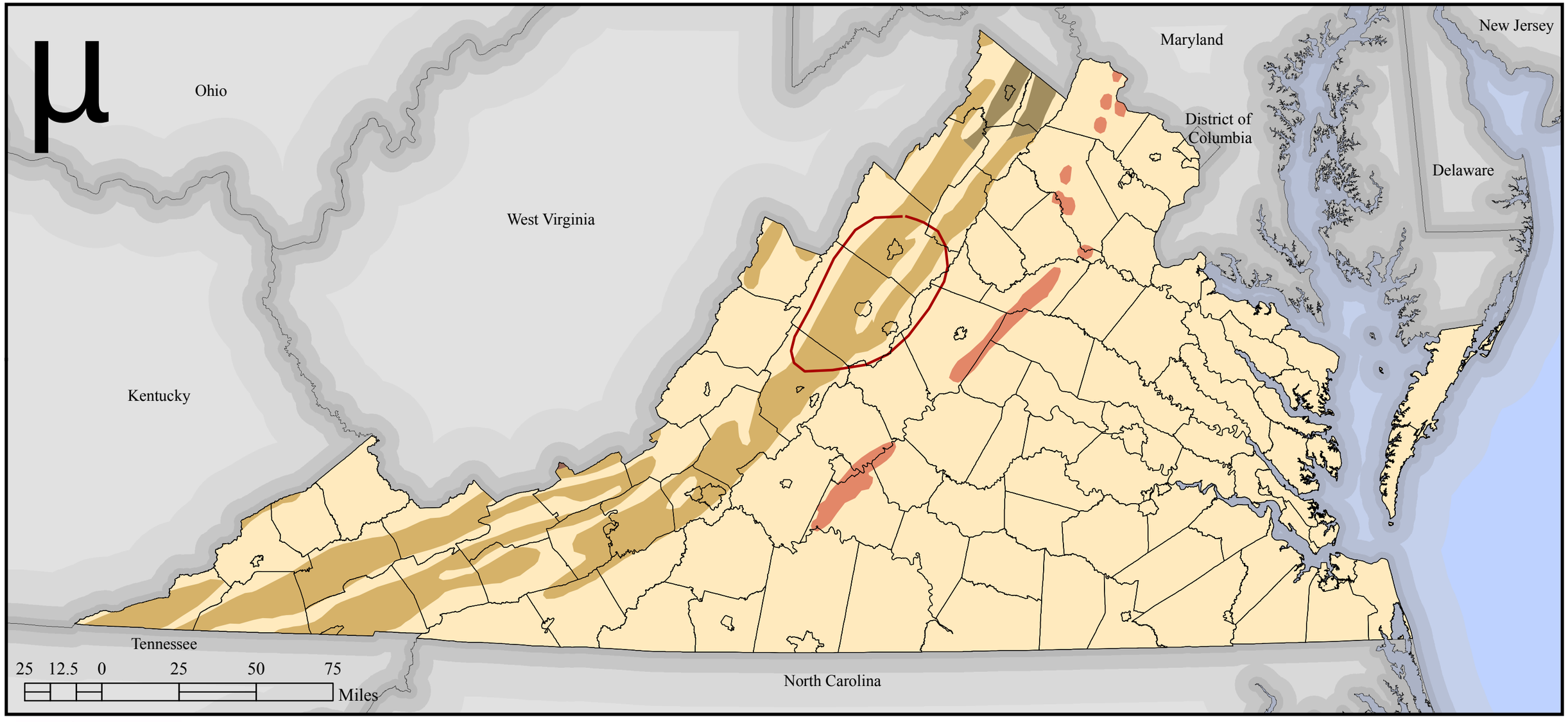
improper waste disposal, or other means, will often damage groundwater resources, cave ecosystems, or man-made structures built on karst.

In the report Natural Hazard Mitigation Planning for Karst Terrains in Virginia, the researcher found that despite an extensive amount of karst terrain in many communities in western Virginia, few communities use comprehensive land use planning and management approaches for development on karst terrain. A survey of local governments, conducted for the Cave Conservancy of the Virginias by the Urban Affairs and Planning Department at Virginia Tech in 2003, indicated that few communities in western Virginia have adopted land use planning and management tools to minimize karst terrain hazard risks. This statement is also true of the localities within the Roanoke Valley-Alleghany Regional Commission.

One of the first steps in the development of any natural hazard mitigation plan is the identification and mapping of natural hazards. Many jurisdictions identify karst features using 7-1/2 minute U.S.G.S. topographic maps (map scale of 1:24,000 and a contour interval of 20-feet) and/or Natural Resource Conservation Service county soil surveys (map scales generally range from 1:12,000 to 1:63,360 (Natural Resources Conservation Service, 2003). Both of these map scales prove too large to correctly identify many karst features present on the landscape. The Virginia Department of Conservation and Recreation estimates that in some parts of Virginia standard 1:24,000 topographic maps show less than 50% of the karst features present on the landscape. For these reasons, a smaller, more detailed mapping scale is necessary for appropriate consideration of karst terrain hazards on individual parcels of land.

Localities within the RVARC should work with Virginia Karst Mapping Project, Virginia Speleological Survey, the USGS and other appropriate agencies to identify karst areas and sinkholes, maps these sites, and provide this information to local governments to use as a land use and natural hazards planning tool.

Figure 7: Karst Regions and Historical Subsidence



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VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

DATA SOURCES:

USGS Engineering Aspects of Karst
VGIN Jurisdicational Boundaries
ESRI State Boundaries

LEGEND:

Historical Subsidence

Karst Type (Long)

- In moderately to steeply dipping beds of carbonate rock
- In gently dipping to flat- lying beds of carbonate rock

Karst Type (Short)

- In metamorphosed limestone, dolostone, and marble
- In moderately to steeply dipping beds of carbonate rock

HAZARD IDENTIFICATION:

Long Karst Type: Fissures, tubes, and caves over 1,000 ft long; 50 ft to over 250 ft vertical extent
Short Karst Type: Fissures, tubes and caves generally less than 1,000 ft long; 50 ft or less vertical extent

Historical subsidence represents areas of extensive sinkhole development.

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

By combining karst GIS spatial and attribute data from state, regional, and local sources, including karst feature buffers and overlay areas, local governments could create a valuable natural hazard planning tool. Natural Hazard Mitigation Planning For Karst Terrains in Virginia recommends that including GIS data for abandoned wells, active wells and springs, septic systems, source water protection boundaries, hazardous waste storage sites, ground water dye tracings, streams, etc. to enhance this planning tool.

The four-step planning process proposed in Natural Hazard Mitigation Planning For Karst Terrains in Virginia, serves as an example for local governments to follow in the development of local karst hazard mitigation plans. The process starts with community education and partnership building to develop community support and commitment for the subsequent steps in the planning process. The karst terrain risk assessment and vulnerability analysis clarifies the hazards that local karst terrain poses to a community. In the final two steps, local governments develop both regulatory and non-regulatory mitigation strategies to minimize community exposure to local karst terrain natural hazards. By using a karst terrain buffer and overlay hierarchy local governments can target regulatory and non-regulatory mitigation strategies to those karst areas that pose the highest natural hazard risks.

Karst Terrain Hazard Mitigation Plan Development Process

I. Community Education and Partnership Building
II. Karst Terrain Hazard Assessment
    A. Develop a karst feature classification system
    B. Develop a karst buffer and overlay hierarchy system
    C. Develop geographic information system capabilities for karst terrain hazard planning
III. Develop Regulatory Karst Terrain Hazard Mitigation Strategies
    A. Update the subdivision ordinance to reflect community goals and objectives for development on karst terrain
    B. Develop a karst terrain zoning overlay district requiring:
        i. effective karst feature buffers
        ii. geotechnical studies for development on karst terrain
        iii. karst terrain related performance standards
    C. Enforce Virginia stormwater management regulations
    D. Enforce Virginia erosion and sediment control regulations
    E. Enhance Virginia septic system regulations to better address the unique geo-hydrology of karst terrain
    F. Develop spring and wellhead protection policies that reflect the unique geo-hydrology of karst terrain
IV. Develop Non-Regulatory Karst Terrain Hazard Mitigation Strategies
    A. Use capital improvements programming to steer development away from high-risk karst terrain
    B. Encourage voluntary land use restrictions in karst terrains through the use of:
        i. Conservation easements
        ii. Purchase of development rights
        iii. Agricultural and forestal districts
        iv. Land use assessment and taxation programs

Source: Natural Hazard Mitigation Planning For Karst Terrains in Virginia, B. P. Belo, 2003.

References:

Natural Hazard Mitigation Planning For Karst Terrains in Virginia, Bradley Paul Belo, 2003.

Virginia Speleological Survey, Project Areas, http://www.virginiacaves.org, 2005.

Living on Karst: A Reference Guide for Landowners in Limestone Regions, Cave Conservancy of the Virginias, 1997.

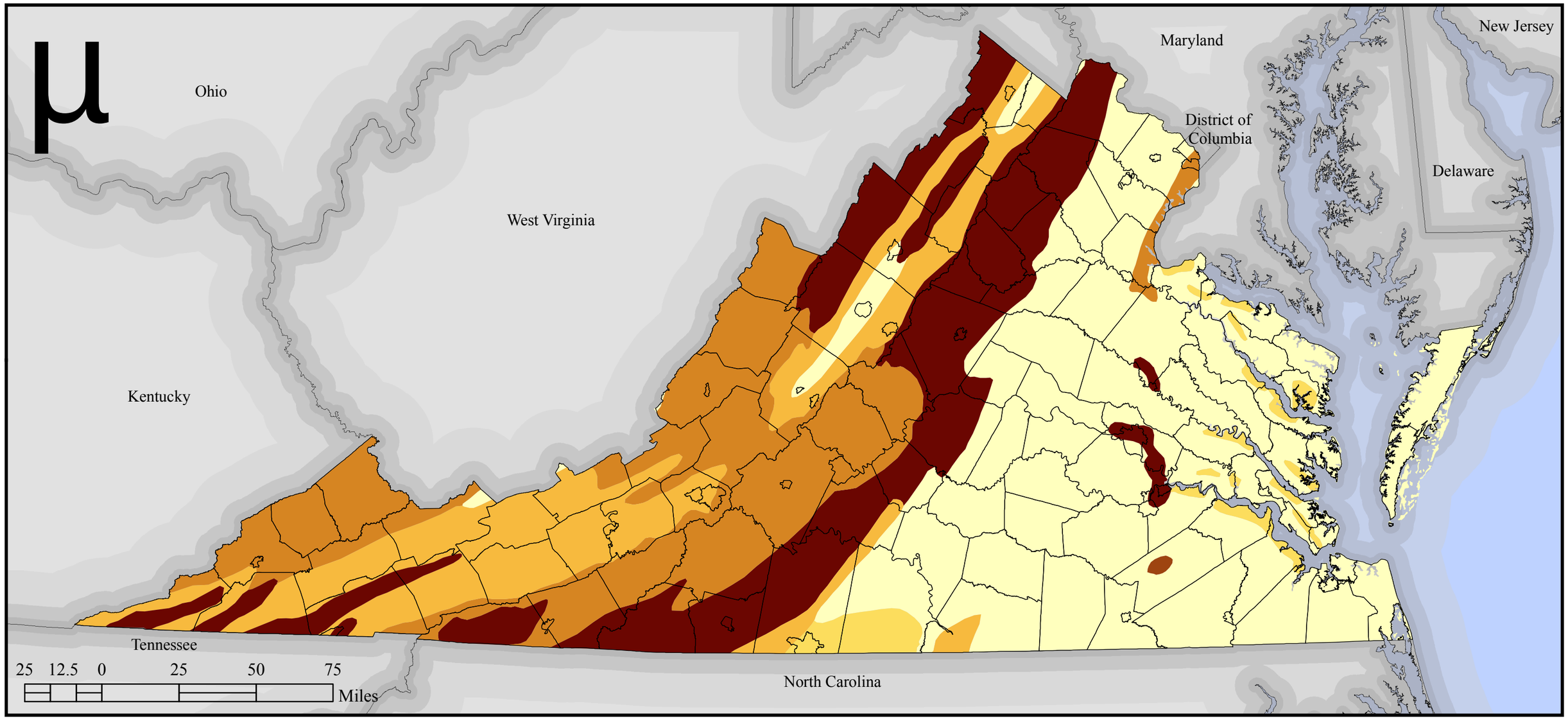
Living With Sinkholes, Virginia Cave Board, Virginia Department of Conservation and Recreation.

Landslide

All 50 states and the U.S. Territories experience landslides and other ground failure problems; 36 states have moderate to highly severe landslide hazards. The greatest landslide damage occurs in the Appalachian, Rocky Mountain, and Pacific Coast regions and Puerto Rico.

The Blue Ridge region of Virginia has experienced landslides throughout its history. Boulders, uprooted trees and tallis are all evidence of these events that can be found throughout the region. Records show that landslides and debris flows in the Appalachian Mountains occur when unusually heavy rain from hurricanes and intense storms soaks the ground, reducing the ability of steep slopes to resist the downslope pull of gravity. Scientists have documented 51 historical debris-flow events between 1844 and 1985 in the Appalachians – most of them in the Blue Ridge region. (Debris Flow Hazards in the Blue Ridge of Virginia, USGS Fact Sheet 159-96P. L. Gori and W. C. Burton, 1996). There have been no known significant landslide events since the previous plan was adopted. *The probability of an occurrence of a landslide event has remained unchanged since the adoption of the 2006 Regional Pre-Disaster Mitigation Plan.*

Figure 8: Landslide Incidence and Susceptibility



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DATA SOURCES:

USGS NLHP
VGIN Jurisdicational Boundaries
ESRI State Boundaries

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

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LEGEND:

Landslide Categories

- High Susceptibility & Moderate Incidence
- High Susceptibility & Low Incidence
- High Incidence
- Moderate Susceptibility & Low Incidence
- Moderate Incidence
- Low Incidence

HAZARD IDENTIFICATION:

The Landslide Incidence and Susceptibility map layer shows areas of landslides and areas susceptible to future landsliding. Areas where large numbers of landslides have occurred and areas which are susceptible to landsliding have been delineated in this layer.

Landslides are defined to include most types of gravitational mass movement such as rockfalls, debris flows, and the failure of engineered soil materials.

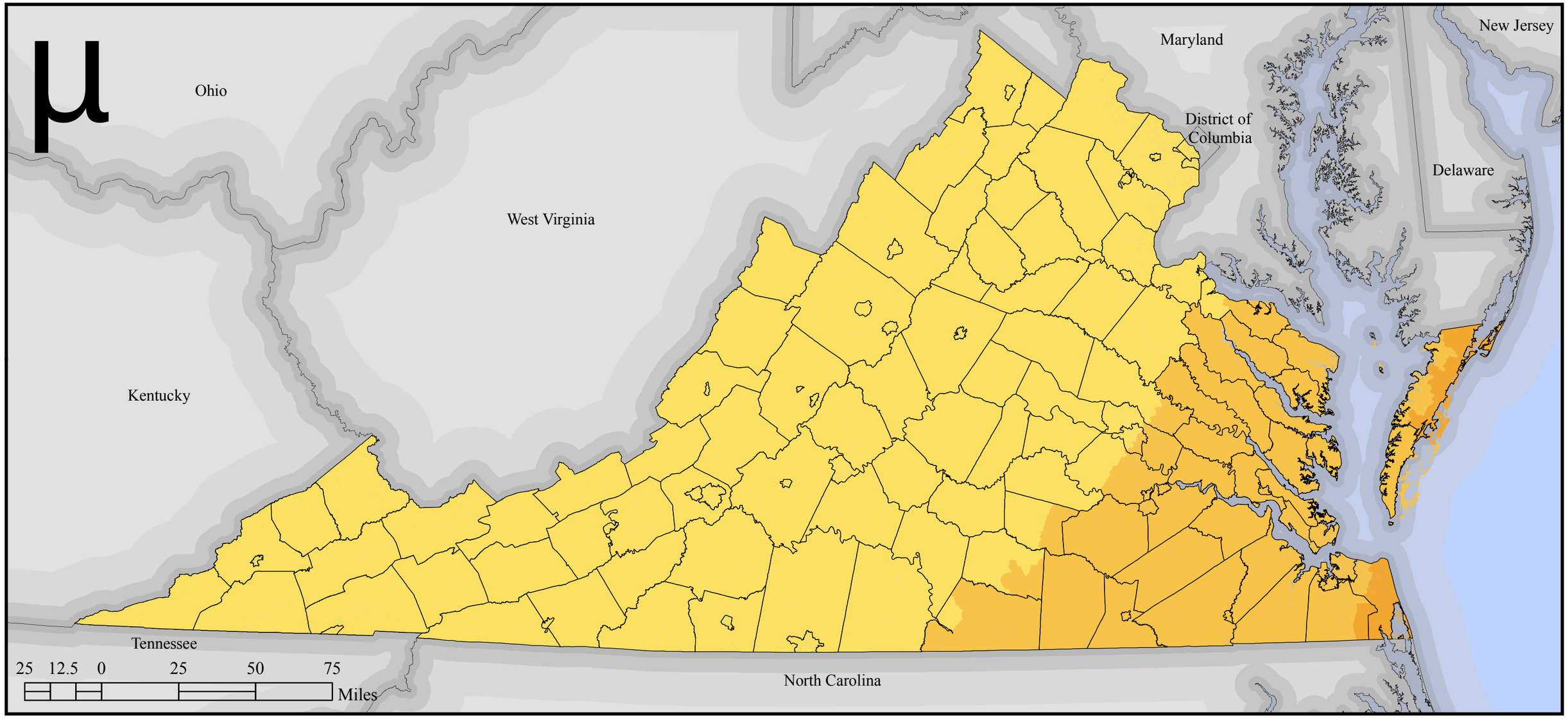
Straight Line Wind

Damaging wind events can develop with little advanced warning and straight line wind events can occur anywhere in the planning region. People outside may not have access to warning information, so boaters and campers are very susceptible. Those in cars and trucks also are vulnerable to being hit by falling trees and utility poles. High profile vehicles such as semi-trailer trucks, buses, and sport utility vehicles may be blown over. At outside events such as fairs and festivals, people may be killed or injured by collapsing tents and flying debris. Typical impacts from straight line winds include damage to roofs, siding, and carports from winds as well as damage caused by falling trees to buildings and electric power lines. Even those indoors may be at risk for death or injury. Mobile homes, in particular, may be overturned or destroyed, while barns and similar buildings can collapse. People inside homes, businesses, and schools are sometimes victims of falling trees and branches that crash through walls and roofs; they also may be injured by flying glass from broken windows or structural damage to the building itself.

According to the State HIRA, tropical weather patterns are the source of the strongest winds to impact most jurisdictions. While stronger winds may occasionally occur due to thunderstorm events, or as a result of local topographic conditions, sources of information on the probability and impact of these winds are not as well-developed as the sources of information related to hurricanes. Therefore, the probabilistic models of hurricane wind speeds were used for an analysis of the non-rotational wind hazard in the State HIRA.

The Straight Line Winds hazard was added to the Regional Pre-Disaster Mitigation Plan during the 2012 update of the document based on past occurrences and potential future impacts from this type of weather event.

Figure 9: HAZUS 100-Year Wind Speeds



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DATA SOURCES:

HAZUS-MH MR3 Wind Model
VGIN Jurisdicational Boundaries
ESRI State Boundaries

LEGEND:

3-Second Peak Gust Wind Speed (mph)

- 0 - 38 (Tropical Depression)
- 39 - 73 (Tropical Storm)
- 74 - 95 (Category 1)
- 96 - 110 (Category 2)
- 111 - 130 (Category 3)
- 131 - 155 (Category 4)
- > 156 (Category 5)

HAZARD IDENTIFICATION:

HAZUS-MH Hurricane Wind Model makes use of an existing state-of-the-art windfield model, which has been calibrated and validated using full-scale hurricane data. The model calculates wind speed as a function of central pressure, translation speed, and surface roughness.

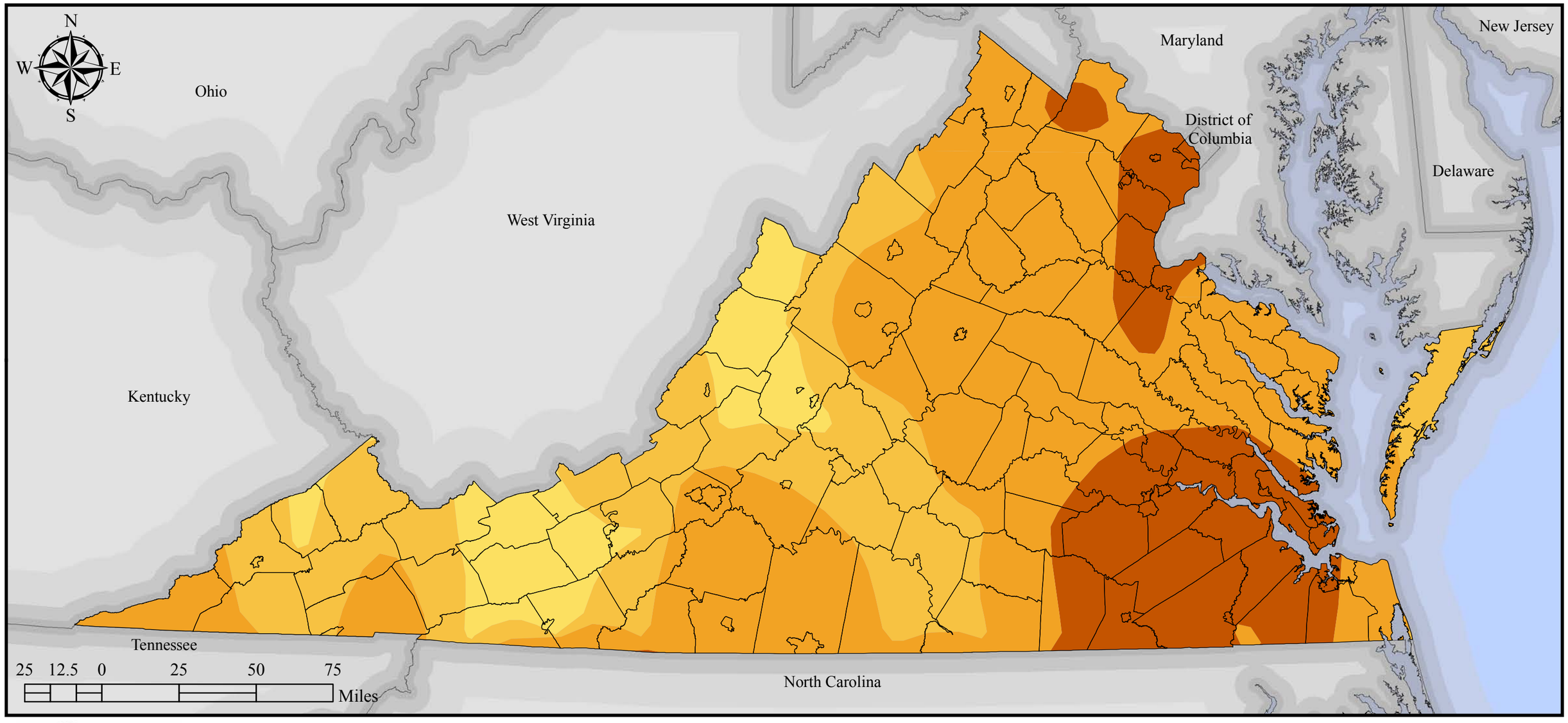
PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

Tornado

A number of factors were considered in the tornado risk assessment map to be able to compare between jurisdictions and hazards. The risk in the planning region ranges from in Craig County and the Alleghany Highlands to medium high in the City of Roanoke and Roanoke County. Factors were combined to come up with the overall total ranking for each hazard for the State HIRA. Some factors were weighted based on input from the State HIRA sub-committee. Weighting factors are: Population Vulnerability & Density 0.5 weighting; Injuries & Deaths 1.0 weighting; Crop & Property Damage 1.0 weighting; Annualized Events 1.0 weighting; and Geographic Extent 1.5 weighting.

Figure 10: Tornado Hazard Frequency



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VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

DATA SOURCES:

SVRGIS / SeverePlot
VGIN Jurisdicational Boundaries
ESRI State Boundaries

LEGEND:

Annual Tornado Hazard Frequency
Times One Million

0 - 1.25	Low
1.251 - 10	Medium-Low
10.1 - 100	Medium-High
100.1 - 316	High

HAZARD IDENTIFICATION:

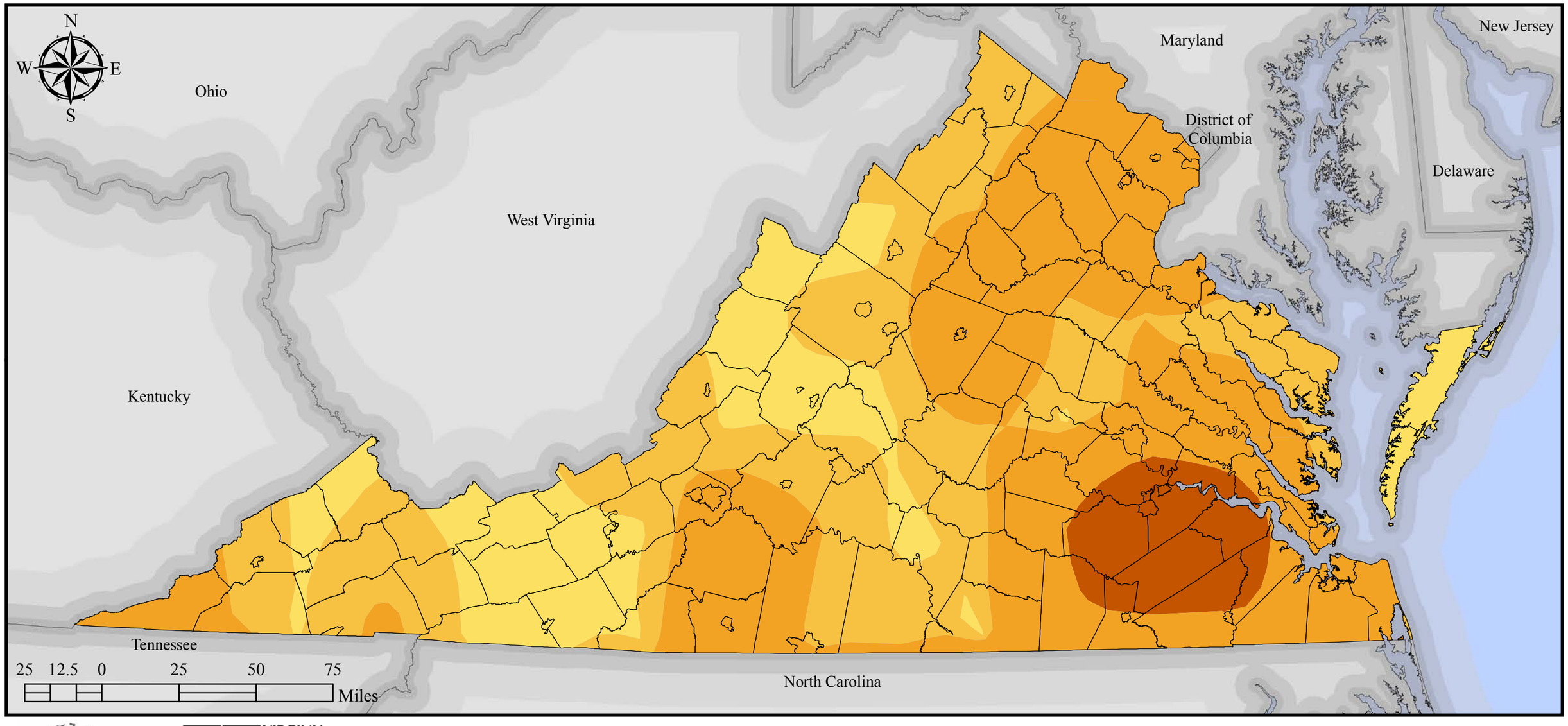
Annual tornado hazard frequency is an estimate of the frequency with which a point will experience a tornado, interpolating from neighboring tornado impact areas over the period of record. This map shows hazard frequency of any intensity of tornado. Note that "high" frequency in the state of Virginia is still rather low in comparison to many midwestern and southern states.

PROJECTION:

VA Lambert Conformal Conic
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

Figure 11: Significant Tornado Hazard Frequency (F2+)



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VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

DATA SOURCES:

SVRGIS / SeverePlot
VGIN Jurisdicational Boundaries
ESRI State Boundaries

LEGEND:

Annual Tornado Hazard Frequency
Times One Million

0 - 1.25	Low
1.251 - 10	Medium-Low
10.1 - 100	Medium-High
100.1 - 252	High

HAZARD IDENTIFICATION:

Annual tornado hazard frequency is an estimate of the frequency with which a point will experience a tornado, interpolating from neighboring tornado impact areas over the period of record. This map shows hazard frequency of "significant" tornadoes, defined as F2 or greater. Note that "high" frequency in the state of Virginia is still rather low in comparison to many midwestern and southern states.

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

Wildfire

In order to determine the base hazard factor of specific wildfire hazard sites and interface regions, the following factors must be considered: topographic location, site/building construction and design, fuel profile, defensible space, accessibility, and water availability.

The Department of Forestry utilizes a Geographic Information System (GIS) - based Wildfire Risk Assessment of the entire state. Agency Firewise Specialists are now actively working to better assess the level of wildfire risk for the more than 4,000 individual, at risk, Wildland Urban Interface communities identified in the Commonwealth, however, this is only the first step in the process. Once communities have been visited and assessed for their level of wildfire risk, positive actions need to be taken to help reduce or mitigate the hazards identified.

Through the use of the GIS, the Virginia Department of forestry has recently identified areas of high, medium and low risk from wildfire. Figure 10, Wildfire Risk Assessment Map, illustrates these areas on a regional level.

VDOF has developed the Wildfire Risk Assessment to more objectively reflect the potential for wildfire across Virginia. By building a GIS model that assigns relative weights and ranks to input layers, VDOF has produced a map of Wildfire Risk that will help the agency perform community Firewise outreach, better allocate resources, and increase response preparedness. Input layers include slope, aspect, landcover, distance to railroads, distance to roads, population density, and historical fire occurrence. Maps of the model output were sent to each DOF field office for verification. Changes were made to the model weights to better reflect the conditions at the local scale. This Wildfire Risk Assessment is meant to be used at county or regional scales; it is not as reliable at the site scale. A maps illustrating wildfire risk for the region is shown in Figure 10.

The information in the analysis and the GIS is provided by the Virginia Department of Forestry with the understanding that it is not guaranteed to be correct or complete and conclusions drawn from such information are the sole responsibility of the user. While The Virginia Department of Forestry has attempted to ensure that this documentation is accurate and reliable, DOF does not assume liability for any damages caused by inaccuracies in these data or documentation, or as a result of the failure of the data or software to function in a particular manner. DOF makes no warranty, express or implied, as to the accuracy, completeness, or utility of this information, nor does the fact of distribution constitute a warranty. For more detailed information about modeling methodology, go to the GIS Data Downloads

page and read the Info file (metadata) for the Wildfire Risk Assessment at the Virginia Department of Forestry at http://www.dof.virginia.gov/gis/dwnld-Statewide-faq.shtml.

Risk is defined as the probability of an event occurring. The wildfire hazard-risk assessment consists of six inputs described above. These six inputs are weighted according to their importance and geographical location (coastal plain, piedmont and mountain regions). For example, homes within or adjacent to wildland fuels and in areas of high fire occurrence, on steep slopes may have a higher risk of burning. Homes that are not located near wildland fuels, in areas of low fire occurrence and in relatively flat terrain may have a low risk of burning. State, county and local governments or communities need to know where their high-risk areas are, the factors that make those areas at risk and what can be done to mitigate this risk.

The areas at greatest risk for forest fire are those at the urban-wildland interface, or where people and forests meet. A wildfire mitigation project is currently underway that will update and refine the wildfire risk analysis described above. Another goal of this project is to improve decision-making capabilities for fire suppression and prevention activities by adding to the GIS database. Data are being collected on locations and attributes of wildfire suppression resources, woodland home communities, and historical fire incidents. Understanding the spatial relationship of these and other features will help VDOF concentrate their prevention education, resource allocation, and emergency response efforts where fire poses the greatest risk.

Model Inputs and Analysis Development

Due to the importance wildfire risk in the region and the need for local governments and citizens to have a better understanding of this risk, a detailed description of the Virginia Department of Forestry's model inputs and analysis development is described below.

The Virginia Department of Forestry (VDOF) used GIS to develop a statewide spatial Wildfire Risk Assessment model that aims to: (1) identify areas where conditions are more conducive and favorable to wildfire occurrence and wildfire advancement; (2) identify areas that require closer scrutiny at larger scales; and (3) examine the spatial relationships between areas of relatively high risk and other geographic features of concern such as woodland home communities, fire stations and fire hydrants. This model incorporates data from several other state and federal agencies including land cover, demographics, transportation corridors and topography. Differences in the relative importance of model variables necessitated the use of three individual analyses broken along Virginia's mountain, piedmont and coastal

plain physiographical regions. The three model results were merged to produce the statewide Wildfire Risk Assessment.

In 2002 and 2003, VDOF examined which factors influence the occurrence and advancement of wildfires and how these factors could be represented in a GIS model. VDOF determined that historical fire incidents, land cover (fuels surrogate), topographic characteristics, population density, and distance to roads were critical variables in a wildfire risk analysis. DOF gathered these data layers, sometimes creating them, and used them in a raster-based weighted aggregate model.

The weights assigned to input variables (specifically topographic variables) differ depending on the physiographic zone being represented because the topographic characteristics of the landscape change dramatically across Virginia. The resolution of the model is defined by the coarsest resolution of input data. The National Land Cover Dataset and National Elevation Dataset both have a spatial resolution of 30-meter pixels, therefore all other layers were created or resampled to this resolution. Each input layer is normalized on an interval scale from 0 to 10 with 10 representing the characteristics of each layer that have the highest wildfire risk.

Density of Historical Wildfires was mapped to identify areas where wildfires have historically been relatively prevalent and relatively absent. It is assumed that these spatial patterns will remain similar in the future. · Data Preparation: Point locations for wildfires occurring in the years 1995 - 2001 inclusive were obtained from the George Washington and Jefferson National Forests and Shenandoah National Park. They were merged with the point wildfire locations documented by VDOF. Generally, VDOF does not document fires occurring on federal lands and unsuccessful attempts were made to obtain wildfire GIS data from most of the remaining federal agencies that manage land in the Commonwealth. Using ESRI's Spatial Analyst for ArcView 8.2, a Kernel density function was applied to the point data using a search radius of 5000 meters. The output grid was reclassified into ten classes using the natural breaks classification method and then assigned an interval value from 1 to 10.

Land Cover data reveal the type of wildfire fuels that are likely to be found in different areas. The USGS Multi-Resolution Land Cover data were used in this model to identify areas of the state where there are fuel types that ignite more easily, burn with greater intensity and facilitate a greater rate of wildfire advancement. Fuels data of this resolution and scale have their limitations and the lack of detailed fuel models is commonly recognized as the most prominent limitation in the various types of wildfire risk modeling. Although some advanced processing of remotely sensed data can be used to estimate canopy

crown closure and moisture content, data of these types can rarely divulge the degree of fuel loading within a pixel.

Each fuel type identified by the MRLC data was rated on a 0 to 10 interval scale as follows: Water: No Data* Low-Intensity Development: 3 High-Intensity Development: 2 Hay, Pasture, Grass: 6 Row Crops: 2 Probable Row Crops: 3 Conifer (Evergreen) Forest: 10 Mixed Forest: 9 Deciduous Forest: 8 Woody Wetlands: 2 Emergent Wetlands: 1 Barren (Quarry, Coal, Beach): 0 Barren Transitional (includes clear-cut): 2

Water was classified as No Data due to the undesirable effect a value of zero would have on the final output. Because land cover is weighted relatively high, the initial output would contain very low values over water bodies if the water class was assigned a value of zero. This effect seems appropriate, but these low values would have a profound and undesired effect on the surrounding areas when the neighborhood function was executed. Hence, the water class was initially classified as No Data.

Fire Resources

Not only are we at risk from naturally occurring wildfires but we are also responsible for wildfire ignition through deliberate actions or carelessness. In the past low rural population levels plus adequate suppression resources have kept the loss of life and property low.

A first concern about wildland fire is the rapidly growing number of woodland home communities that are evident all across Virginia. In the past, rural communities were typically scattered agricultural operations. Today, new rural communities are more likely to be residential communities whose residents commute to urban jobs. These rural communities are becoming increasingly attractive to the urban populations.

Fire organizations, which have found their roots in rural America, evolved into two separate groups, the more rural volunteer organization and the professional urban fire organizations each with its own distinct philosophy. Fires within or threatening the wildland-urban interface have elements of both wildland and urban fires. For this reason both organizations become involved in protection and suppression of wildfires.

The woodland home communities are shown on Figure 11. Resources are mapped at a regional scale due to the nature of rural emergency services that are not limited by governmental boundaries; for example

the Buchanan Volunteer Fire Department would respond to a fire on Purgatory Mountain which is located outside of the town limits in Botetourt County. The number of homes located in woodland communities and their level of risk are shown in the following tables.

Table 50
Woodland Home Community Fire Risk, Alleghany County

Community	Number of Homes	Risk Level
Jackson River	10	Moderate
Cline Meadow Road	15	Moderate
Longdale Furnace Road	25	Moderate
Bens	10	Moderate
Tucker Road	10	Moderate
Falcon Ridge	31	Moderate
Lakewood Lane	10	High
Dunbrach Road	10	High
Woodland Road	70	High
Ridgevue	30	High
Total	221	-

Source: Virginia Department of Forestry, 2010.

Table 51
Woodland Home Community Fire Risk, Town of Clifton Forge

Community	Number of Homes	Risk Level
Roxbury St	20	High
Verge Street	15	High
Horseshoe Blvd	100	High
Richmond Ave	120	High
County Road	10	High
Total	265	-

Source: Virginia Department of Forestry, 2010.

Table 52
Woodland Home Community Fire Risk, City of Covington

Community	Number of Homes	Risk Level
Sally Ann Drive	100	Low
Detroit St	30	High
Total	130	-

Source: Virginia Department of Forestry, 2010.

Table 53
Woodland Home Community Fire Risk, Botetourt County

Community	Number of Homes	Risk Level
Wood Ridge Estates	30	Low
Ball Park Road	65	Moderate
Roses Ridge Lane/Purgatory Mtn Road	28	Moderate
Dale Nita Estates	18	Moderate
Stone Coal	20	Moderate
Fields Ave.	25	Moderate
Rainbow Estates	20	Moderate
Hunters Trail/Beach Lane	15	Moderate
Brunswick Forge Road	34	High
Black Berry Lane	30	High
Andrew Drive	49	High
Autumnwood/Four Seasons Drive	38	High
North Oakwood	16	High
Lakeridge Circle	30	High
Brookfield Road	30	High
Leonard/Park View Drive	54	High
Longwood Lane	45	High
Sherwood Drive	53	High
Stratford Drive	28	High
White Oak Drive	48	High
Blue Ridge Drive	30	High
Archway Road	38	High
Applewood/Steeple Chase	105	High
Laurel Lane	12	High
Emerald Lake	28	High
Salt Pond Road	12	High
Total	901	-

Source: Virginia Department of Forestry, 2010.

Table 54
Woodland Home Community Fire Risk, Craig County

Community	Number of Homes	Risk Level
Mountain Acres	25	Moderate
Va. Mineral Spring	12	Moderate
Olde Glade Trail	10	Moderate
Sycamore Crossing	15	Moderate
Hunters Drive	35	High
Aps Knob	20	High
Craig Springs Camp	10	High
Hickory Brook Drive	10	High
Miller Cove	10	High
Mcafee Branch Lane	10	High
Waltons Mountain Rd.	17	High
Total	174	-

Source: Virginia Department of Forestry, 2010.

Table 55
Woodland Home Community Fire Risk, Roanoke County

Community	Number of Homes	Risk Level
Whipple Tree	200	Low
Chaparral	300	Low
Bradshaw Road	20	Moderate
Cove Hollow	17	Moderate
Flintlock	75	Moderate
Bryant Lane	10	High
Sagewood Circle	16	High
Shawnee/ Apache	50	High
Mountain Heights	40	High
Forest Acre	35	High
Laurel Mountain Road	20	High
Laurel Woods	16	High
Timberview Road	16	High
Timberview Road East	30	High
Puritan / Summit Ridge	200	High
Glenvar Heights	45	High
Cherokee Hills	60	High
Brandy Run Off Wildwood Rd	30	High
Skyview Road	50	High
Twin Mountains	200	High
Fort Mason	70	High
Carriage Hills	150	High
Remington Road	150	High
Chestnut Estates	102	High
Falling Creek	187	High
Total	2,089	-

Source: Virginia Department of Forestry, 2010.

Table 56
Woodland Home Community Fire Risk, City of Roanoke

Community	Number of Homes	Risk Level
Cassell Lane	200	Low
Robin Hood Road	500	Low
Estates / Hartsock Road	100	High
Total	800	-

Source: Virginia Department of Forestry, 2010.

Table 57
Woodland Home Community Fire Risk, City of Salem

Community	Number of Homes	Risk Level
Niblick/ Bent Ridge	100	High
Total	100	-

Source: Virginia Department of Forestry, 2010.

Table 58
Woodland Home Community Fire Risk, Town of Vinton

Community	Number of Homes	Risk Level
Elizabeth Drive	200	High
Elizabeth Drive	210	High
Total	410	-

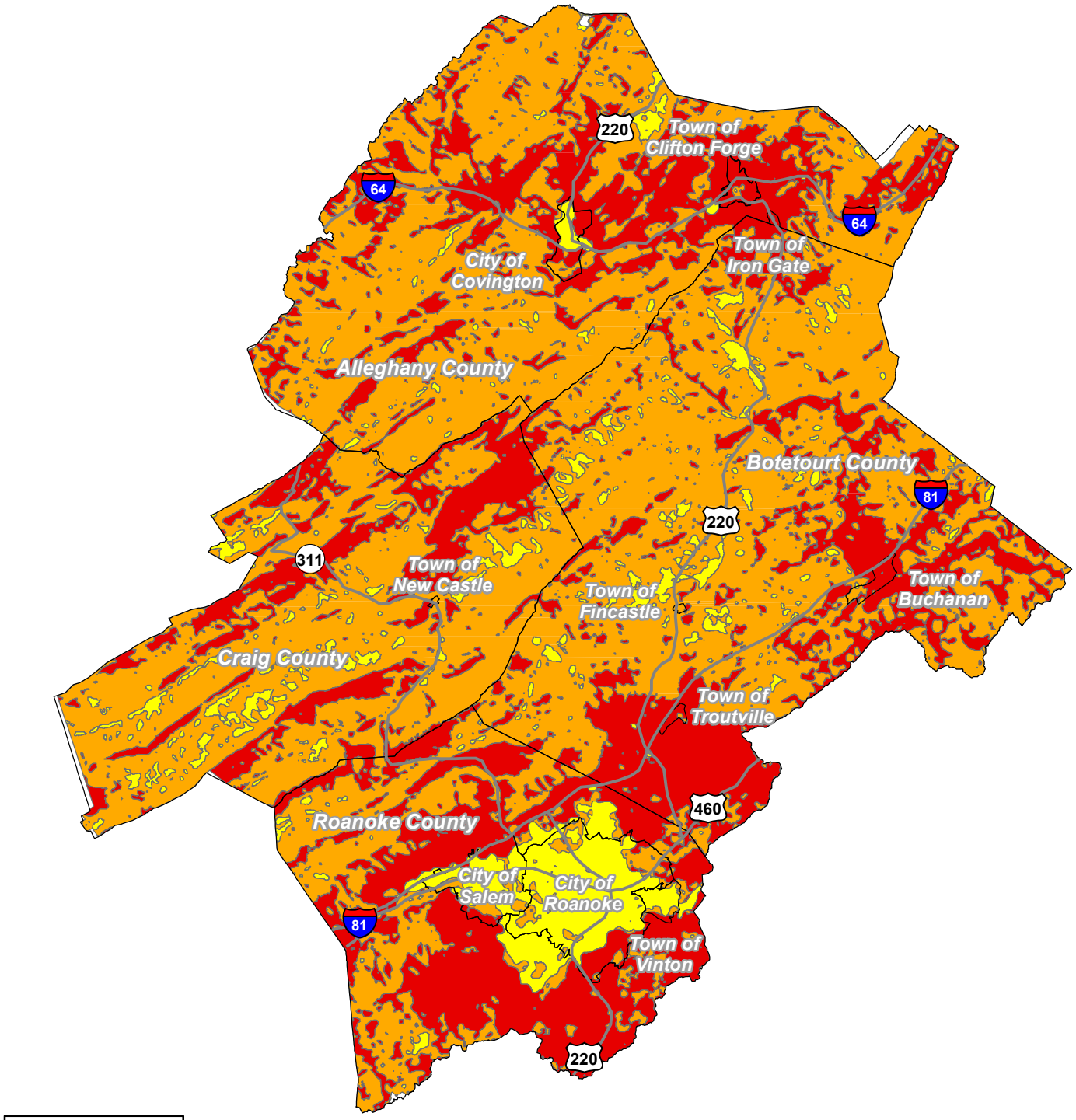
Source: Virginia Department of Forestry, 2010.

The localities of Buchanan, Fincastle, Iron Gate, New Castle, and Troutville do not have any Woodland Home Communities listed in the Virginia Department of Forestry analysis; however this does not necessarily mean that those localities are not at risk from wildfire.

The total number of homes in the region for each Risk Level is: low risk, 1330; moderate risk, 466; and high risk, 3,294. The total number of homes at risk from wildfire for the region is 5,090.

Based on past events it is likely that wildfires will continue to impact the Roanoke Valley – Alleghany Region in the future. The probability of an occurrence of a wildfire event has remained unchanged since the adoption of the 2006 Regional Pre-Disaster Mitigation Plan.

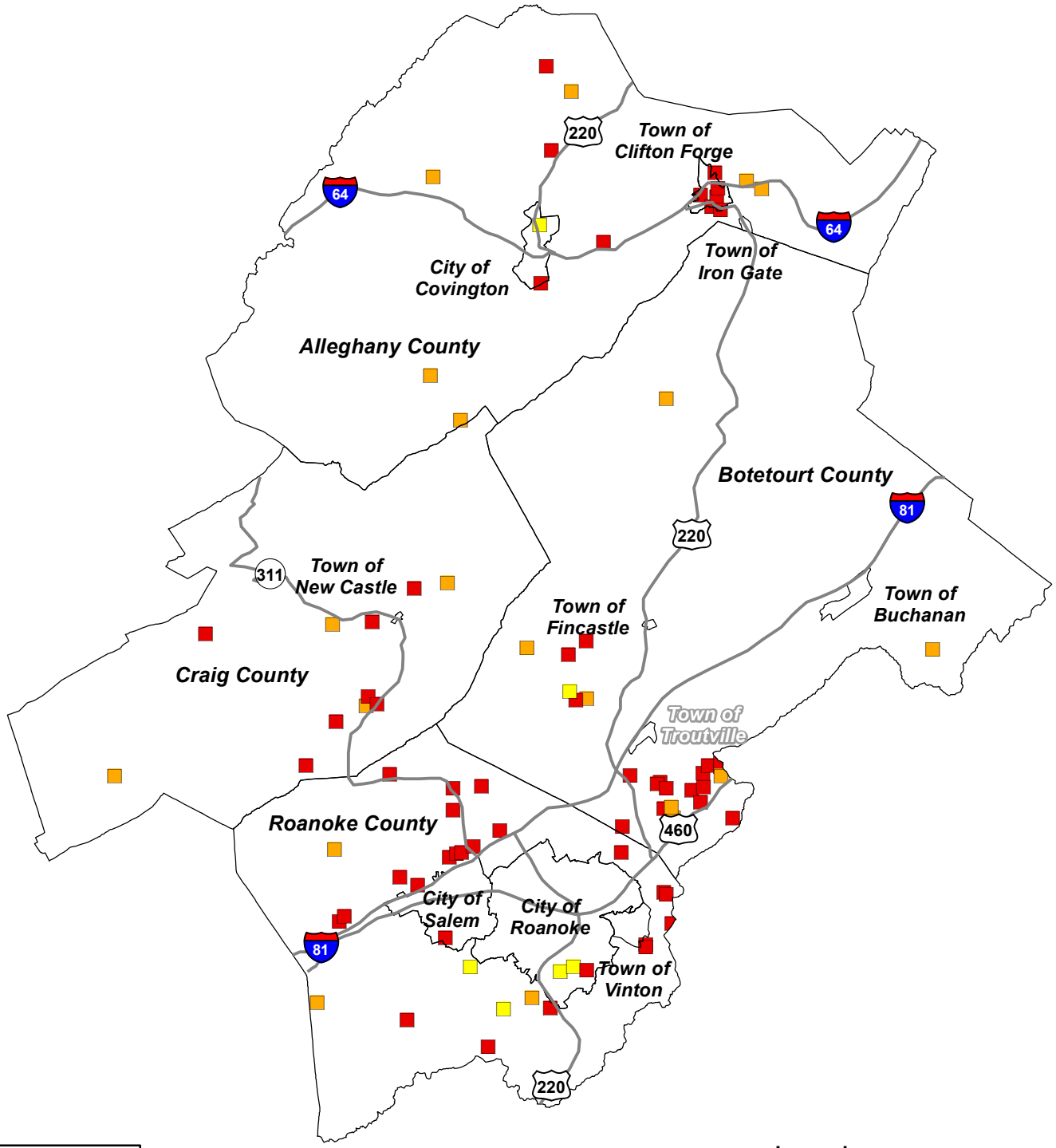
Figure 12: Wildfire Risk Assessment



Scale 1:500,000

Source: Roanoke Valley-Alleghany Regional Commission, 2012.

Figure 13: Woodland Home Communities



Legend

Woodland Home Community

Fire Risk

- High
- Moderate
- Low

Scale 1:500,000

Source: Roanoke Valley-Alleghany Regional Commission, 2012.

Winter Storm

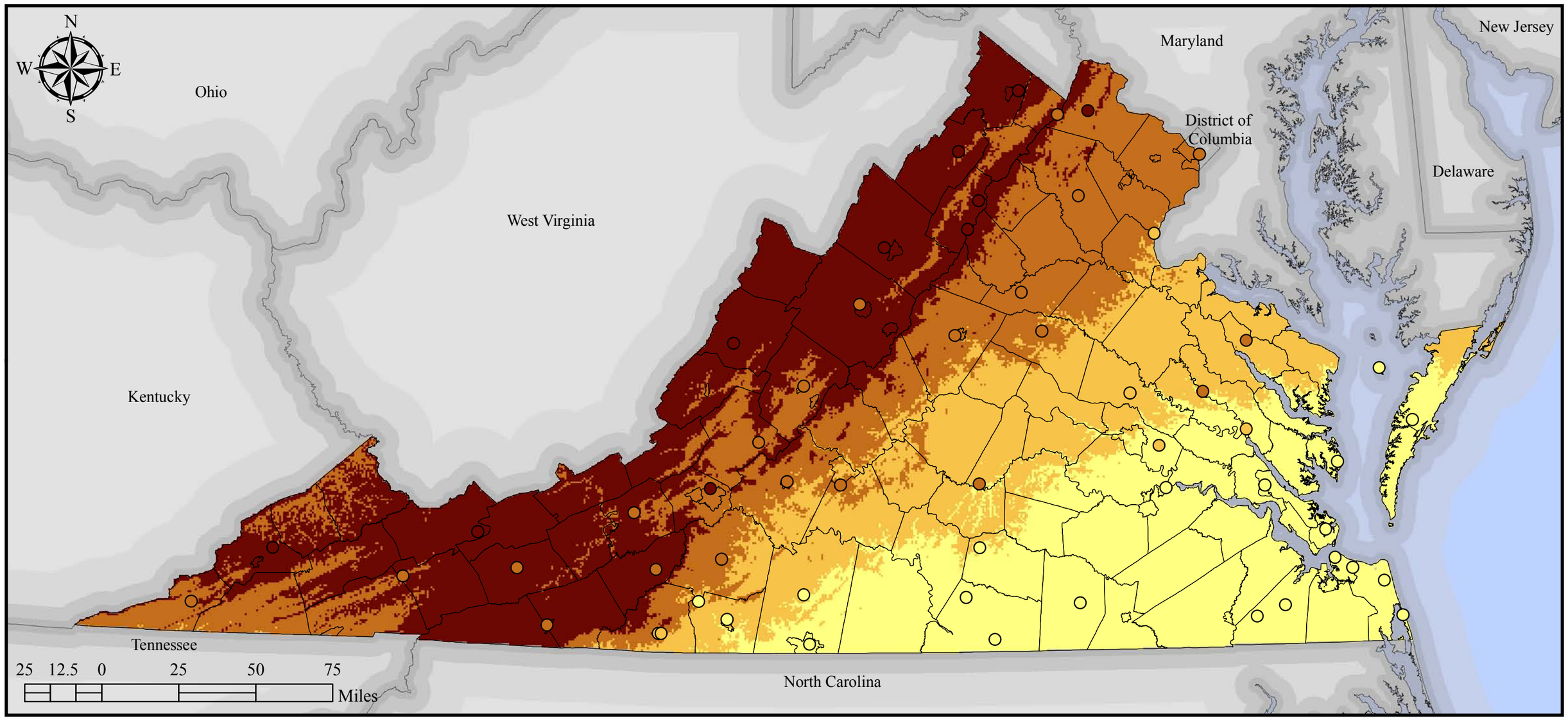
The entire region is vulnerable to winter storms based on the evidence of past events. Winter storms impact entire jurisdictions. The potential impacts to each locality can be seen on the Winter Storm Risk map on the following page. The Virginia Department of Emergency Management ranks all of the localities within the RVARC regions as being at risk for "high severity" winter storms. A typical winter in the Roanoke Valley-Alleghany region is relatively mild, but Arctic blasts and Gulf moisture or coastal storms driven inland have historically combined to deliver serious winter weather. There is potential for dangerous winter weather from November to as late as May. Severe winter weather might come in the form of snow, ice, sleet and freezing rain, or blustery cold temperatures and winds.

When heavy snow falls quickly, commuters are often stranded, the delivery of essential goods and supplies stopped, and emergency responses delayed. Heavy snow can knock down trees, power and telephone lines, and collapse roofs. In rural areas, livestock and pets can die while homes are isolated for days. Additionally, the costs of snow removal, damage repair, and lost business can have a serious economic impact. The dangers of winter are intensified when extremely cold temperatures accompany a winter storm. Extremely cold weather is most dangerous to infants and the elderly. Additionally, freezing temperatures can cause damage to vegetation, wildlife, pets, and even homes and businesses as pipes freeze and burst. Streams can freeze; creating ice jams that can cause flooding. When snow is driven by the wind, the result is blizzard conditions that are often blinding and deadly.

Winter ice storms are frequent in the region. When rain falls onto a surface that is below freezing, it freezes to that surface. Anything the freezing rains contact becomes glazed with accumulating ice. Even modest accumulations of ice can quickly down trees, electrical and telephone wires, communications towers and antennas critical for emergency communications. Repair of these utilities can take days, leaving citizens without power or telephone service. Light accumulations of ice are hazardous to motorists and pedestrians.

Based on past events it is likely that winter storms will continue to impact the Roanoke Valley – Alleghany Region in the future. The probability of an occurrence of a winter storm event has remained unchanged since the adoption of the 2006 Regional Pre-Disaster Mitigation Plan.

Figure 14: Average number of days with at least 3 inches of snow



Center for Geospatial Information Technology

VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

DATA SOURCES:

CGIT analysis of NCDC data
VGIN Jurisdicational Boundaries
ESRI State Boundaries

LEGEND:

Avg. Number of Days per Year

- 1.5 or lower
- 1.51 - 2.0
- 2.01 - 3.0
- 3.01 - 6.72

HAZARD IDENTIFICATION:

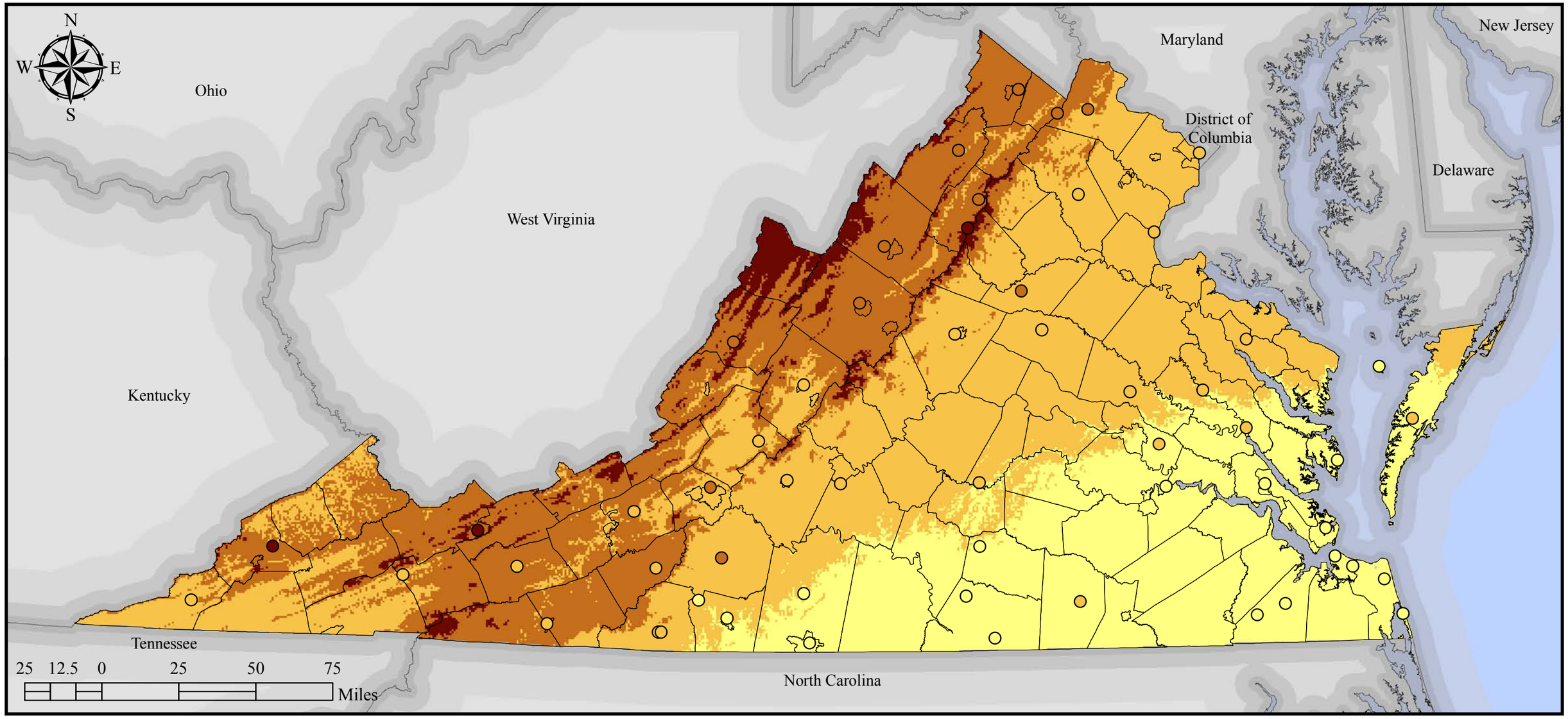
Winter weather statistics were estimated from daily NCDC weather station reports from 1960 - 2000; the values at the weather stations are symbolized with small round dots, and a statewide regression fit depicts the overall trend in the weather station statistics.

These results depict general trends, and local conditions may vary widely.

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

Figure 15: Frequency of 3 or more days with at least 3 inches of snow



Center for Geospatial Information Technology

VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

DATA SOURCES:

CGIT analysis of NCDC data
VGIN Jurisdicational Boundaries
ESRI State Boundaries

LEGEND:

Avg. Annual Frequency

- 0 - 0.25
- 0.251 - 0.5
- 0.51 - 0.75
- 0.751 - 1

HAZARD IDENTIFICATION:

Winter weather statistics were estimated from daily NCDC weather station reports from 1960 - 2000; the values at the weather stations are symbolized with small round dots, and a statewide regression fit depicts the overall trend in the weather station statistics. Average annual frequency ranges from zero to one: zero means that the condition never occurs in a year, one means that it always occurs in a year. These results depict general trends, and local conditions may vary widely.

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

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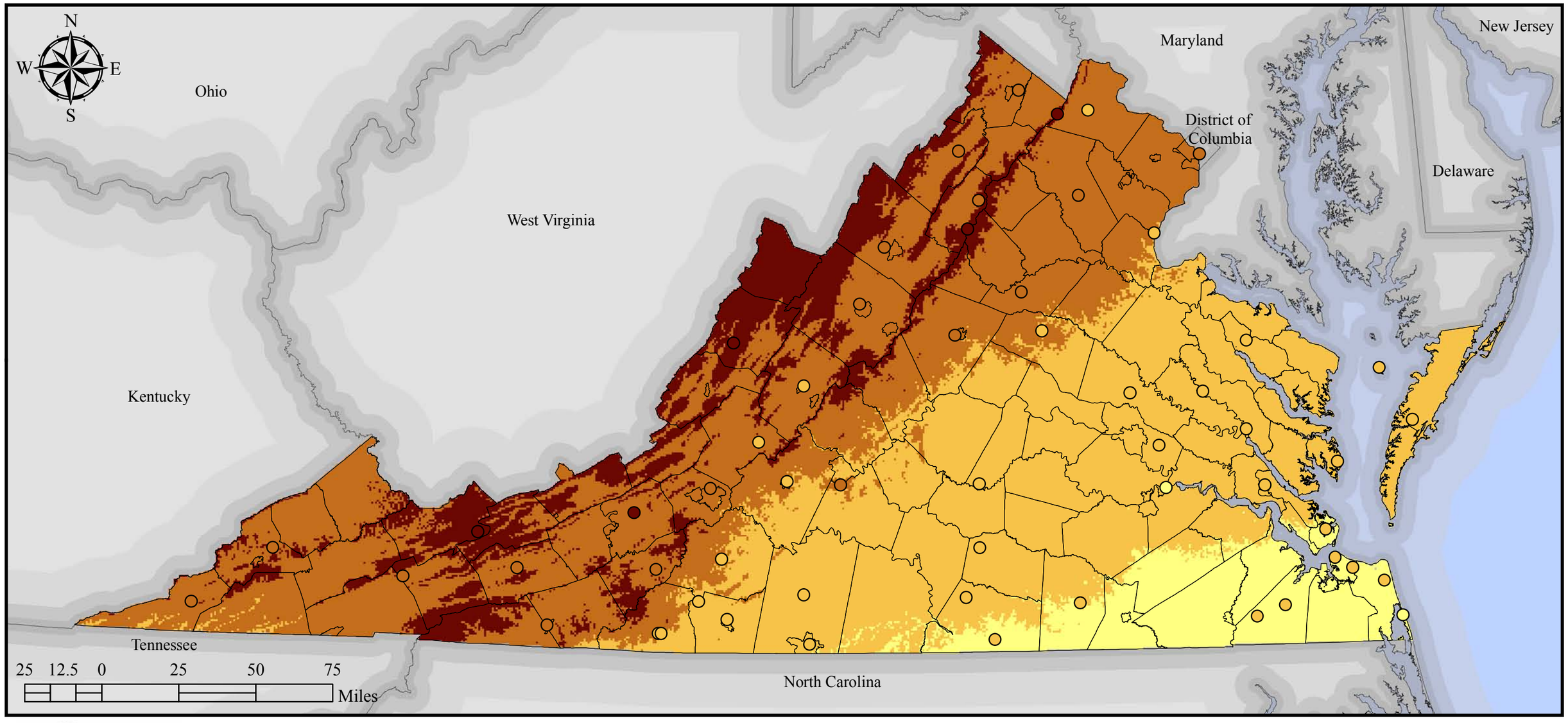
Figure 16: Average number of days entirely at or below 32 F



Center for Geospatial Information Technology

VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

DATA SOURCES:

CGIT analysis of NCDC data
VGIN Jurisdicational Boundaries
ESRI State Boundaries

LEGEND:

Avg. Number of Days per Year

- 3 or lower
- 3.1 - 9
- 9.1 - 18
- 18.1 - 40

HAZARD IDENTIFICATION:

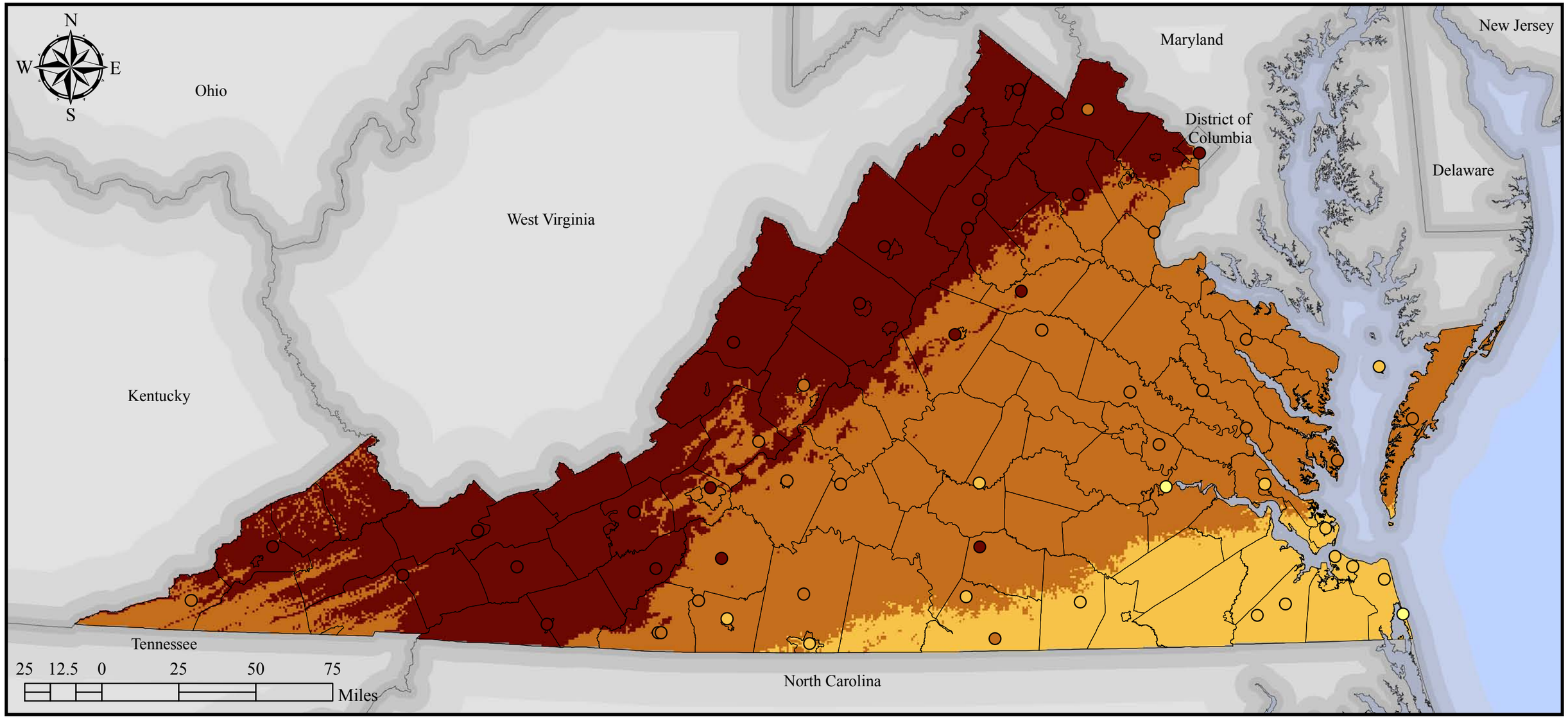
Winter weather statistics were estimated from daily NCDC weather station reports from 1960 - 2000; the values at the weather stations are symbolized with small round dots, and a statewide regression fit depicts the overall trend in the weather station statistics.

These results depict general trends, and local conditions may vary widely.

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

Figure 17: Frequency of 5 or more days entirely at or below 32 F



Center for Geospatial Information Technology

VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

DATA SOURCES:

CGIT analysis of NCDC data
VGIN Jurisdicational Boundaries
ESRI State Boundaries

LEGEND:

Avg. Annual Frequency

- 0 - 0.25
- 0.251 - 0.5
- 0.51 - 0.75
- 0.751 - 1

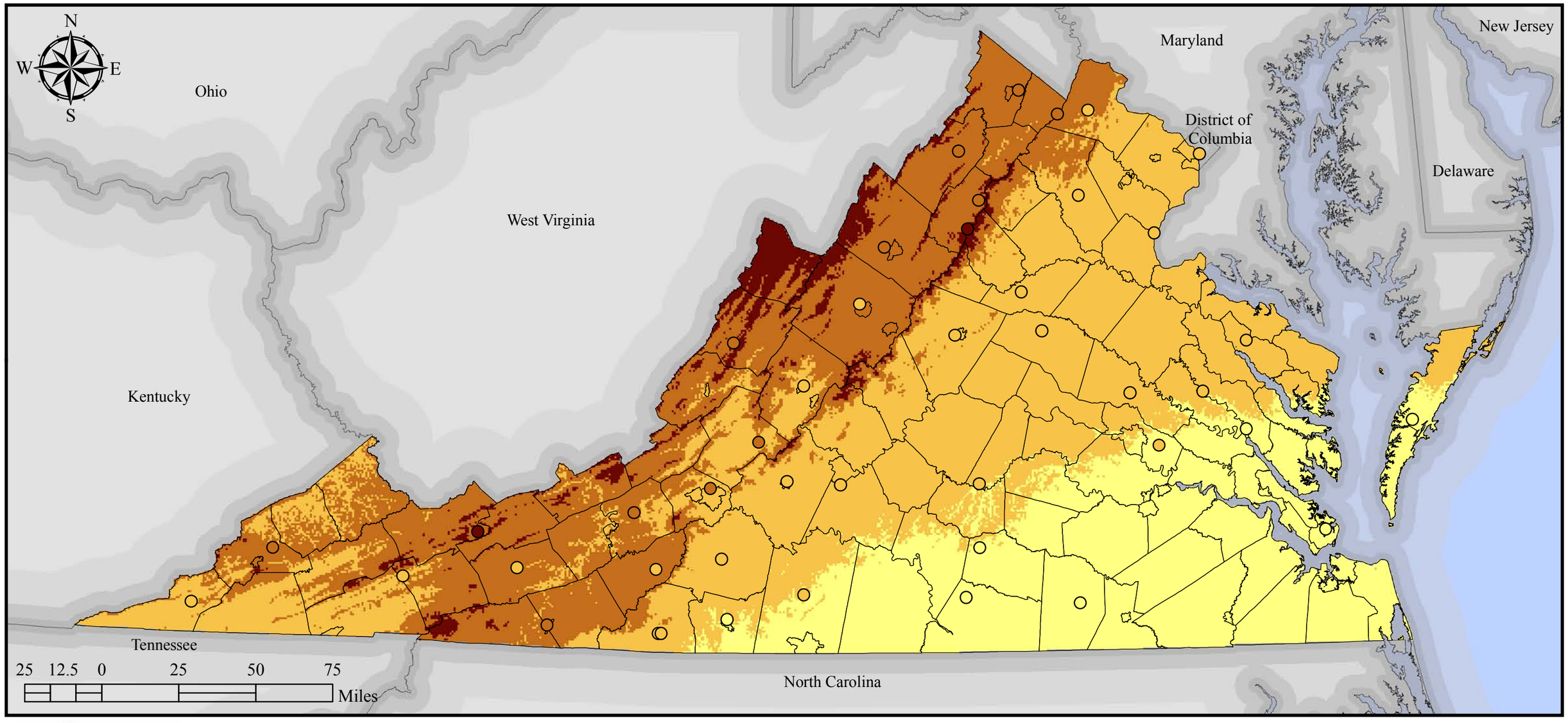
HAZARD IDENTIFICATION:

Winter weather statistics were estimated from daily NCDC weather station reports from 1960 - 2000; the values at the weather stations are symbolized with small round dots, and a statewide regression fit depicts the overall trend in the weather station statistics. Average annual frequency ranges from zero to one: zero means that the condition never occurs in a year, one means that it always occurs in a year. These results depict general trends, and local conditions may vary widely.

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

Figure 18: Average number of days with at least 6 inches of snow



Center for Geospatial Information Technology

VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

DATA SOURCES:

CGIT analysis of NCDC data
VGIN Jurisdicational Boundaries
ESRI State Boundaries

LEGEND:

Avg. Number of Days per Year

- 0.5 or lower
- 0.51 - 1.0
- 1.01 - 1.5
- 1.51 - 2.3

HAZARD IDENTIFICATION:

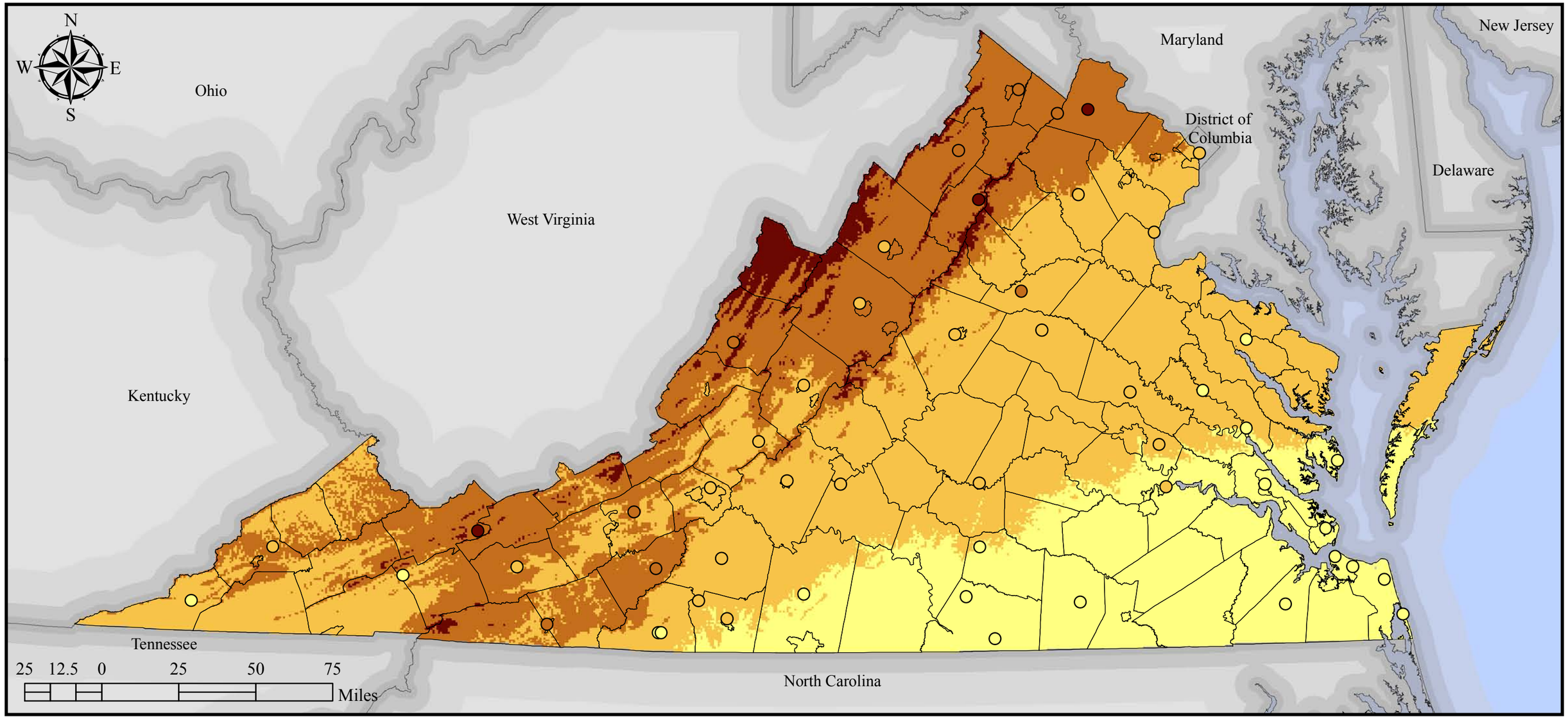
Winter weather statistics were estimated from daily NCDC weather station reports from 1960 - 2000; the values at the weather stations are symbolized with small round dots, and a statewide regression fit depicts the overall trend in the weather station statistics.

These results depict general trends, and local conditions may vary widely.

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

Figure 19: Frequency of 1 or more days with at least 12 inches of snow



Center for Geospatial Information Technology

VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

DATA SOURCES:

CGIT analysis of NCDC data
VGIN Jurisdicational Boundaries
ESRI State Boundaries

LEGEND:

Avg. Annual Frequency

- 0 - 0.05
- 0.051 - 0.15
- 0.151 - 0.25
- 0.251 - 0.4

HAZARD IDENTIFICATION:

Winter weather statistics were estimated from daily NCDC weather station reports from 1960 - 2000; the values at the weather stations are symbolized with small round dots, and a statewide regression fit depicts the overall trend in the weather station statistics. Average annual frequency ranges from zero to one: zero means that the condition never occurs in a year, one means that it always occurs in a year. These results depict general trends, and local conditions may vary widely.

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

Chapter 4

Loss Estimation

Loss estimates were calculated for flooding only. Other disasters are too variable and widespread to determine any useful loss estimates.

Methodology for Flood Damage Estimates

The methodology for determining flood losses varied depending on the data available for each locality. Estimates were calculated for residential and commercial structures only. Structures in the floodplain were identified by viewing aerial photos supplied by Commonwealth of Virginia, the most recent version of the FEMA Digital Flood Insurance Rate Maps and local tax parcel maps. Parcels were then selected based on structure's use determined by land use codes/zoning classification. Value of the structure was then calculated based on information from the local tax parcel database.

Residential Structure Damage is based on a Split Level or Two Story home with a basement at a flood depth of 3feet and equates to a 33% of the structure value. Residential Content Damage is based on a two story or split level home with a basement at a flood depth of 3feet and equates to an 18% of structure value. Commercial Structure Damage is estimated at 33% and contents loss is estimated at 20% of structure value.

Table 59
Alleghany County Flood Loss Estimate (unincorporated areas)

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	630	$38,966,900	$12,859,077	$7,014,142	$19,873,119
Commercial	34	$7,342,600	$2,423,058	$1,468,520	$3,891,578
Total	664	$46,309,500	$15,282,135	$8,482,562	$23,764,697

Average Damage per Residential Structure in Floodplain:	$31,545
Average Value per Residential Structure in Floodplain:	$61,852
Average Damage per Commercial Structure in Floodplain:	$114,458
Average Value per Commercial Structure in Floodplain:	$215,959

Table 60
Town of Clifton Forge Flood Loss Estimate

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	57	$2,624,700	$866,151	$472,446	$1,338,597
Commercial	16	$2,661,300	$878,229	$532,260	$1,410,489
Total	73	$5,286,000	$1,744,380	$1,004,706	$2,749,086

Average Damage per Residential Structure in Floodplain:	$23,484
Average Value per Residential Structure in Floodplain:	$46,047
Average Damage per Commercial Structure in Floodplain:	$88,156
Average Value per Commercial Structure in Floodplain:	$166,331

Table 61
Town of Iron Gate Flood Loss Estimate

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	1	$254,000	$83,820	$45,720	$129,540
Commercial	0	$0	$0	$0	$0
Total	1	$254,000	$83,820	$45,720	$129,540

Average Damage per Residential Structure in Floodplain:	$129,540
Average Value per Residential Structure in Floodplain:	$254,000
Average Damage per Commercial Structure in Floodplain:	na
Average Value per Commercial Structure in Floodplain:	na

Table 62
City of Covington Flood Loss Estimate

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	305	$33,550,000	$11,071,500	$6,039,000	$17,110,500
Commercial	52	$13,000,000	$4,290,000	$2,600,000	$6,890,000
Total	357	$46,550,000	$15,361,500	$8,639,000	$24,000,500

Average Damage per Residential Structure in Floodplain:	$56,100
Average Value per Residential Structure in Floodplain:	$110,000
Average Damage per Commercial Structure in Floodplain:	$132,500
Average Value per Commercial Structure in Floodplain:	$250,000

Table 63
Botetourt County Flood Loss Estimate (unincorporated areas)

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	422	$31,863,000	$10,514,790	$5,735,340	$16,250,130
Commercial	36	$11,627,500	$3,837,075	$2,325,500	$6,162,575
Total	458	$43,490,500	$14,351,865	$8,060,840	$22,412,705

Average Damage per Residential Structure in Floodplain:	$38,507
Average Value per Residential Structure in Floodplain:	$75,505
Average Damage per Commercial Structure in Floodplain:	$171,183
Average Value per Commercial Structure in Floodplain:	$322,986

Table 64
Town of Buchanan Flood Loss Estimate

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	52	$3,842,900	$1,268,157	$691,722	$1,959,879
Commercial	11	$883,100	$291,423	$176,620	$468,043
Total	63	$4,726,000	$1,559,580	$868,342	$2,427,922

Average Damage per Residential Structure in Floodplain:	$37,690
Average Value per Residential Structure in Floodplain:	$73,902
Average Damage per Commercial Structure in Floodplain:	$42,549
Average Value per Commercial Structure in Floodplain:	$80,282

Table 65
Town of Fincastle Flood Loss Estimate

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	2	$189,600	$62,568	$34,128	$96,696
Commercial	2	$410,100	$135,333	$82,020	$217,353
Total	4	$599,700	$197,901	$116,148	$314,049

Average Damage per Residential Structure in Floodplain:	$48,348
Average Value per Residential Structure in Floodplain:	$94,800
Average Damage per Commercial Structure in Floodplain:	$108,677
Average Value per Commercial Structure in Floodplain:	$205,050

Table 66
Town of Troutville Flood Loss Estimate

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	51	$4,283,300	$1,413,489	$770,994	$2,184,483
Commercial	9	$2,352,300	$776,259	$470,460	$1,246,719
Total	60	$6,635,600	$2,189,748	$1,241,454	$3,431,202

Average Damage per Residential Structure in Floodplain:	$42,833
Average Value per Residential Structure in Floodplain:	$83,986
Average Damage per Commercial Structure in Floodplain:	$138,524
Average Value per Commercial Structure in Floodplain:	$261,367

Table 67
Craig County Flood Loss Estimate (including New Castle)

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	93	$6,170,000	$2,036,100	$1,110,600	$3,146,700
Mobile Homes	27	$270,000	$270,000	$270,000	$540,000
Commercial	6	$600,000	$198,000	$120,000	$318,000
Total	126	$7,040,000	$2,504,100	$1,500,600	$4,004,700

Average Damage per Residential Structure in Floodplain:	$33,835
Average Value per Residential Structure in Floodplain:	$66,344
Average Damage per Commercial Structure in Floodplain:	$53,000
Average Value per Commercial Structure in Floodplain:	$100,000

No structures in the Town of New Castle appeared to be in the floodplain.

Roanoke County buildings in floodplain were delineated by viewing aerial photos. Buildings greater than 750sq ft. were selected for review. Parcels with structures were then selected. Dropped parcels with no dwelling value-even if the building was shown on building layer. Separated parcels based on land use into residential and commercial units. Dropped high value parcels from commercial selection. This included a few schools on large parcels, parcels not in the floodplain, Hollins University, and the Regional Fire Training Facility.

Table 68
Roanoke County Flood Loss Estimate (unincorporated area)

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	683	$85,935,200	$28,358,616	$15,468,336	$43,826,952
Commercial	80	$20,930,100	$6,906,933	$4,186,020	$11,092,953
Total	763	$106,865,300	$35,265,549	$19,654,356	$54,919,905

Average Damage per Residential Structure in Floodplain:	$64,168
Average Value per Residential Structure in Floodplain:	$125,820
Average Damage per Commercial Structure in Floodplain:	$138,662
Average Value per Commercial Structure in Floodplain:	$261,626

Town of Vinton buildings in floodplain were delineated by viewing aerial photos. Buildings greater than 750sq ft. were selected for review. Parcels with structures were then selected. Dropped parcels with no dwelling value-even if the building was shown on building layer. Separated parcels based on land use into residential and commercial units. Dropped high value parcels from commercial selection. Separated parcels based on land use into residential and commercial units.

Table 69
Town of Vinton Flood Loss Estimate

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	58	$5,613,100	$1,852,323	$1,010,358	$2,862,681
Commercial	36	$7,064,400	$2,331,252	$1,412,880	$3,744,132
Total	94	$12,677,500	$4,183,575	$2,423,238	$6,606,813

Average Damage per Residential Structure in Floodplain:	$49,357
Average Value per Residential Structure in Floodplain:	$96,778
Average Damage per Commercial Structure in Floodplain:	$104,004
Average Value per Commercial Structure in Floodplain:	$196,233

City of Roanoke buildings in the floodplain were delineated by viewing aerial photos. Buildings greater than 750sq ft and less than 3000 sq ft for residential areas were selected for review. All structures over 3000sq ft were considered commercial for the loss estimates calculations. Some commercial was picked up in the residential selection based on land use-transferred to commercial (i.e. house that was changed to office use). Some residential was picked up in commercial based on land use-transferred to residential (office/warehouse conversion to condominium or apartment). Dropped parcels with no dwelling value-even if the building was shown on building layer. Dropped high value parcels from commercial selection. This included a few schools on large parcels, parcels not in the floodplain, hospitals, parking garages, Ivy Market, and the Regional Waste Water Treatment Plant.

Table 70
City of Roanoke Flood Loss Estimate

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	598	$80,439,700	$26,545,101	$14,479,146	$41,024,247
Commercial	434	$218,931,100	$72,247,263	$43,786,220	$116,033,483
Total	1032	$299,370,800	$98,792,364	$58,265,366	$157,057,730

Average Damage per Residential Structure in Floodplain:	$68,602
Average Value per Residential Structure in Floodplain:	$134,515
Average Damage per Commercial Structure in Floodplain:	$267,358
Average Value per Commercial Structure in Floodplain:	$504,450

City of Salem buildings in floodplain were delineated by viewing aerial photos. Buildings greater than 750sq ft. were selected for review. Parcels with structures were selected for review. Dropped parcels with no dwelling value-even if the building was shown on building layer. Separated parcels based on land use into residential and commercial units. Dropped high value parcels from commercial selection. This included schools on large parcels, parcels not in the floodplain, and Roanoke College upper campus.

Table 71
City of Salem Flood Loss Estimate

	Parcels/Structures in Floodplain	Value of Structures in Floodplain	Structure Damage at 3 ft Flood depth	Contents Damage at 3 ft Flood Depth	Total Estimated Damage
Residential	641	$70,479,300	$23,258,169	$12,686,274	$35,944,443
Commercial	329	$141,183,100	$46,590,423	$28,236,620	$74,827,043
Total	970	$211,662,400	$69,848,592	$40,922,894	$110,771,486

Average Damage per Residential Structure in Floodplain:	$56,076
Average Value per Residential Structure in Floodplain:	$109,952
Average Damage per Commercial Structure in Floodplain:	$227,438
Average Value per Commercial Structure in Floodplain:	$429,128

Chapter 5

Regional Mitigation Goals and Strategies

Regional Mitigation Goals and Strategies

Project Prioritization and Benefit to Cost Consideration

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each individual locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified pre-disaster, applicable local government departments will be the lead in making sure that each project or action will be implemented in timely manner with other departments, other local government representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since the mitigation projects are an investment of public funds to reduce damages, localities have selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

Regional mitigation goals and strategies are those that could apply to the entire region (e.g., mitigation of the impact of flooding) or can be accomplished in a more efficient manner by two or more localities working cooperatively (e.g., hazard outreach and education campaigns).

Earthquake

Mitigation measures for earthquakes are region-wide recommendations for all localities adopting the Regional Pre-Disaster Mitigation Plan.

Goal: Increase public awareness of the probability and potential impact of earthquakes.
Responsible Department(s): Emergency Management, Public Information Office
Strategy:

1. Publish a special section in local newspaper with emergency information on earthquakes. Localize the information by printing the phone numbers of local emergency services offices, the American Red Cross, and hospitals.

Flood

Mitigation measures for floods are region-wide recommendations for all localities adopting the Regional Pre-Disaster Mitigation Plan. Localities have also developed locality specific goals and activities for this disaster that are listed in Chapter 7 Local Mitigation Strategies in this document.

Goal: Mitigation of loss of life and property from flooding and flood related disasters.
Responsible Department(s): Community Development, Engineering, Public Information Office, Public Works, Transportation
Strategies:

1. In cooperation with Federal and State governments, support a comprehensive public information and education program on all hazards addressed in the Regional Hazard Mitigation Plan. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.
2. Develop and maintain an inventory of flood prone roadways in cooperation with local governments and the Virginia Department of Transportation.
3. Develop and maintain an inventory of flood prone critical regional facilities such as hospitals, public utility sites, airports, etc.

Goal: Update existing GIS data layers related to natural hazards.

Responsible Department(s): Engineering, Public Works

Strategies:

1. Consider seeking funding and support programs that update FEMA's Flood Insurance Rate Maps (FIRM). Consider participation in FEMA's Cooperating Technical Partners (CTP) program that establishes partners with local jurisdictions to develop and maintain up-to-date flood maps.
2. In cooperation with local governments, utilize GIS to inventory at risk infrastructure and public and private structures within flood prone areas.
3. Participate in FEMA's Digital Flood Insurance Rate Maps (DFIRM) program.
4. Support FIRM remapping projects that address areas in the region that have the most serious mapping problems and where flooding is a repetitive problem.

Goal: Provide early warning of flooding

Responsible Department(s): Emergency Management, Engineering, Public Works, Transportation

Strategy:

1. Identify areas with recurring flood problems and request additional IFLOW stream/rain gauges as appropriate to ensure that these areas are adequately covered and monitored.

Goal: Identify structural projects that could mitigate the impact of flooding.

Responsible Department(s): Engineering, Public Works, Transportation

Strategies:

1. Consider seeking funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems.
2. Support Virginia Department of Transportation projects that call for improved ditching, replacement of inadequate and undersized culverts, enlargements of bridge openings and drainage piping needed to minimize flooding.

Goal: Maintain an accurate database and map of repetitive loss properties

Responsible Department(s): Emergency Management, Engineering, Public Works

Strategies:

1. Localities will work with RVARC, VDEM and FEMA to update list of repetitive loss properties annually.
2. Localities will obtain updated list of repetitive loss properties annually from VDEM/FEMA.

3. Localities will review property addresses for accuracy and make necessary corrections.
4. Localities will determine if and by what means each property has been mitigated.
5. Localities will map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).
6. Localities will determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

Hurricane

Mitigation measures for hurricanes are region-wide recommendations for all localities adopting the Regional Pre-Disaster Mitigation Plan.

Goal: Mitigate the impact of hurricanes in the Roanoke Valley-Alleghany Region.
Responsible Department(s): Emergency Management
Strategy:

1. Provide information about the *"StormReady"* program to each locality.

Karst

Mitigation measures for karst are region-wide recommendations for all localities adopting the Regional Pre-Disaster Mitigation Plan.

Goal: Improved Hazard Mapping and Assessments for karst areas and sinkholes.
Responsible Department(s): Engineering, Public Works
Strategies:

1. Encourage the delineation of karst areas and areas susceptible to sinkholes through a cooperative effort with the Virginia Karst Mapping Project, Virginia Speleological Survey, and Virginia Department of Conservation and Recreation (Virginia Cave Board).

Landslide

Mitigation measures for landslides are region-wide recommendations for all localities adopting the Regional Pre-Disaster Mitigation Plan.

Goal: Improved Hazard Mapping and Assessments for landslides.
Responsible Department(s): Engineering, Public Works, Transportation
Strategies:

1. Encourage the delineation of susceptible areas and different types of landslide hazards at a scale useful for planning and decision-making, led by USGS and State geological surveys.
2. Work with state and Federal agencies to develop data that will assist in reducing and eliminating impacts from landslides.

Straight Line Winds

Mitigation measures for straight line winds are region-wide recommendations for all localities adopting the Regional Pre-Disaster Mitigation Plan.

Goal: Mitigation of the impact of Straight Line Winds.
Responsible Department(s): Emergency Management, Public Information Office
Strategies:

1. In cooperation with Federal and State governments, support a comprehensive public information and education program on Straight Line Winds. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.

Tornado

Mitigation measures for tornados are region-wide recommendations for all localities adopting the Regional Pre-Disaster Mitigation Plan.

Goal: Mitigation of the impact of Tornados.
Responsible Department(s): Emergency Management, Public Information Office
Strategies:

1. In cooperation with Federal and State governments, support a comprehensive public information and education program on Tornados. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.

Wildfire

Mitigation measures for wildfires are region-wide recommendations for all localities adopting the Regional Pre-Disaster Mitigation Plan.

Goal: Mitigation of the impacts of wildfire to life and property.
Responsible Department(s): Community Development, Emergency Management, Engineering
Strategies:

1. Encourage residents and developers to use FireWise building design, siting, and materials for construction.
2. Encourage VDOF to continue its Community Wildfire Assessments.
3. Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas.

Winter Storms

Mitigation measures for winter storms are region-wide recommendations for all localities adopting the Regional Pre-Disaster Mitigation Plan.

Goal: Mitigation of the effects of extreme winter weather.
Responsible Department(s): Emergency Services, Public Information Office
Strategies:

1. Research and consider participating in the National Weather Service *"Storm Ready"* program.
2. Participate in special statewide outreach/awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc.

All Hazards

Mitigation measures for the all hazards classification are region-wide recommendations for all localities adopting the Regional Pre-Disaster Mitigation Plan.

Goal: Improve general preparedness of the local government for all hazards.
Responsible Department(s): Emergency Services, Public Information Office
Strategies:

1. In cooperation with Federal and State governments, support a comprehensive public information and education program on Tornados. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.
2. Participate in statewide disaster mitigation outreach and awareness activities.

Table 72
Regional Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Publish a special section in local newspaper with emergency information on earthquakes	Earthquake	Increased level of knowledge and awareness in citizens	$5,000	High	Low	FEMA, VDEM Local governments	Local governments	Not started; lack of funding	2014
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	$5,000	High	High	FEMA, VDEM	Local government RVARC, VDEM, FEMA	Ongoing	Ongoing
Utilize GIS to inventory at risk infrastructure and public and private structures within flood prone areas	Flooding	Available inventory of structures that need additional or unique protection from flooding.	$30,000	Medium	Medium	FEMA, VDEM Local governments	Local governments	Not started; lack of funding	2014-2015
Participate in FEMA's Digital Flood Insurance Rate Maps (DFIRM) program	Flooding	Increased accuracy of flood hazard areas through sharing of local knowledge.	$10,000	Medium	Medium	FEMA, Local governments	Local governments	In progress; depends on the locality's ability to provide GIS information	Ongoing
Support FIRM remapping projects in repetitive loss areas	Flooding	Increased accuracy of flood hazard areas through sharing of local knowledge.	unknown	unknown	Medium	FEMA, VDEM Local governments	Local governments	In progress; advocating for flood studies by localities	Ongoing

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Seek funding to prepare site-specific hydrologic and hydraulic studies of areas that have chronic and repetitive flooding	Flooding	Possible determination of solutions to repetitive loss properties.	$5,000	High	Medium	Local governments	Local governments	Ongoing	Ongoing
Support Virginia Department of Transportation projects that minimize flooding	Flooding	Safer transportation system and reduction in flooding of private properties.	$0	High	Medium	Local governments, VDOT	Local governments	In progress; localities advocating for drainage improvements.	Ongoing
Provide information about the "StormReady" program to each locality	All Hazards	Increased knowledge of local officials about the StormReady program; possible applicants to the program.	$1,000	High	Medium	FEMA, VDEM, NWS, Local governments	RVARC	Ongoing	Annual reminder to localities that have not applied to the program
Support a comprehensive public information and education program on natural hazards	All Hazards	Increased level of knowledge and awareness in citizens of natural hazards	$5,000	High	Medium	Local governments	Local governments	Not started; lack of funding	2014-2015
Encourage residents and developers to use FireWise building design, siting, and materials for construction	Wildfire	Reduction in wildfire damage.	$5,000	High	Medium	VA Dept. of Forestry, USFS, Local governments	Local governments	Ongoing	Ongoing

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas	Wildfire	Available inventory of structures that need additional or unique protection from wildfires.	$10,000	Medium	Medium	VA Dept. of Forestry, US Forest Service, Local governments	Local governments	Not started; lack of funding	2015-2016
Seek funding to prepare site-specific hydrologic and hydraulic studies	Flooding	Inventory areas that have chronic and repetitive flooding problems; determine method to eliminate repetitive loss	$20,000	Medium	Medium	FEMA, VDEM	Local governments	Not started; lack of funding	2014-2016
Develop and maintain an inventory of flood prone critical regional facilities	Flooding	Available inventory of critical structures that need additional or unique protection from flooding.	$10,000	Medium	Medium	FEMA, VDEM Local governments	Local governments	Ongoing	Ongoing
Flood prone roadway study / database	Flooding	Inventory of flood prone roadways for planning purposes (road improvements, limitation of development)	$10,000	Medium	Medium	FEMA, VDEM VDOT	RVARC	In progress	2-year updates
Participate in FEMA's Cooperating Technical Partners (CTP) program and Digital Flood Insurance Rate Maps (DFIRM) program	Flooding	Increased accuracy of flood maps and more effective regulation and enforcement of regulations	$5,000	High	Medium	FEMA, VDEM	Local governments	Ongoing; not all localities participate	Ongoing
Identify streams that need additional IFLOW stream/rain gauges	Flooding	Improved early warning of flooding; ensure that these areas are adequately covered and monitored	$12,500	High	Medium	FEMA, VDEM	RVARC	In progress	2014

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Identify funding and resources for delineating landslide hazards	Landslide	Tool for planning and decision-making; limitation of new development.	$5,000	Medium	Low	FEMA, VDEM USGS VDOT	Local governments, VA DCR	Not started; lack of funding	2014
Identify funding and resources for Hazard Mapping and Assessments for karst areas and sinkholes	Karst	Improved Hazard Mapping and Assessments for karst areas and sinkholes	$5,000	Medium	Low	FEMA, VDEM USGS Va DCR VDOT	VA DCR	Not started; lack of funding	2014
Public information and education program	All Hazards	Increased level of knowledge and awareness in citizens of natural hazards.	$5,000	Medium	Medium	FEMA, VDEM Local governments	Local governments	Ongoing local efforts	Ongoing
Community Wildfire Assessments	Wildfire	Identify buildings or locations susceptible to wildfires.	$5,000	High	High	FEMA, VDEM VA DOF	VDOF, local governments	Not started; lack of funding	2015
Participate in special statewide outreach/awareness activities	All Hazards	Increased level of knowledge and awareness in citizens of natural hazards.	$5,000	Medium	Low	FEMA, VDEM	Local governments	Ongoing local efforts	Ongoing

Chapter 6
Local Mitigation Activities, Goals and Strategies, and Proposed Project Listings

ALLEGHANY COUNTY

Current and Past Mitigation Measures

Floodplain Management – Alleghany County adopted its most recent Floodplain District in December 2010 that requires new residential buildings to be elevated to or above the base flood elevation. The floodplain district is an overlay that applies to all other zoning districts. Additional requirements prevent the obstruction of the floodway. In addition to Federal Regulations, the County has established guidelines for development within flood hazard areas. They can be found in Chapter 66-Zoning, of the Code of the County of Alleghany, Virginia. No construction or development, including fill, can be done in a designated floodway. Development can occur in the 100-year floodplain, however the first floor elevation of a structure must be at least one foot above the designated flood elevations shown on the Flood Insurance Rate Maps. Also, structures in the 100-year floodplain must be in compliance with building code requirements for structures in flood hazard areas. Development can occur in the 500-year floodplain with compliance of building code requirements for structures in flood hazard areas.

Erosion and Sediment Control – The County has an Erosion and Sediment Control Ordinance that is part of the County Code. Pursuant to Code of Virginia, §10.1-562, the Alleghany County adopted the regulations, references, guidelines, standards and specifications promulgated by the state soil and water conservation board for the effective control of soil erosion and sediment deposition to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources. Such regulations, references, guidelines, standards and specifications for erosion and sediment control are included in but not limited to the Virginia Erosion and Sediment Control Regulations and the Virginia Erosion and Sediment Control Handbook, as amended from time to time.

National Flood Insurance Program – The County participates in, and is in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements. This program allows property owners to purchase flood insurance from NFIP. There are currently 182 NFIP policies in force in the County.

Dam Safety – There are four dams in Alleghany County. These are the Clifton Forge Dam (owned and maintained by the Town of Clifton Forge), Gathwright Dam (owned and maintained by US Army Corps

of Engineers), Pond Lick Branch Dam (privately owned) and Mead Westvaco #2 Flyash Lagoon Dam (owned and maintained by Mead Westvaco).

Gathright Dam was completed in 1979 and is operated for flood control. The facility is managed by the Army Corps of Engineers. The dam controls the runoff from a 345 square mile drainage area and reduces the effects of flooding along the Jackson and James Rivers. The Corps of Engineers estimates that the project has prevented more than $70 million in flood damages. In May 2009, the U.S. Army Corps of Engineers (USACE) inspected the Gathright Dam as part of Screening Portfolio Risk Analysis and routine inspections. Later in the year on September 2, the USACE assigned the dam a Safety Action Classification (DSAC) II which is defined as "Urgent (Unsafe or Potentially Unsafe)". The rating is attributed to concerns about possible increased seepage at the toe of the dam, and an undetermined flow rate at the river spring a quarter mile downstream, and potential flow channels through limestone below the spillway during pool events above 1600 feet. Because of this rating, the USACE has implemented risk reduction measures which include increased monitoring, updating emergency operation plans and reducing the water level in the reservoir. As of early 2010, the USACE has reduced and continues to maintain the reservoir at an elevation of 1,562 ft above sea level compared to the normal level of 1,582 ft.. Throughout 2010, the USACE conducted safety exercises with local/state officials, conduct a series of investigations on the dam, update inundation mapping and reevaluate the DSAC status. In November 2010, Lake Moomaw was restored to a level of 1,582 ft and the DSAC will be reevaluated in the future.

All of these dams are subject to the National Dam Safety Program Act of 1996 and the resulting 1998 Federal Guidelines for Dam Safety. FEMA requires all dam owners to develop an Emergency Action Plan for warning, evacuation and post-flood actions. The dams are also subject to the Virginia Dam Safety Act that is administered by the by the Department of Conservation and Recreation and Dam Safety Regulations enacted by the Virginia Soil and Water Conservation Board. All dams in the County are in good standing with State and Federal regulatory agencies at this time.

IFLOWS – The County participates in a flood warning system developed by the National Weather Service called Integrated Flood Observing and Warning System (IFLOWS). Through the use of radio-transmitted information, this system provides advanced flood forecasting to the County Emergency Operation Center. There are eight (8) IFLOW stations located in the County.

Alleghany County Mitigation Goals and Strategies

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified pre-disaster, applicable local government departments will be the lead in making sure that each project or action will be implemented in a timely manner with other departments, other local government representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since the mitigation projects are an investment of public funds to reduce damages, localities have selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

Flood

Goal: Mitigation of loss of life and property from flooding and flood related disasters.
Responsible Department(s): Emergency Services, Public Works
Strategies:

1. In cooperation with Federal and State governments, support a comprehensive public information and education program on all hazards addressed in the Regional Hazard Mitigation Plan. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.

2. Develop and maintain an inventory of flood prone roadways in cooperation with local residents and the Virginia Department of Transportation.
3. Develop and maintain an inventory of flood prone critical facilities and public utilities and evaluate measures for flood proofing.
4. Identify households in flood hazard areas and work to remove them to reduce repetitive loss, loss of life, and loss of property.
5. Identify areas with recurring flood problems and request additional IFLOW stream/rain gauges as appropriate to ensure that these areas are adequately covered and monitored.
6. Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements.
7. Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.

Goal: Identify structural projects that could mitigate the impact of flooding.

Responsible Department(s): Public Works

Strategies:

1. Consider seeking funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems caused by rivers, creeks, streams, and/or drainage/runoff.
2. Support Virginia Department of Transportation projects that call for improved ditching, replacement of inadequate and undersized culverts, enlargements of bridge openings and drainage piping needed to minimize flooding.

Goal: Update existing GIS data layers related to natural hazards.

Responsible Department(s): Public Works

Strategies:

1. Consider seeking funding and support programs that update FEMA's Flood Insurance Rate Maps (FIRM). Consider participation in FEMA's Cooperating Technical Partners (CTP) program that establishes partners with local jurisdictions to develop and maintain up-to-date flood maps.
2. Participate in FEMA's Digital Flood Insurance Rate Maps (DFIRM) program.
3. Support FIRM re-mapping projects that address areas that have the most serious mapping problems and where flooding is a repetitive problem.

4. Develop and utilize GIS to inventory at risk infrastructure and public and private structures to increase accuracy and improve hazard mitigation planning.

Goal: Maintain an accurate database and map of repetitive loss properties

Responsible Department(s):

Strategies:

1. Work with VDEM and FEMA to update list of repetitive loss properties annually.
2. Obtain updated list of repetitive loss properties annually from VDEM/FEMA.
3. Review property addresses for accuracy and make necessary corrections.
4. Determine if and by what means each property has been mitigated.
5. Map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).
6. Determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

All Hazards

Goal: Improve general preparedness of the local government for all hazards.

Responsible Department(s): Emergency Services

Strategies:

1. Improve interoperability with surrounding jurisdictions by improving existing radio equipment and acquiring additional/alternate methods by which to communicate.
2. Work with local officials and emergency volunteers to evaluate the necessity of placing generators at emergency facilities.
3. Work to evaluate local development codes that would improve disaster mitigation.

Wildfire

Goal: Mitigation of the impacts of wildfire to life and property.

Responsible Department(s): Emergency Services

Strategies:

1. Encourage residents and developers to use Fire-Wise building design, siting, and materials for construction.
2. Encourage VDOF to continue it program of Community Wildfire Assessments.
3. Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas.

Table 73
Alleghany County Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Develop and maintain an inventory of flood prone roadways	Flooding	Inventory of flood prone roadways for planning purposes (road improvements, limitation of development)	$25,000	Medium	Medium	FEMA, VDEM, RVARC, VDOT, Local government	RVARC	In progress	Ongoing updates
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	Unknown	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Not started; lack of funding	2013-2018
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	N/A	High	High	FEMA	Local government	In progress	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	Unknown	High	High	FEMA, VDEM	Local government, RVARC, VDEM	Ongoing	Ongoing
Identify areas with recurring flood problems and request additional IFLOW stream/rain gauges	Flooding	Improved early warning of flooding; ensure that these areas are adequately covered and monitored	$12,500	High	Medium	FEMA, VDEM	RVARC	In progress	2013
Seek funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems	Flooding	Possible determination of solutions to repetitive loss properties.	$5,000	High	Medium	Local governments	Local governments	Not started; lack of funding	Unknown

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Continue participation in FEMA DFIRM program	Flooding	Increased accuracy of flood hazard areas through sharing of local knowledge.	$10,000	Medium	Medium	FEMA, local governments	Local governments	In progress	Ongoing
Support FIRM re-mapping projects	Flooding	Increased accuracy of flood hazard areas through sharing of local knowledge.	Unknown	unknown	Medium	FEMA, local governments	Local government	In progress	Ongoing
Encourage residents and developers to use Fire-Wise building design, siting, and materials for construction	Wildfire	Reduction in damages from wildfire	$5,000	High	Medium	VA Dept. of Forestry, Local governments	Local government	Not started; lack of funding	Unknown
Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas	Wildfire	Available inventory of structures that need additional or unique protection from wildfires.	$10,000	Medium	Medium	VA Dept. of Forestry, US Forest Service, Local governments	Local government, VDOF, USFS	Not started; lack of funding	Unknown
Flood hazard mapping update/ modernization	Flooding	Increased accuracy of flood maps and more effective regulation and enforcement of regulations	$50,000	N/A	High	FEMA, VDEM	Local government	Complete	Completed in 2010
Support Virginia Department of Transportation projects that minimize flooding	Flooding	Clear debris and repair banks to prevent backup, erosion and flooding of existing drainage systems	$500,000	N/A	Medium	FEMA, VDEM, VDOT	Local government or VDOT	Not started; lack of funding	Unknown

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Evaluate critical facilities and public utilities for flood-proofing	Flooding	Evaluation of critical facilities and public utilities for retrofitting or flood-proofing to prevent failure during disasters	$250,000	N/A	Medium	FEMA, Local government	Local government	In progress; need funds for flood-proofing	Ongoing
Communication equipment interoperability	All hazards	Improved coordination among jurisdictions; improved response times	$1,000,000	N/A	High	FEMA, Local government	Local government	In progress	Current / Ongoing
Creation of hazard related GIS layers/data	All hazards	Increased accuracy of hazard mitigation planning	$100,000	N/A	Medium	USGS, NOAA, FEMA, VDEM, VDOT, VDOF	Local government or Emergency Services Council	Complete	2012
Public education	All hazards	Inform public about hazards and mitigation options	$25,000	N/A	High	FEMA, VDEM, Local government	Local government	In progress	Current - Ongoing
Determine the need for generators at public emergency facilities	All hazards	Ensure that emergency facilities can be operational during hazard events	$250,000	N/A	Medium	FEMA, Local government	Local government	In progress	2013
Local codes review	All hazards	Review of development codes to evaluate need for changes that would improve disaster mitigation	$10,000	N/A	Medium	FEMA, Local government	Local government	Not started; lack of funding	Unknown
Community wildfire assessments	Wildfire	Reduction of loss to wildfire	$25,000	N/A	Medium	VDOF	Local government	Not started; lack of funding	Unknown

TOWN OF CLIFTON FORGE

Current and Past Mitigation Measures

Floodplain Management – Clifton Forge has adopted a Floodplain Management Ordinance (1992) which requires new residential buildings to be elevated to or above the base flood elevation. Additional requirements prevent the obstruction of the floodway. The Town has a Floodplain Overlay in its Zoning Ordinance. Clifton Forge is working with FEMA to appeal the 2010 FIRM changes that deal primarily with the downtown and Smith Creek corridor.

National Flood Insurance Program – The Town participates in, and is in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements. This program allows property owners to purchase flood insurance from NFIP. There are currently 15 NFIP policies in force in the Town.

Dam Safety – There are three dams in Alleghany County that could impact the Town of Clifton Forge. These are the Clifton Forge Dams along Smith Creek (owned and maintained by the Town of Clifton Forge), Gathwright Dam (owned and maintained by US Army Corps of Engineers), and Mead Westvaco #2 Flyash Lagoon Dam (owned and maintained by Mead Westvaco). Gathright Dam was completed in 1979 and is operated for flood control. The facility is managed by the Army Corps of Engineers. The dam controls the runoff from a 345 square mile drainage area and reduces the effects of flooding along the Jackson and James Rivers. The Corps of Engineers estimates that the project has prevented more than $70 million in flood damages. In May 2009, the U.S. Army Corps of Engineers (USACE) inspected the Gathright Dam as part of Screening Portfolio Risk Analysis and routine inspections. Later in the year on September 2, the USACE assigned the dam a Safety Action Classification (DSAC) II which is defined as "Urgent (Unsafe or Potentially Unsafe)". The rating is attributed to concerns about possible increased seepage at the toe of the dam, and an undetermined flow rate at the river spring a quarter mile downstream, and potential flow channels through limestone below the spillway during pool events above 1600 feet. Because of this rating, the USACE has implemented risk reduction measures which include increased monitoring, updating emergency operation plans and reducing the water level in the reservoir. As of early 2010, the USACE has reduced and continues to maintain the reservoir at an elevation of 1,562 ft above sea level compared to the normal level of 1,582 ft.. Throughout 2010, the USACE conducted safety exercises with local/state officials, conduct a series of investigations on the dam, update inundation

mapping and reevaluate the DSAC status. In November 2010, Lake Moomaw was restored to a level of 1,582 ft and the DSAC will be reevaluated in the future.

Clifton Forge has three (3) dams located on Smith Creek. Smith Creek Reservoir serves as the water supply for the Town of Clifton Forge and indirectly supplies water to portions of Alleghany County and the Town of Iron Gate. The Town of Clifton Forge is responsible for the maintenance of the dams. The Smith Creek Reservoir dam is being inspected and reviewed in 2013 in preparation for the renewal of the structures permit in 2014. It is anticipated that notification procedures and emergency plans for the dam will have to be expanded for the renewal.

All of the dams are subject to the National Dam Safety Program Act of 1996 and the resulting 1998 Federal Guidelines for Dam Safety. FEMA requires all dam owners to develop an Emergency Action Plan for warning, evacuation and post-flood actions. The dams are also subject to the Virginia Dam Safety Act that is administered by the by the Department of Conservation and Recreation and Dam Safety Regulations enacted by the Virginia Soil and Water Conservation Board. All dams are in good standing with State and Federal regulatory agencies at this time.

IFLOWS – The Town participates in a flood warning system developed by the National Weather Service called Integrated Flood Observing and Warning System (IFLOWS). Through the use of radio-transmitted information, this system provides advanced flood forecasting to the Town Emergency Operation Center. There are no IFLOW stations located in the Town.

Erosion and Sediment Control – The Town of Clifton Forge has an Erosion and Sediment Control inspector on staff and has adopted the regulations, references, guidelines, standards and specifications promulgated by the State Water Control Board for the effective control of soil erosion and sediment deposition to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources. Such regulations, references, guidelines, standards and specifications for erosion and sediment control are included in but not limited to the Virginia Erosion and Sediment Control Regulations and the Virginia Erosion and Sediment Control Handbook, as amended.

Clifton Forge Mitigation Goals and Strategies

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified pre-disaster, applicable local government departments will be the lead in making sure that each project or action will be implemented in a timely manner with other departments, other local government representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since the mitigation projects are an investment of public funds to reduce damages, localities have selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

Flooding

Goal: Maintain an accurate database and map of repetitive loss properties

Responsible Department(s):

Strategies:

1. Work with VDEM and FEMA to update list of repetitive loss properties annually.
2. Obtain updated list of repetitive loss properties annually from VDEM/FEMA.
3. Review property addresses for accuracy and make necessary corrections.
4. Determine if and by what means each property has been mitigated.
5. Map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).
6. Determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

Goal: Mitigation of loss of life and property from flooding and flood related disasters.

Responsible Department(s): Emergency Services, Public Works

Strategies:

1. In cooperation with Federal and State governments, support a comprehensive public information and education program on all hazards addressed in the Regional Hazard Mitigation Plan. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.
2. Develop and maintain an inventory of flood prone roadways in cooperation with local residents and the Virginia Department of Transportation.
3. Develop and maintain an inventory of flood prone critical facilities and public utilities and evaluate measures for flood proofing.
4. Identify households in flood hazard areas and work to remove them to reduce repetitive loss, loss of life, and loss of property.
5. Identify areas with recurring flood problems and request additional IFLOW stream/rain gauges as appropriate to ensure that these areas are adequately covered and monitored.
6. Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements.

7. Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.
8. Work with the Department of Conservation and Recreation Dam Safety Program to improve emergency notification methods and inundation plans for Smith Creek dam structures.

Goal: Identify structural projects that could mitigate the impact of flooding.

Responsible Department(s): Public Works

Strategies:

1. Consider seeking funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems caused by rivers, creeks, streams, and/or drainage/runoff.
2. Support projects that call for improved ditching, replacement of inadequate and undersized culverts, enlargements of bridge openings and drainage piping needed to minimize flooding.

Goal: Update existing GIS data layers related to natural hazards.

Responsible Department(s): Public Works

Strategies:

1. Consider seeking funding and support programs that update FEMA's Flood Insurance Rate Maps (FIRM). Consider participation in FEMA's Cooperating Technical Partners (CTP) program that establishes partners with local jurisdictions to develop and maintain up-to-date flood maps.
2. Participate in FEMA's Digital Flood Insurance Rate Maps (DFIRM) program.
3. Support FIRM re-mapping projects that address areas that have the most serious mapping problems and where flooding is a repetitive problem.
4. Develop and utilize GIS to inventory at risk infrastructure and public and private structures to increase accuracy and improve hazard mitigation planning.
5. Work with FEMA to make corrections to the 2010 FIRM in the downtown area and the Smith Creek corridor.

All Hazards

Goal: Improve general preparedness of the local government for all hazards.

Responsible Department(s): Emergency Services

Strategies:

1. Improve interoperability with surrounding jurisdictions by improving existing radio equipment and acquiring additional/alternate methods by which to communicate.
2. Work with local officials and emergency volunteers to evaluate the necessity of placing generators at emergency facilities.
3. Work to evaluate local development codes that would improve disaster mitigation.

Wildfire

Goal: Mitigation of the impacts of wildfire to life and property.

Responsible Department(s): Emergency Services

Strategies:

1. Encourage residents and developers to use Fire-Wise building design, siting, and materials for construction.
2. Encourage VDOF to continue it program of Community Wildfire Assessments.
3. Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas.

Table 74
Town of Clifton Forge Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost	Benefit-to-Cost	Priority	Funding Partners	Implementation/Lead Agency	Status	Proposed Schedule
Town Mapping by Degree of Urgency	Flooding	Identify Problem Areas	$25,000	High	Medium	Local Government	Local Government; Public works	Not started; lack of funding	12 months
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	Unknown	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Not started; lack of funding	2013-2018
Revise the 2010 FIRM for downtown and the Smith Creek Corridor	Flooding	Improved accuracy of FIRM	$30,000	Medium	High	FEMA	Local Government; Public Works	Underway	2013
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	0	High	High	FEMA	Local government; Community Development	Ongoing	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	Unknown	High	High	FEMA, VDEM	Local government, RVARC, VDEM	Ongoing	Ongoing
Identify areas with recurring flood problems and request additional IFLOW stream/rain gauges	Flooding	Improved early warning of flooding; ensure that these areas are adequately covered and monitored	$12,500	High	Medium	FEMA, VDEM	Local Government, Public Works, RVARC	In progress	2013

Project	Hazard Mitigated	Benefit	Cost	Benefit-to-Cost	Priority	Funding Partners	Implementation/Lead Agency	Status	Proposed Schedule
Seek funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems	Flooding	Possible determination of solutions to repetitive loss properties.	$5,000	High	Medium	Local governments	Local government; Community Development	Not started; lack of funding	Unknown
Continue participation in FEMA DFIRM program	Flooding	Increased accuracy of flood hazard areas through sharing of local knowledge.	$10,000	Medium	Medium	FEMA, local governments	Local governments	In progress	Ongoing
Support FIRM re-mapping projects	Flooding	Increased accuracy of flood hazard areas through sharing of local knowledge.	Unknown	unknown	High	FEMA, local governments	Local government	In progress	Ongoing
Encourage residents and developers to use Fire-Wise building design, siting, and materials for construction	Wildfire	Reduction in damages from wildfire	$5,000	High	Medium	VA Dept. of Forestry, Local governments	Local government, Building Official	Not started; lack of funding	Unknown
Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas	Wildfire	Available inventory of structures that need additional or unique protection from wildfires.	$10,000	Medium	Medium	VA Dept. of Forestry, US Forest Service, Local governments	Local government, VDOF, USFS	Not started; lack of funding	Unknown

Project	Hazard Mitigated	Benefit	Cost	Benefit-to-Cost	Priority	Funding Partners	Implementation/Lead Agency	Status	Proposed Schedule
Flood hazard mapping update/ modernization	Flooding	Increased accuracy of flood maps and more effective regulation and enforcement of regulations	$50,000	N/A	High	FEMA, VDEM	Local government, Public Works	Complete	Completed in 2010
Support local street projects that minimize flooding	Flooding	Clear debris and repair banks to prevent backup, erosion and flooding of existing drainage systems	$500,000	N/A	Medium	FEMA, VDEM	Local government, Public Works	Not started; lack of funding	Unknown
Evaluate critical facilities and public utilities for flood-proofing	Flooding	Evaluation of critical facilities and public utilities for retrofitting or flood-proofing to prevent failure during disasters	$250,000	N/A	Medium	FEMA, Local government	Local government, Public Works	In progress; need funds for flood-proofing	Ongoing
Communication equipment interoperability	All hazards	Improved coordination among jurisdictions; improved response times	$1,000,000	N/A	High	FEMA, Local government	Local government, Police Department	In progress	Current / Ongoing
Creation of hazard related GIS layers/data	All hazards	Increased accuracy of hazard mitigation planning	$100,000	N/A	Medium	USGS, NOAA, FEMA, VDEM, VDOT, VDOF	Local government or Emergency Services Council	Complete	2012
Public education	All hazards	Inform public about hazards and mitigation options	$25,000	N/A	High	FEMA, VDEM, Local government	Local government, Community Development	In progress	Current - Ongoing
Determine the need for generators at public emergency facilities	All hazards	Ensure that emergency facilities can be operational during hazard events	$250,000	N/A	Medium	FEMA, Local government	Local government, Public Works	In progress	2013
Local codes review	All hazards	Review of development codes to evaluate need for changes that would improve disaster mitigation	$10,000	N/A	Medium	FEMA, Local government	Local government, Community Development, Building Official	Not started; lack of funding	Unknown

Project	Hazard Mitigated	Benefit	Cost	Benefit-to-Cost	Priority	Funding Partners	Implementation/Lead Agency	Status	Proposed Schedule
Community wildfire assessments	Wildfire	Reduction of loss to wildfire	$25,000	N/A	Medium	VDOF	Local government, Community Development	Not started; lack of funding	Unknown
Local Flood Profile	Flood	Identify Hazards	$100,000	High	High	USDA	VA Soil and Water Conservation Board	Not started; lack of funding	2014-15
Stream Bed Survey	Flood	Identify Repairs Required	$25,000	Medium	Medium	RWA, Local Government	Local Government Public Works	Not started; lack of funding	Unknown
Identify Geologic Hazard Areas	Earthquake, Landslide and Karst	Identify Hazards	$75,000	Medium	Medium	Local Government	FEMA, Local Government, Community Development	Not started; lack of funding	12 months
Communications Plan	All Hazards	Improved Communication and Response	$5,000	Medium	High	Local Government	FEMA, Local Government, Police Department	In progress	Ongoing
Identify Dam and Reservoir Upgrade Needs	Flood	Identify Repairs Needed	$150,000	High	High	USDA, VA Dept of Health	FEMA, VA Soil and Water Conservation Board	Not started; lack of funding	1-3 years
Water Reservoir Hazard Plan	All Hazards	Protection of Town Water Supply	$125,000	High	High	VA Dept of Health, FEMA	Local Government, VA Department of Health	Not started; lack of funding	12 months

TOWN OF IRON GATE

Current and Past Mitigation Measures

Floodplain Management – Town of Iron Gate has chosen to adopt the Alleghany County Zoning Ordinance that includes a Floodplain District that requires new residential buildings to be elevated to or above the base flood elevation.

National Flood Insurance Program – The Town participates in, and is in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements. This program allows property owners to purchase flood insurance from NFIP. There are currently 5 NFIP policies in force in the Town.

Dam Safety – There are three dams in Alleghany County that could impact the Town of Iron Gate. These are the Clifton Forge Dam (owned and maintained by the Town of Clifton Forge), Gathright Dam (owned and maintained by US Army Corps of Engineers), and Mead Westvaco #2 Flyash Lagoon Dam (owned and maintained by Mead Westvaco).

Gathright Dam was completed in 1979 and is operated for flood control. The facility is managed by the Army Corps of Engineers. The dam controls the runoff from a 345 square mile drainage area and reduces the effects of flooding along the Jackson and James Rivers. The Corps of Engineers estimates that the project has prevented more than $70 million in flood damages. In May 2009, the U.S. Army Corps of Engineers (USACE) inspected the Gathright Dam as part of Screening Portfolio Risk Analysis and routine inspections. Later in the year on September 2, the USACE assigned the dam a Safety Action Classification (DSAC) II which is defined as "Urgent (Unsafe or Potentially Unsafe)". The rating is attributed to concerns about possible increased seepage at the toe of the dam, and an undetermined flow rate at the river spring a quarter mile downstream, and potential flow channels through limestone below the spillway during pool events above 1600 feet. Because of this rating, the USACE has implemented risk reduction measures which include increased monitoring, updating emergency operation plans and reducing the water level in the reservoir. As of early 2010, the USACE has reduced and continues to maintain the reservoir at an elevation of 1,562 ft above sea level compared to the normal level of 1,582 ft.. Throughout 2010, the USACE conducted safety exercises with local/state officials, conduct a series of

investigations on the dam, update inundation mapping and reevaluate the DSAC status. In November 2010, Lake Moomaw was restored to a level of 1,582 ft and the DSAC will be reevaluated in the future.

All of these dams are subject to the National Dam Safety Program Act of 1996 and the resulting 1998 Federal Guidelines for Dam Safety. FEMA requires all dam owners to develop an Emergency Action Plan for warning, evacuation and post-flood actions. The dams are also subject to the Virginia Dam Safety Act that is administered by the by the Department of Conservation and Recreation and Dam Safety Regulations enacted by the Virginia Soil and Water Conservation Board. All dams in the County are in good standing with State and Federal regulatory agencies at this time.

IFLOWS – The Town participates in a flood warning system developed by the National Weather Service called Integrated Flood Observing and Warning System (IFLOWS). Through the use of radio-transmitted information, this system provides advanced flood forecasting to the Town Emergency Operation Center. There are no IFLOW stations located in the Town.

Erosion and Sediment Control – The Town utilizes the E&S Control services of Alleghany County. Alleghany County adopted the regulations, references, guidelines, standards and specifications promulgated by the State Water Control Board for the effective control of soil erosion and sediment deposition to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources. Such regulations, references, guidelines, standards and specifications for erosion and sediment control are included in but not limited to the Virginia Erosion and Sediment Control Regulations and the Virginia Erosion and Sediment Control Handbook, as amended from time to time.

Iron Gate Mitigation Goals and Strategies

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified pre-disaster, applicable local government departments will be the lead in making sure that each project or action will be implemented in a timely manner with other departments, other local government representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since the mitigation projects are an investment of public funds to reduce damages, localities have selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

Flood

Goal: Mitigation of loss of life and property from flooding and flood related disasters.

Responsible Department(s): Administration

Strategies:

1. Develop and maintain an inventory of flood prone roadways in cooperation with local residents and the Virginia Department of Transportation.
2. Develop and maintain an inventory of flood prone critical facilities and public utilities and evaluate measures for flood proofing.
3. Identify repetitive loss properties for acquisition and/or elevation projects.
4. Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements.
5. Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.

Goal: Identification of structural projects to mitigate flooding

Responsible Department(s): Administration, Public Works

Strategies:

1. Consider seeking funding to prepare site-specific hydrologic and hydraulic studies that address areas that have chronic and repetitive flooding problems caused by streams, inadequate road drainage, failing stormwater drains, and natural runoff.
2. Encourage Virginia Department of Transportation projects that call for improved ditching, replacement of inadequate and undersized culverts, and drainage piping needed to minimize flooding.

Goal: Maintain an accurate database and map of repetitive loss properties

Responsible Department(s):

Strategies:

1. Work with VDEM and FEMA to update list of repetitive loss properties annually.
2. Obtain updated list of repetitive loss properties annually from VDEM/FEMA.
3. Review property addresses for accuracy and make necessary corrections.
4. Determine if and by what means each property has been mitigated.

5. Map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).
6. Determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

All Hazards

Goal: Improve general preparedness of the local government and emergency service providers for all hazards.

Responsible Department(s): Administration, Police Department

Strategies:

1. Expand the existing Volunteer Fire Department facility to create a disaster shelter for use by local residents.
2. Improve interoperability with surrounding jurisdictions by improving existing radio equipment and acquiring additional/alternate methods by which to communicate.
3. Work with local officials and emergency volunteers to evaluate the necessity of placing generators at emergency facilities. Purchase and install generators.
4. Work to evaluate local development codes (subdivision, zoning, etc.) that would improve disaster mitigation.

Table 75
Town of Iron Gate Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Communication equipment interoperability	All hazards	Improved coordination among jurisdictions; improved response times	$250,000	High	High	FEMA, Local government	Local government, Sheriff Dept., Police Dept.	In progress	2014
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	$500,000	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Not started; lack of funding	2013-2018
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	$2,000	High	High	FEMA	Local government,	Ongoing	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	$2,500	High	High	FEMA, VDEM	Local government, RVARC, VDEM	Ongoing	Ongoing
Develop and maintain an inventory of flood prone roadways	Flooding	Inventory of flood prone roadways for planning purposes (road improvements, limitation of development)	$25,000	Medium	Medium	FEMA, VDEM, RVARC, VDOT, Local government	RVARC	In progress	Ongoing updates
Evaluate critical facilities and public utilities for flood-proofing	Flooding	Evaluation of critical facilities and public utilities for retrofitting or flood-proofing to prevent failure during disasters	$25,000	N/A	Medium	FEMA, Local government	Local government	In progress	2014

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Seek funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems	Flooding	Possible determination of solutions to repetitive loss properties.	$50,000	High	Medium	Local governments	Local governments	Not started; lack of funding	
Communication equipment interoperability	All hazards	Improved coordination among jurisdictions; improved response times	$1,000,000	N/A	High	FEMA, Local government	Local government	In progress	Current / Ongoing
Identify repetitive loss properties for acquisition/elevation projects	Flooding	Removal of structures from flood hazard areas; reduce repetitive loss; reduce loss of life and property	unknown	NA	High	FEMA, VDEM, Local government	Local government, Police Dept.	In progress	Ongoing
Public education	All hazards	Inform public about hazards and mitigation options	$4,000	Medium	Medium	FEMA, VDEM, Local government	Local government; RVARC	In progress	ongoing
Identify needed upgrade/repairs to stormwater system	Flooding	Reduce frequency and impact of flooding	$100,000	High	High	FEMA, VDEM, VDOT	Local government, Pubic Works Dept, VDOT	In progress	Ongoing
VDOT Drainage system maintenance	Flooding	Clear debris and repair banks to prevent backup, erosion and flooding of existing drainage	Unknown	Unknown	High	FEMA, VDEM, VDOT	Local government, Pubic Works Dept, VDOT	In progress	Annual review of projects with VDOT
Evaluate public utilities for floodproofing	Flooding	Evaluation of public utilities for retrofitting or floodproofing to prevent failure during disasters	$10,000	High	High	FEMA, Local government	Local government, Public Works Dept	Not started; lack of funding	Annually
Expand Volunteer Fire Dept. Building for use as Public Shelter	All Hazards	Provide shelter for the public to use during disasters (Town does not have a shelter)	$500,000	High	High	FEMA, USDA, Local government	Local government, Iron Gate VFD	Not started; lack of funding	Unknown

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Flood hazard mapping update/ modernization	Flooding	Increased accuracy of flood maps and more effective regulation and enforcement of regulation	$50,000	High	High	FEMA	Local government, FEMA	Complete	Completed in 2010
Determine the need for generators at public facilities; purchase generators	All hazards	Ensure that emergency services, Town Hall/Police Dept. and water and sewer service (pumps) can be operational during hazard events	$75,000	Medium	Medium	FEMA, Local government	Local government	In progress; need funds for generators	2014
Local codes review	All hazards	Review of development codes to evaluate need for changes that would improve disaster mitigation	$5,000	High	Medium	FEMA, Local government	Local government	Not started; lack of funding	2014

CITY OF COVINGTON

Current and Past Mitigation Measures

Floodplain Management – City of Covington has adopted a Floodplain Management Ordinance that requires new residential buildings to be elevated to or above the base flood elevation. Additional requirements prevent the obstruction of the floodway.

National Flood Insurance Program – The City participates in, and is in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements. This program allows property owners to purchase flood insurance from NFIP. There are currently 113 NFIP policies in force in the City.

Dam Safety – There are three dams in Alleghany County that could impact the City of Covington. These are the Gathwright Dam (owned and maintained by US Army Corps of Engineers), Pond Lick Branch Dam (privately owned) and Mead Westvaco #2 Flyash Lagoon Dam (owned and maintained by Mead Westvaco).

Gathright Dam was completed in 1979 and is operated for flood control. The facility is managed by the Army Corps of Engineers. The dam controls the runoff from a 345 square mile drainage area and reduces the effects of flooding along the Jackson and James Rivers. The Corps of Engineers estimates that the project has prevented more than $70 million in flood damages. In May 2009, the U.S. Army Corps of Engineers (USACE) inspected the Gathright Dam as part of Screening Portfolio Risk Analysis and routine inspections. Later in the year on September 2, the USACE assigned the dam a Safety Action Classification (DSAC) II which is defined as "Urgent (Unsafe or Potentially Unsafe)". The rating is attributed to concerns about possible increased seepage at the toe of the dam, and an undetermined flow rate at the river spring a quarter mile downstream, and potential flow channels through limestone below the spillway during pool events above 1600 feet. Because of this rating, the USACE has implemented risk reduction measures which include increased monitoring, updating emergency operation plans and reducing the water level in the reservoir. As of early 2010, the USACE has reduced and continues to maintain the reservoir at an elevation of 1,562 ft above sea level compared to the normal level of 1,582 feet. Throughout 2010, the USACE conducted safety exercises with local/state officials, conduct a series

of investigations on the dam, update inundation mapping and reevaluate the DSAC status. In November 2010, Lake Moomaw was restored to a level of 1,582 ft. and the DSAC will be reevaluated in the future.

All of these dams are subject to the National Dam Safety Program Act of 1996 and the resulting 1998 Federal Guidelines for Dam Safety. FEMA requires all dam owners to develop an Emergency Action Plan for warning, evacuation and post-flood actions. The dams are also subject to the Virginia Dam Safety Act that is administered by the by the Department of Conservation and Recreation and Dam Safety Regulations enacted by the Virginia Soil and Water Conservation Board. All dams in the County are in good standing with State and Federal regulatory agencies at this time.

IFLOWS – The City participates in a flood warning system developed by the National Weather Service called Integrated Flood Observing and Warning System (IFLOWS). Through the use of radio-transmitted information, this system provides advanced flood forecasting to the City Emergency Operation Center. There is one IFLOW station located in the City.

Erosion and Sediment Control – The City has adopted the regulations, references, guidelines, standards and specifications promulgated by the State Water Control Board for the effective control of soil erosion and sediment deposition to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources. Such regulations, references, guidelines, standards and specifications for erosion and sediment control are included in but not limited to the Virginia Erosion and Sediment Control Regulations and the Virginia Erosion and Sediment Control Handbook, as amended from time to time.

City of Covington Mitigation Goals and Strategies

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified pre-disaster, applicable local government departments will be the lead in making sure that each project or action will be implemented in a timely manner with other departments, other local government representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since the mitigation projects are an investment of public funds to reduce damages, localities have selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

Flood

Goal: Mitigation of Property Damage from Flooding.

Responsible Department(s): Public Works

Strategies:

1. Acquisitions of Residential and Commercial properties in the Flood Plain. Acquisition of properties in the flood plain and their removal would eliminate the danger of damage to these residences, the danger to the residents and first responders during their evacuation or rescue. As some of these residences have had previous damage on several occasions, the repetitive loss would be eliminated.
2. Evaluation of Public Utilities and Building. The evaluation of public facilities for the delivery of services to the citizens would enable the planning of actions to allow these facilities to be better utilized during emergency situations and also prevent damage to them.
3. Elevation of Structures at the City Playground & Pool. The elevation of the bathhouse and pool at the City Park would allow these structures to withstand flooding without damage.
4. Drainage Improvements - Parrish Court, Marshall Street, Rayon View Area, and West Jackson Street Area. The improvement of the drainage systems in these areas would lessen the damage in these areas due to drainage off adjoining areas and drain backups.
5. Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements.
6. Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.

Goal: The Development of Information Systems for Better Planning, Regulation, and Response.

Responsible Department(s): Emergency Services

Strategies:

1. Flood Hazard Mapping Update & Modernization. Conversion of the flood insurance maps to digital form and the updating of these maps to reflect needed changes (complete 2010).
2. Hazard Related "GIS" Layers. The development of layers for the City of Covington GIS System which indicate areas of flooding, road closures, man-made hazards, hazardous material sites, landslide sites, transportation hazards, shelter sites, and any other information related to emergency operations and planning.

3. Additional Flood Hazard Data. The addition of additional data on previous flooding, elevation data, and flood insurance requirements would allow the plotting of residence which require elevation certificates and recording of these residences.

Goal: The addition of local IFLOWS monitoring stations and additional stream gauges.
Responsible Department(s): Emergency Services
Strategies:

1. The addition of local IFLOWS monitoring and the addition of any needed stream gauges. Project would allow the emergency responders of the City of Covington, Virginia to have more timely access to the water levels in the streams which affect the City. This would allow them to take action sooner with better information than they can at present.

Goal: Maintain an accurate database and map of repetitive loss properties
Responsible Department(s):
Strategies:

1. Work with VDEM and FEMA to update list of repetitive loss properties annually.
2. Obtain updated list of repetitive loss properties annually from VDEM/FEMA.
3. Review property addresses for accuracy and make necessary corrections.
4. Determine if and by what means each property has been mitigated.
5. Map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).
6. Determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

All Hazards

Goal: Mitigation of the impacts of natural hazards.
Responsible Department(s): Emergency Services
Strategies:

1. Public Education. The public education function of emergency management is an on-going activity. It comes into play anytime an emergency is foreseen or actually occurs. An intensive

program is needed to inform all citizens of the hazards in the area, the actions being taken to protect them, and the things that they can do to protect themselves.

Goal: The Improvement of Response Capabilities for All Hazards.

Responsible Department(s): Emergency Services

Strategies:

1. Reverse 9-1-1. Fast notification of citizens of emergencies and instructions to follow to protect themselves.
2. Communications Interoperability. The City of Covington, Virginia has the capability to talk to City agencies on our 450 MHz System. An interface is in place to allow County agencies on their 800 MHz System to talk to City agencies on Our 450 MHz System. The modernization of the Alleghany County fire, rescue, public works, and law enforcement communications system would allow the interoperability of communications between the City of Covington, Alleghany County, and the towns of Clifton Forge and Iron Gate. The 450 MHz System of the City of Covington will be completed by the acquisition of 450 MHz pagers for the Covington Fire Department and Covington Rescue Squad and the establishment of a new transmitter site specifically constructed for this system for better antenna separation and better radio coverage.
3. Add / Replace Generators at emergency facilities. The addition of generators to the designated shelters in the City of Covington (old Armory, Edgemont School, Jeter-Watson School, and Covington High School), the public works facility on South Maple Avenue, and the old Rivermont School would allow these facilities to be utilized at any time and under almost any conditions to house and feed residents of the City and adjoining Alleghany County. The replacement of the generators at Covington Fire & Rescue - Station One and Covington Fire & Rescue - Station Two would allow the evaluation of these facilities to determine the proper size generator for the facility and after it's installation, the facility would be much more valuable to the emergency personnel manning them and the citizen of the City of Covington, Virginia during emergencies. The generator at the City Hall should be upgraded to provide service to the entire building.
4. Upgrade the Weather Terminal at the Covington EOC. This upgrade will provide better weather warnings and have alarms which warn City personnel when storms approach the City at a pre-determined distance. The alarms could be set at a specific distance or specific storm intensity.

Goal: Local Codes and Regulations that assist in the mitigation of impacts from natural disasters.

Responsible Department(s): Administration, Planning

Strategy:

1. Local Code and Regulation Review. The review of the local codes, ordinances, regulations, policies, and procedures is an activity which needs to be done on a regular basis in order to keep these essential texts up-to-date, in proper legal form, and in line with the needs of the community. These instruments can prevent the use of property in inappropriate manners, inappropriate location of buildings, and regulate many other hazards and dangerous situations.

Table 76
City of Covington Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Flood Hazard mapping update / modernization	Flooding	Increased accuracy of flood maps and more effective regulation and enforcement of regulations	$40,000	High	High	VDEM / FEMA / LOCAL GOVT	FEMA / Locality	Complete	Completed in 2010
Reverse 911 System	All Hazards	Reduce losses and danger to the public through improved warning	$75,000	High	High	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	
Communications Equipment Interoperability	All Hazards	Improved coordination between City, County, and State responders	$325,000	High	High	VDEM / FEMA / LOCAL GOVT	Local Government	In progress with Alleghany County	2012
Hazard Related GIS layers	All Hazards	Increased accuracy of responses and mitigation planning	$15,000	High	High	VDEM / FEMA / LOCAL GOVT	Local Government	Complete	Completed in 2011
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	Unknown	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Not started; lack of funding	2013-2018
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	$5,000	High	High	FEMA	Local government	Ongoing	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	$5,000	High	High	FEMA, VDEM	Local government, RVARC, VDEM	Ongoing	Ongoing

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Additional Hazard Field Data	Flooding	Elevation Certificates for residential, business, and critical facilities. Increased accuracy of hazard mitigation planning	$25,000	High	Medium	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	
Structure Acquisition – residential and commercial	Flooding	Removal of structures from flood hazard areas; reduce repetitive losses; reduce the loss of life and property	$3,800,000	Medium	Medium	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	
Public Education	All Hazards	Inform the public about hazards, mitigation options, flood insurance, NFIP, and protective actions	$12,500	High	High	VDEM / FEMA / LOCAL GOVT	Local Government	In progress	2012 - Ongoing
Evaluate Public Utilities for Flood proofing	Flooding	Evaluation of public utilities for retrofitting or flood proofing to prevent failures and lessen damages during disasters	$25,000	High	High	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	
Local code and regulation review	All Hazards	Reduction in flood insurance rates; reduction in flood losses	$2,500	Medium	Medium	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	
Add / Replace Generators at emergency facilities, public utilities and City Hall	All Hazards	Evaluate the facilities and install appropriate generating equipment and controls to allow them to be better utilized during disasters and severe events	$220,000	High	High	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	
Add local IFLOWS monitoring and additional stream gauges	Flooding / Heavy Rains	Provide better, more timely information to allow faster, more accurate warnings to be issued to the public	$18,500	High	Medium	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Elevation of Structures - City Pool and Playground	Flooding	Reduced damages and repair costs	$100,000	Medium	Medium	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	
Drainage Improvements - W Jackson Street Area	Flooding	Reduced damages and repair costs	$600,000	High	High	VDEM / FEMA / LOCAL GOVT	Local Government	Engineering/ design underway	2013
Drainage Improvements - Parrish Court, Marshall Street, and Rayon View Area	Flooding	Reduced damages and repair costs	$500,000	High	High	VDEM / FEMA / LOCAL GOVT	Local Government	Engineering/ design underway	2013
The upgrading of the present weather terminal at the Covington EOC	Flooding And Other Severe Weather Occurrences	Better and more timely weather information will allow first responders to make better decision about actions to take, evacuations, and the possibility of flooding and other severe weather	$10,000	Medium	High	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	

BOTETOURT COUNTY AND THE TOWNS OF BUCHANAN, FINCASTLE AND TROUTVILLE

Current and Past Mitigation Measures

Floodplain Management – Botetourt County has adopted a Flood Hazard Overlay District as part of its Zoning Ordinance (2002). The boundaries of the floodplain district are established as shown on the flood boundary and floodway and/or Flood Insurance Rate Maps. The towns of Buchanan, Fincastle, and Troutville have each adopted a Floodplain Management Ordinance that requires new residential buildings to be elevated to or above the base flood elevation. Additional requirements prevent the obstruction of the floodway.

Erosion and Sediment Control Ordinance – Botetourt County adopted its most current Erosion and Sediment Control ordinance in 1996. The County utilizes the regulations, references, guidelines, standards and specifications promulgated by the Virginia Soil and Water Conservation Board (and any local handbook or publication of the board) for the effective control of soil erosion and sediment deposition to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources. Such regulations, references, guidelines, standards and specifications for erosion and sediment control are included in, but not limited to, the Virginia Erosion and Sediment Control Regulations and the Virginia Erosion and Sediment Control Handbook, as amended from time to time. The towns of Buchanan, Fincastle and Troutville utilize Botetourt County's E&S staff for erosion and sediment control monitoring.

National Flood Insurance Program – The County participates in, and is in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements. The towns of Buchanan, Fincastle and Troutville all participate in the NFIP and are in good standing. This program allows property owners to purchase flood insurance from NFIP. There are currently 158 NFIP policies in force in the County (including the towns of Buchanan, Fincastle and Troutville).

Dam Safety – Botetourt County adopted a Drainage and Flood Control Ordinance in 1987. Division 2 Dam Safety, in Sec. 8.5-31 addresses issues concerning impoundment construction, inspection and maintenance stating "No one shall have a right to build or maintain an impoundment structure which

unreasonably threatens the life or property of another. The [county] administrator shall cause safety inspections to be made of impounding structures on such schedule, as he deems appropriate. The time of the initial inspection and the frequency of reinspection shall be established depending on such factors as the condition of the structure and its size, type, location and downstream hazard potential. The owners of impounding structures found to have deficiencies which could threaten life or property if uncorrected, shall take the corrective actions needed to remove such deficiencies within the time limits established by this article, or if no time limit is established, within a reasonable time."

There are five dams of significance in Botetourt County. These are the Blue Ridge Estates Dam on Laymantown Creek, Carvin Cove Dam on Carvin Creek, Orchard Lake Dam on Glade Creek, Rainbow Forest Dam on Laymantown Creek and Greenfield dam on an unnamed creek. Gathright Dam, located on the Jackson River in Alleghany County, was completed in 1979 and is operated for flood control of the Jackson and James Rivers. The facility is managed by the Army Corps of Engineers. The dam controls the runoff from a 345 square mile drainage area and reduces the effects of flooding along the Jackson and James Rivers. The Corps of Engineers estimates that the project has prevented more than $70 million in flood damages. The James River passes through the northern part of Botetourt County and impacts the communities of Eagle Rock and Glen Wilton and the Town of Buchanan. All of these dams are subject to the National Dam Safety Program Act of 1996 and the resulting 1998 Federal Guidelines for Dam Safety. FEMA requires all dam owners to develop an Emergency Action Plan for warning, evacuation and post-flood actions. The dams are also subject to the Virginia Dam Safety Act that is administered by the by the Department of Conservation and Recreation and Dam Safety Regulations enacted by the Virginia Soil and Water Conservation Board. All operational dams in the County are in good standing with State and Federal regulatory agencies at this time. Rainbow Forest Dam is currently drained pending state-mandated repair. The Rainbow Forest Recreation Association (owner) estimates that it would take $200,000 to make the necessary improvements.

IFLOWS – The County participates in a flood warning system developed by the National Weather Service called Integrated Flood Observing and Warning System (IFLOWS). Through the use of radio-transmitted information, this system provides advanced flood forecasting to the County Emergency Operation Center. There are twelve (12) IFLOW stations located in Botetourt County (including the towns of Buchanan, Fincastle and Troutville.

Botetourt County and the Towns of
Buchanan, Fincastle and Troutville Mitigation Goals and Strategies

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified pre-disaster, applicable local government departments will be the lead in making sure that each project or action will be implemented in a timely manner with other departments, other local government representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since the mitigation projects are an investment of public funds to reduce damages, localities have selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

It is important to note that the majority of Goals and Strategies listed for Botetourt County would also benefit its three incorporated towns by extension of overall services / mitigation activities.

Flood

Goal: Mitigation of loss of life and property from flooding and flood related disasters.

Responsible Department(s): Emergency Services

Strategies:

1. Develop and maintain an inventory of flood prone roadways in cooperation with local governments and the Virginia Department of Transportation.
2. Develop and maintain an inventory of flood prone critical regional facilities such as public utility sites, shelters, etc.
3. In cooperation with local governments, support a comprehensive public information and education program on flooding, living in the floodplain, flood risks, low cost simple flood mitigation measures, flood insurance, stream remediation, hydrology, floodplain ordinances, and NFIP. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.
4. Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements.
5. Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.

Goal: Update existing GIS data layers related to natural hazards.

Responsible Department(s): GIS Department

Strategies:

1. Seek funding and support programs that update FEMA's Flood Insurance Rate Maps (completed in 2010).
2. Participate in FEMA's Cooperating Technical Partners (CTP) program that establishes partners with local jurisdictions to develop and maintain up-to-date flood maps.
3. In cooperation with local governments, utilize GIS to inventory at risk infrastructure and public and private structures within flood prone areas.
4. Participate in FEMA's Digital Flood Insurance Rate Maps (DFIRM) program.
5. Support FIRM remapping projects that address areas in the region that have the most serious mapping problems and where flooding is a repetitive problem.

Goal: Provide early warning of flooding.

Responsible Department(s): Emergency Services

Strategies:

1. Identify areas with recurring flood problems and request additional IFLOW stream/rain gauges as appropriate to ensure that these areas are adequately covered and monitored.
2. Expand existing 911 capacities to include social media communication for warnings and disasters.
3. Review Emergency Operation Plan annexes for effectiveness of early flood warnings.

Goal: Identification of structural projects that could mitigate the impact of flooding.

Responsible Department(s): Engineering

Strategies:

1. Seek funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems.
2. Support Virginia Department of Transportation projects that call for improved ditching, replacement of inadequate and undersized culverts, enlargements of bridge openings and drainage piping needed to minimize flooding.
3. Identify congested streams and remove debris to enhance flow and mitigate flooding.

Goal: Maintain an accurate database and map of repetitive loss properties

Responsible Department(s): GIS and Emergency Services

Strategies:

1. Work with VDEM and FEMA to update list of repetitive loss properties annually.
2. Obtain updated list of repetitive loss properties annually from VDEM/FEMA.
3. Review property addresses for accuracy and make necessary corrections.
4. Determine if and by what means each property has been mitigated.
5. Map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).
6. Determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

Hurricane

Mitigation measures for hurricanes are region-wide recommendations for all localities adopting the Regional Pre-Disaster Hazard Mitigation Plan.

Goal: Mitigate the impact of hurricanes.
Responsible Department(s): Emergency Services / Administration
Strategy:

1. Participate in the *"StormReady"* program.

Tornado / Severe Thunderstorm

Mitigation measures for tornados are region-wide recommendations for all localities adopting the Regional Pre-Disaster Hazard Mitigation Plan.

Goal: Mitigate the impact of tornados.
Responsible Department(s): Emergency Services / Administration
Strategies:

1. Conduct a series of public workshops about how to protect yourself during a tornado in case you are at home, in a car, at the office, or outside.
2. Coordinate with local schools to ensure existence, effectiveness, and practice of Tornado drills.
3. Continue improvements to automated citizen alert system to include social media or other means.

Wildfire

Mitigation measures for wildfires are region-wide recommendations for all localities adopting the Regional Pre-Disaster Hazard Mitigation Plan.

Goal: Mitigation of the impacts of wildfire to life and property.
Responsible Department(s): Emergency Services / Administration
Strategies:

1. Encourage residents and developers to use FireWise building design, siting, and materials for construction.
2. Conduct Community Wildfire Assessments in cooperation with VDoF staff using the Wildland Urban Interface Fire Protection Program's *Woodland Community Wildfire Hazard Assessment* form.
3. Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas.

Winter Storms

Mitigation measures for winter storms are region-wide recommendations for all localities adopting the Regional Pre-Disaster Hazard Mitigation Plan.

Goal: Mitigate the effects of extreme winter weather by implementing programs that provide early warning and preparation.
Responsible Department(s): Emergency Services / Administration
Strategy:

1. Research and consider participating in the National Weather Service *"Storm Ready"* program.
2. Participate in special statewide outreach/awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc.

Table 77
Botetourt County Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Flood hazard mapping update/ modernization	Flooding	Increased accuracy of flood maps and more effective regulation and enforcement of regulations	$250,000 (for accurate contour mapping)	Medium	High	FEMA, VDEM	RVARC or local government	Complete	Completed in 2009
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	Unknown	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Not started; lack of funding	2013-2018
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	$5,000	High	High	FEMA	Local government	Ongoing	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	Unknown	High	High	FEMA, VDEM	Local government, RVARC, VDEM	Ongoing	Ongoing
Develop and maintain an inventory of flood prone roadways	Flooding	Inventory of flood prone roadways for planning purposes (road improvements, limitation of development)	$25,000	Medium	Medium	FEMA, VDEM, RVARC, VDOT, Local government	RVARC	In progress	Ongoing updates
Support Virginia Department of Transportation projects that minimize flooding	Flooding	Clear debris and repair banks along roads to prevent backup, erosion and flooding of existing drainage systems	$500,000	N/A	Medium	FEMA, VDEM, VDOT	Local government or VDOT	Not started; lack of funding	
Identify congested streams and remove debris to enhance flow and mitigate flooding.	Flooding	Clear debris and repair banks on private property to prevent backup, erosion and flooding of existing drainage systems	unknown	N/A	Medium	FEMA, local government	Local government	Not started; lack of funding	

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Evaluate critical facilities and public utilities for flood-proofing	Flooding	Evaluation of critical facilities and public utilities for retrofitting or flood-proofing to prevent failure during disasters	$25,000	N/A	Medium	FEMA, Local government	Local government	In progress	2014
Seek funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems	Flooding	Possible determination of solutions to repetitive loss properties.	$5,000	High	Medium	Local governments	Local governments	Not started; lack of funding	
Participate in the "StormReady" program	All Hazards	Community is better prepared through planning and education	$1,000	High	Medium	FEMA, VDEM, NWS, Local governments	Local government	Accepted to program in 2011	Completed in 2011
Reverse 911	All hazards	Reduced loss through improved warning system	$50,000	High	Low	FEMA, VDEM, ODP, Local Government	Local government, ESC, Sheriff Dept.	Complete	Completed in 2009
Communication equipment interoperability	All hazards	Improved coordination among jurisdictions; improved response times	Varied, based on solution	Medium	High	FEMA, , Local government	Local government, ESC, Sheriff Dept.	In progress	Ongoing
Additional hazard related GIS layers/data	All hazards	Increased accuracy of hazard mitigation planning	Varied, based on layers/detail	Medium	Low	USGS, NOAA, FEMA, VDEM, VDOT, VDOF	Local government, Engineering Dept., ESC	Complete	Complete in 2012
Add local IFLOWS monitoring and additional stream gauges	Flooding / Heavy Rains	Provide better, more timely information to allow faster, more accurate warnings to be issued to the public	$20,000	High	Medium	VDEM / FEMA / LOCAL GOVT	Local Government	In progress	2013
Public education	All hazards	Inform public about hazards and mitigation options	$5,000	High	High	FEMA, VDEM, Local government	Local government	In progress	Ongoing
Public education workshops for tornado drills (public, businesses and schools)	Tornado	Public informed about how to protect yourself during a tornado in case you are at home, in a car, at the office, or outside	$5,000	High	Medium	Local government	Local government	Not started; lack of funding	

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Evaluate public utilities for floodproofing	Flooding	Evaluation of public utilities for retrofitting or floodproofing to prevent failure during disasters	$10,000	Medium	Medium	FEMA, Local government	Local government, Engineering Dept.	In progress	Ongoing
Participate in FEMA's Cooperating Technical Partners (CTP) program	Flooding	Continuing updates to flood hazard maps	$12,000	High	High	FEMA, local government	Local government, Engineering Dept.	In progress	Ongoing
Continue participation in FEMA's DFIRM program	Flooding	Updated flood hazard mapping	$12,000	High	High	FEMA, local government	Local government, Engineering Dept.	In progress	Ongoing
Participate in CRS	Flooding	Reduction in flood insurance rates; reduction in flood loss	Unsure	Unsure	High	FEMA, Local government	Local government, ESC	In progress	2013
Encourage residents and developers to use Fire-Wise building design, siting, and materials for construction	Wildfire	Reduction in damages from wildfire	$5,000	High	Medium	VA Dept. of Forestry, Local governments	Local government	Not started; lack of funding	
Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas	Wildfire	Available inventory of structures that need additional or unique protection from wildfires.	$10,000	Medium	Medium	VA Dept. of Forestry, US Forest Service, Local governments	Local government, VDOF, USFS	Not started; lack of funding	
Identify projects that would mitigate or eliminate repetitive loss properties	Flooding	Reduction and/or elimination of repetitive loss properties	unknown	Unknown	High	FEMA, VDEM	Local government	Not started; lack of funding	
Local codes review	All hazards	Review of development codes to evaluate need for changes that would improve disaster mitigation	Unsure	Unsure	Medium	FEMA, Local government	Local government, Emergency Services, Planning Dept	In progress	Ongoing
Community wildfire assessments	Wildfire	Reduction of loss to wildfire	Unsure	Unsure	Medium	VA Dept of Forestry	VA Dept of Forestry	Not started; lack of funding	

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Increase automated weather warning system capability	All Hazards	Increased speed in public notification of weather emergencies	$5,000	High	High	NWS, IFLOWS	Local Government	Not started; lack of funding	
Identification and tracking of special needs populations	All hazards	Preparation for assisting special needs populations to prevent loss of life and property	Unsure	Unsure	Medium	Local government	Local government	In progress	Ongoing
Identification and installation of generator quick-connect locations for critical public service facilities	All Hazards	Continuity of critical services during disasters	$150,000	High	High	FEMA, VDEM, Local	Local government	In progress	2013-14
Pet sheltering plans and facilities	All hazards	Increased sheltering capability	$30,000	High	High	Local Government	Local government	Complete	Complete

Table 78
Town of Buchanan Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Evaluate public utilities for floodproofing	Flooding	Evaluation of public utilities for retrofitting or floodproofing to prevent failure during disasters	$10,000	Low	High	FEMA, Local government	Local government, Public Works Dept	Not started; lack of funding	Ongoing
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	Unknown	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Not started; lack of funding	2013-2018
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	$2,500	High	High	FEMA	Local government	Ongoing	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	$2,500	High	High	FEMA, VDEM	Local government, RVARC, VDEM	Ongoing	Ongoing
Local Code Review	All Hazards	Review of development codes to evaluate need for changes that would improve disaster mitigation	$5,000	Medium	High	FEMA, VDEM	Local government	Not started; lack of funding	Ongoing
Identification of appropriate properties for acquisition and/or elevation out of flood area	Flooding	Reduction of flood loss	Unsure	Medium	Low	FEMA, VDEM, Local	Local government	Not started; lack of funding	2014
Public education	All hazards	Inform public about hazards and mitigation options	$5,000	High	High	FEMA, VDEM, Local	Local government	In progress	Ongoing
Protection of the Town Lift Station on Parkway Drive	Flooding	Continuation of sewer service during disasters	unknown	High	High	FEMA, VDEM, Local	Local government	Not started; lack of funding	2014

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Protection of the Town Sewage Treatment Plant on Parkway Drive	Flooding	Continuation of sewer service during disasters	unknown	High	High	FEMA, VDEM, Local	Local government	Not started; lack of funding	2014
Installation of generator at Town Sewage Treatment Plant and lift stations	All Hazards	Continuation of sewer service during disasters	$150,000	High	High	FEMA, Local	Local government	Not started; lack of funding	2013
Mitigation of culvert at intersection of 19th Street and New Town Road	Flooding	Elimination of street and business flooding	unknown	Medium	High	FEMA, VDEM, VDOT, Local	Local government	Not started; lack of funding	2014
Mitigation of culvert at Main Street and 19th Street	Flooding	Elimination of street and business flooding	unknown	Medium	High	FEMA, VDEM, VDOT, Local	Local government	Not started; lack of funding	2014
Mitigation of culvert between Main Street and Lowe Street near Alley.	Flooding	Elimination of street, business and residential flooding downtown	unknown	Medium	High	FEMA, VDEM, VDOT, Local	Local government	Not started; lack of funding	2014
Flood Wall to protect Lowe Street and Main Street	Flooding	Elimination of street, business and residential flooding downtown	unknown	High	High	FEMA, VDEM, Local	Local government	Not started; lack of funding	2014

Table 79
Town of Fincastle Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Local codes review	All hazards	Review of development codes to evaluate need for changes that would improve disaster mitigation	$5,000	Medium	High	FEMA, Local government	Local government	Not started; lack of funding	Ongoing
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	Unknown	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Not started; lack of funding	2013-2018
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	$2,500	High	High	FEMA	Local government	Ongoing	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	$2,500	High	High	FEMA, VDEM	Local government, RVARC, VDEM	Ongoing	Ongoing
Evaluate public utilities for floodproofing	Flooding	Evaluation of public utilities for retrofitting or floodproofing to prevent failure during disasters	$10,000	Low	High	FEMA, Local government	Local government, Public Works Dept	Not started; lack of funding	Ongoing
Public Education	All hazards	Inform public about hazards and mitigation options	$5,000	High	High	FEMA, VDEM, Local government	Local government	In progress	Ongoing

Table 80
Town of Troutville Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Evaluate public utilities for floodproofing	Flooding	Evaluation of public utilities for retrofitting or floodproofing to prevent failure during disasters	$10,000	Low	High	FEMA, Local government	Local Government, Public Works Dept.	Not started; lack of funding	Ongoing
Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	Unknown	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Not started; lack of funding	2013-2018
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	$2,500	High	High	FEMA	Local government	Ongoing	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	$2,500	High	High	FEMA, VDEM	Local government, RVARC, VDEM	Ongoing	Ongoing
Local Code Review	All Hazards	Review of development codes to evaluate need for changes that would improve disaster mitigation	$5,000	Medium	High	FEMA, VDEM	Local government	Not started; lack of funding	Ongoing
Public education	All hazards	Inform public about hazards and mitigation options	$10,000	High	High	FEMA, VDEM, Local government	Local government	In progress	Ongoing

CRAIG COUNTY AND THE TOWN OF NEW CASTLE

Current and Past Mitigation

Floodplain Management – Craig County has adopted a Floodplain Management Ordinance (1996) as part of its Zoning Ordinance. The Town of New Castle has adopted a Floodplain Management Ordinance that requires new residential buildings to be elevated to or above the base flood elevation. Additional requirements prevent the obstruction of the floodway.

National Flood Insurance Program – The County and Town of New Castle participate in, and are in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements. This program allows property owners to purchase flood insurance from NFIP. There are currently 57 NFIP policies in force in the County.

Dam Safety – There are four dams in Craig County. The Mountain Castles Soil and Water Conservation District has responsibility for the operation and maintenance of these dams. The dams are located on Johns Creek, Little Oregon Creek, Mudlick Branch, and Dicks Creek. The dams were constructed during the period of 1966 to 1968 for the purpose of flood control in the Johns Creek watershed.

IFLOWS – The County participates in a flood warning system developed by the National Weather Service called Integrated Flood Observing and Warning System (IFLOWS). Through the use of radio-transmitted information, this system provides advanced flood forecasting to the Craig County Emergency Operation Center. There is one IFLOW station located in the County.

Erosion and Sediment Control – Craig County adopted the regulations, references, guidelines, standards and specifications promulgated by the State Water Control Board for the effective control of soil erosion and sediment deposition to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources. Such regulations, references, guidelines, standards and specifications for erosion and sediment control are included in but not limited to the Virginia Erosion and Sediment Control Regulations and the Virginia Erosion and Sediment Control Handbook, as amended from time to time. The Town of New Castle utilizes the E&S Control services of Craig County.

Craig County and the Town of New Castle
Mitigation Goals and Strategies

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified pre-disaster, applicable local government departments will be the lead in making sure that each project or action will be implemented in a timely manner with other departments, other local government representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since the mitigation projects are an investment of public funds to reduce damages, localities have selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

Earthquake

Craig County will adopt Mitigation measures for earthquakes that are region-wide recommendations for all localities adopting the Regional Pre-Disaster Hazard Mitigation Plan.

Goal: Increase public awareness of the probability and potential impact of earthquakes.
Responsible Department(s): Administration
Strategy:

1. Publish a special section in local newspaper with emergency information on earthquakes. Localize the information by printing the phone numbers of local emergency services offices, the American Red Cross, and hospitals.

Flood

Craig County has developed locality specific goals and activities for this disaster that are listed below.

Goal: Mitigation of loss of life and property from flooding and flood related disasters.
Responsible Department(s): Emergency Services
Strategies:

1. Develop and maintain an inventory of flood prone roadways in cooperation with local governments and the Virginia Department of Transportation.
2. Develop and maintain an inventory of flood prone critical facilities such as hospitals, public utility sites, airports, etc.
3. In cooperation with local governments, support a comprehensive public information and education program on flooding, living in the floodplain, flood risks, low cost simple flood mitigation measures, flood insurance, stream remediation, hydrology, floodplain ordinances, and NFIP. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.
4. Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements.
5. Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.

Goal: Update existing GIS data layers related to natural hazards.

Responsible Department(s): Emergency Services

Strategies:

1. Consider seeking funding and support programs that update FEMA's Flood Insurance Rate Maps (FIRM). Consider participation in FEMA's Cooperating Technical Partners (CTP) program that establishes partners with local jurisdictions to develop and maintain up-to-date flood maps.
2. In cooperation with local governments, utilize GIS to inventory at risk infrastructure and public and private structures within flood prone areas.
3. Participate in FEMA's Digital Flood Insurance Rate Maps (DFIRM) program.
4. Support FIRM remapping projects that address areas in the region that have the most serious mapping problems and where flooding is a repetitive problem.

Goal: Provide early warning of flooding.

Responsible Department(s): Emergency Services

Strategies:

1. Identify areas with recurring flood problems and request an additional 3 IFLOW stream/rain gauges to ensure that these areas are adequately covered and monitored.
2. Seek assistance to fund reverse E 911 to provide early warning to flood prone area's

Goal: Identification of structural projects that could mitigate the impact of flooding.

Responsible Department(s): Administration

Strategies:

1. Consider seeking funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems.
2. Support Virginia Department of Transportation projects that call for improved ditching, replacement of inadequate and undersized culverts, enlargements of bridge openings and drainage piping needed to minimize flooding.

Goal: Maintain an accurate database and map of repetitive loss properties
Responsible Department(s): Emergency Services
Strategies:

1. Work with VDEM and FEMA to update list of repetitive loss properties annually.
2. Obtain updated list of repetitive loss properties annually from VDEM/FEMA.
3. Review property addresses for accuracy and make necessary corrections.
4. Determine if and by what means each property has been mitigated.
5. Map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).
6. Determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

Hurricane

Mitigation measures for hurricanes are region-wide recommendations for all localities adopting the Regional Pre-Disaster Hazard Mitigation Plan.

Goal: Mitigate the impact of hurricanes in the Roanoke Valley-Alleghany Region.
Responsible Department(s): Administration
Strategy:

1. Research and consider participating in the National Weather Service *"Storm Ready"* program.

Landslide

Mitigation measures for landslides are region-wide recommendations for all localities adopting the Regional Pre-Disaster Hazard Mitigation Plan.

Goal: Improved Hazard Mapping and Assessments for landslides.
Responsible Department(s): Emergency Services
Strategy:

1. Encourage delineation of susceptible areas and different types of landslide hazards at a scale useful for planning and decision-making by USGS and State geological surveys.

2. Work with state and Federal agencies to develop data that will assist in reducing and eliminating impacts from landslides.

Tornado

Mitigation measures for tornados are region-wide recommendations for all localities adopting the Regional Pre-Disaster Hazard Mitigation Plan.

Goal: Mitigate the impact of tornados.
Responsible Department(s): Emergency Services
Strategy:

1. Conduct a series of public workshops about how to protect yourself during a tornado in case you are at home, in a car, at the office, or outside.

Wildfire

Mitigation measures for wildfires are region-wide recommendations for all localities adopting the Regional Pre-Disaster Hazard Mitigation Plan.

Goal: Mitigation of the impacts of wildfire to life and property.
Responsible Department(s): Emergency Services
Strategy:

1. Encourage residents and developers to use FireWise building design, siting, and materials for construction.
2. Conduct Community Wildfire Assessments in cooperation with VDOF staff using the Wildland Urban Interface Fire Protection Program's *Woodland Community Wildfire Hazard Assessment* form.
3. Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas.

Winter Storms

Mitigation measures for winter storms are region-wide recommendations for all localities adopting the Regional Pre-Disaster Hazard Mitigation Plan.

Goal: Mitigate the effects of extreme weather by implementing programs that provide early warning and preparation.

Responsible Department(s): Emergency Services

Strategy:

1. Research and consider participating in the National Weather Service *"Storm Ready"* program.
2. Participate in special statewide outreach/awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc.

Table 81
Craig County Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Reverse 911	All hazards	Reduced loss through improved warning system	$38,000	High	High	FEMA, VDEM, Local Government	Local government, ESC, Sheriff Dept.	Not started; lack of funding	2014-15
Communication equipment interoperability	All hazards	Improved coordination among jurisdictions; improved response times	$150,000	High	High	FEMA, , Local government	Local government, ESC, Sheriff Dept.	Not started; lack of funding	2014-15
Publish a special section in local newspaper with emergency information on earthquakes	Earthquake	Increased level of knowledge and awareness in citizens	$2,500	High	Low	FEMA, VDEM	Local government	Not started; lack of funding	2014
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	Unknown	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Not started; lack of funding	2013-2018
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	$2,500	High	High	FEMA	Local government	Ongoing	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	$2,500	High	High	FEMA, VDEM	Local government, RVARC, VDEM	Ongoing	Ongoing
Develop and maintain an inventory of flood prone roadways	Flooding	Inventory of flood prone roadways for planning purposes (road improvements, limitation of development)	$25,000	Medium	Medium	FEMA, VDEM, RVARC, VDOT, Local government	RVARC	In progress	Ongoing updates

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Support Virginia Department of Transportation projects that minimize flooding	Flooding	Clear debris and repair banks along roads to prevent backup, erosion and flooding of existing drainage systems	$700,000	N/A	Medium	FEMA, VDEM, VDOT	Local government or VDOT	Not started; lack of funding	
Seek funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems	Flooding	Possible determination of solutions to repetitive loss properties.	$5,000	High	Medium	Local governments	Local governments	Not started; lack of funding	
Add local IFLOWS monitoring and additional stream gauges	Flooding / Heavy Rains	Provide better, more timely information to allow faster, more accurate warnings to be issued to the public	$25,000	High	Medium	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	
Seek funding and support programs that update FEMA's Flood Insurance Rate Maps	Flooding	Updated flood hazard mapping	unknown	NA	High	FEMA	Local government	Not started; lack of funding	
Identify projects that would mitigate or eliminate repetitive loss properties	Flooding	Reduction and/or elimination of repetitive loss properties	unknown	Unknown	High	FEMA, VDEM	Local government	Not started; lack of funding	
Participate in FEMA's Cooperating Technical Partners (CTP) program	Flooding	Continuing updates to flood hazard maps	$12,000	High	High	FEMA, local government	Local government,	Not started; lack of funding	
Continue participation in FEMA's DFIRM program	Flooding	Updated flood hazard mapping	$5,000	High	High	FEMA, local government	Local government	In progress	Ongoing

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Develop and maintain an inventory of flood prone critical facilities	Flooding	Available inventory of critical structures that need additional or unique protection from flooding.	$1,000	Medium	Medium	FEMA, VDEM	Local government	Not started; lack of funding	
Identify funding and resources for delineating landslide hazards	Landslide	Landslide Tool for planning and decision-making; limitation of new development.	$5,000	Low	Medium	VDEM, DCR	DCR	Not started; lack of funding	
Public education workshops for tornado drills (public, businesses and schools)	Tornado	Public informed about how to protect yourself during a tornado in case you are at home, in a car, at the office, or outside	$5,000	High	Medium	Local government	Local government	Not started; lack of funding	
Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas	Wildfire	Available inventory of structures that need additional or unique protection from wildfires.	$10,000	Medium	Medium	VA Dept. of Forestry, US Forest Service, Local governments	Local government, VDOF, USFS	Not started; lack of funding	
Encourage residents and developers to use Fire-Wise building design, siting, and materials for construction	Wildfire	Reduction in damages from wildfire	$5,000	High	Medium	VA Dept. of Forestry, Local government	Local government	Not started; lack of funding	
Community wildfire assessments	Wildfire	Reduction of loss to wildfire	$25,000	N/A	Medium	VA Dept. of Forestry, Local government	VA Dept. of Forestry, Local government	Not started; lack of funding	

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Participate in special statewide outreach/awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc	All Hazards	Inform public about hazards and mitigation options	$5,000	High	High	VDEM, FEMA, NWS	Local government	In progress	Ongoing events
Research and consider participating in the National Weather Service "Storm Ready" program	All Hazards	Community will be better prepared through planning and education about hazards	Unknown	Medium	Medium	NWS	Local government	Not started	2014
Public education	All hazards	Inform public about hazards and mitigation options	$12,000	Medium	Medium	FEMA, VDEM, Local government	Local government, ESC	Not started; lack of funding	

Table 82

Town of New Castle Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	Unknown	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Not started; lack of funding	2013-2018
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	0	High	High	FEMA, VDEM	Local government	Not started; lack of funding	2014
Downtown Flooding	Flooding	Enhance downtown to improve growth potential; protect properties from damage	$400,000	High	High	FEMA, VDOT, VA DHCD	Local government and VDOT	Not started; lack of funding	
Reverse 911	All hazards	Reduced loss through improved warning system	$10,000	High	High	FEMA, VDEM, Local Government	Local government, ESC, Sheriff Dept.	Not started; lack of funding	
Public education	All hazards	Inform public about hazards and mitigation options	$2,000	Medium	Medium	FEMA, VDEM, Local government	Local government, ESC	Not started; lack of funding	

ROANOKE COUNTY

Current and Past Mitigation Measures

Floodplain Management – Roanoke County has adopted a new Stormwater Management Ordinance and Design Manual (2008) that require new residential buildings to be elevated two feet and new commercial buildings one foot above the 100 year base flood elevation. The County has a floodplain overlay district, corresponding to areas identified on Flood Insurance Rate Maps (FIRM) prepared by FEMA. Roanoke County also has up to date DFIRMS of all FEMA studied streams. Additionally, the County has adopted regulations for development in areas that contain more than 100 acres of drainage area that require flood studies for elevations of additions or new construction.

Roanoke River Corridor Conservation and Overlay District – Roanoke County has adopted a Roanoke River Corridor Conservation and Overlay District. Although primarily designed to protect water quality, it also helps reduce siltation, which in turn protects the channel that is carrying floodwaters. In this overlay district, smaller sites (2,500 square feet in lieu of standard 10,000 square feet minimum) must meet erosion and sediment controls standards.

Roanoke Valley Regional Stormwater Management Plan – All four Roanoke Valley jurisdictions participated in the development of the plan that was coordinated through the efforts of the Fifth Planning District Commission (Roanoke Valley-Alleghany Regional Commission). It offers alternative solutions for both flooding and flash flooding problems. These alternatives include clearing stream channels, enlarging drainage openings, constructing regional detention facilities, and flood proofing individual structures. The plan presents a total of 138 individual projects to address flooding in the 16 watersheds. These are ranked in order of priority within each watershed but no overall ranking within the valley is presented. Cost estimates are presented for each project, but neither individual project benefits, nor cumulative benefits are discussed. It would be essential to analyze the benefits of these projects before the plan can be used as a guideline for specific activities. The identified projects would cost a total of $66 million in 2001 dollars, not including land acquisition or efforts to flood proof or move over 2,200 buildings. A formal quantification of the corresponding benefits would go a long way toward justifying this cost, which can initially seem overwhelming to both citizens and community officials. For example, the 1997 plan reports that between 1972 and 1992, floods caused over $200 million in damages in the

valley, and resulted in 10 deaths. The plan's Financing Options Report recommends creation of a regional stormwater utility as a means of funding the identified work.

Stormwater Management – The County has a Stormwater Management Ordinance that is part of the County Code. It was developed to bring the County into compliance with state laws on stormwater management and erosion and sedimentation control. In addition to using the Virginia Erosion and Sediment Control Handbook, Roanoke County publishes a separate Stormwater Management Design Manual that specifies acceptable methodologies, design events for a wide variety of facilities, and administrative requirements such as submittal checklists. Appendices provide a wide variety of charts and tables to be used in applying the approved methodologies.

National Flood Insurance Program – The County participates in, and is in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements. This program allows property owners to purchase flood insurance from NFIP. There are currently 415 NFIP policies in force in the County.

Community Rating System - The Community Rating System (CRS) is a voluntary program for NFIP-participating communities. The goals of the CRS are to reduce flood damages to insurable property, strengthen and support the insurance aspects of the NFIP, and encourage a comprehensive approach to floodplain management. The CRS has been developed to provide incentives in the form of flood insurance premium discounts for communities to go beyond the minimum floodplain management requirements to develop extra measures to provide protection from flooding. Roanoke County entered the CRS program in October 1991 and has a rating of 8 (10% discount).

Dam Safety – There are eight regulated dams that could impact properties in Roanoke County: Privately owned Loch Haven Lake Dam located on a tributary of Deer Branch Creek; Appalachian Electric Power owned Niagara Dam located on the Roanoke River; privately owned Orchard Dam on a tributary of Glade Creek; Carvin Cove Reservoir Dam, located on a tributary of the Carvin Creek and owned by the Western Virginia Water Authority, Spring Hollow Reservoir Dam located on a tributary of the Roanoke River and owned by the Western Virginia Water Authority, Montclair Dam and North lakes Dam in the Peters Creek watershed managed by Roanoke City, and Hidden Valley Dam in southwest county managed by Roanoke County.

Erosion and Sediment Control – Roanoke County has adopted the regulations, references, guidelines, standards and specifications promulgated by the Virginia Soil and Water Conservation Board (and any local handbook or publication of the board) for the effective control of soil erosion and sediment deposition to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources. Such regulations, references, guidelines, standards and specifications for erosion and sediment control are included in, but not limited to, the Virginia Erosion and Sediment Control Regulations and the Virginia Erosion and Sediment Control Handbook, as amended from time to time. Roanoke County administers the Town of Vinton program under the handbook guidelines.

IFLOWS – The County participates in a flood warning system developed by the National Weather Service called Integrated Flood Observing and Warning System (IFLOWS). Through the use of radio-transmitted information, this system provides advanced flood forecasting to the County Emergency Operation Center. There are eleven (11) IFLOW stations located in the County.

Project Impact Roanoke Valley – Project Impact Roanoke Valley was a partnership of FEMA, Roanoke County, the cities of Roanoke and Salem and the Town of Vinton to reduce destruction to life and property during disasters through planning and mitigation. The Project Impact Roanoke Valley Steering Committee and its work groups evaluated hazard mitigation needs from 1998 to 2001. The four work groups were: Hazard Mitigation, Public Information and Community Education, Stormwater Management and Partnership and Resource group. The Stormwater Management group was responsible for the preparation of over 1,500 floodplain elevation certificates in the participating localities. The Public Information and Community Education and Partnership and Resource groups met with community organizations, civic groups, businesses and the general public to promote hazard mitigation activities. The Land Use group focused on the how local plans and ordinances relate to hazard mitigation and published Hazard Mitigation through Land Use Planning in 2001. The Hazard Mitigation group addressed flooding, wildfire, meteorological events, and hazardous materials incidents in its report Hazard Analysis.

Roanoke County Mitigation Goals and Strategies

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified pre-disaster, applicable local government departments will be the lead in making sure that each project or action will be implemented in a timely manner with other departments, other local government representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since the mitigation projects are an investment of public funds to reduce damages, localities have selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

Earthquake

Goal: Increase public awareness of the probability and potential impact of earthquakes.
Responsible Department(s): Engineering, Public Information, Emergency Services
Strategies:

1. Publish a special section in local newspaper with emergency information on earthquakes. Localize the information by printing the phone numbers of local emergency services offices, the American Red Cross, and hospitals.

Flood

Goal: Mitigation of loss of life and property from flooding and flood related disasters.
Responsible Department(s): Engineering, Emergency Services
Strategies:

1. Support a comprehensive, regional public information and education program on flooding, living in the floodplain, flood risks, low cost simple flood mitigation measures, flood insurance, stream remediation, hydrology, floodplain ordinances, and NFIP. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.
2. Develop and maintain an inventory of flood prone roadways in cooperation with local governments and the Virginia Department of Transportation.
3. Develop and maintain an inventory of flood prone critical regional facilities such as hospitals, public utility sites, airports, etc.
4. Maintain an inventory of flood prone residential properties and repetitive loss properties.
5. Develop and maintain damage assessment information.
6. Continue the acquisition of elevation certificates for flood prone properties.
7. Continue the flood proofing/acquisition of flood prone properties.
8. Revise stormwater management and floodplain management ordinances.
9. Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements.
10. Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.

Goal: Update existing GIS data layers related to natural hazards.

Responsible Department(s): Engineering

Strategies:

1. Consider seeking funding and support programs that update FEMA's Flood Insurance Rate Maps (FIRM). Continue participation in FEMA's Cooperating Technical Partners (CTP) program that establishes partners with local jurisdictions to develop and maintain up-to-date flood maps.
2. Utilize GIS to inventory at risk infrastructure and public and private structures within flood prone areas.
3. Continue participate in FEMA's Digital Flood Insurance Rate Maps (DFIRM) program.
4. Support FIRM remapping projects that address areas in the region that have the most serious mapping problems and where flooding is a repetitive problem.

Goal: Provide early warning of flooding.

Responsible Department(s): Engineering, Emergency Services

Strategies:

1. Identify areas with recurring flood problems and request additional IFLOW stream/rain gauges as appropriate to ensure that these areas are adequately covered and monitored.
2. Consider a reverse 911 early warning system.
3. Consider on-site notification of flood prone properties.

Goal: Identification of structural projects that could mitigate the impact of flooding.

Responsible Department(s): Engineering

Strategies:

1. Consider seeking funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems.
2. Support Virginia Department of Transportation projects that call for improved ditching, replacement of inadequate and undersized culverts, enlargements of bridge openings and drainage piping needed to minimize flooding.
3. Update the Roanoke Valley Regional Stormwater Master Plan.
4. Expand the number of watersheds studied in the master plan and develop watershed plans for each.

Goal: Maintain an accurate database and map of repetitive loss properties

Responsible Department(s): Engineering

Strategies:

1. Work with VDEM and FEMA to update list of repetitive loss properties annually.
2. Obtain updated list of repetitive loss properties annually from VDEM/FEMA.
3. Review property addresses for accuracy and make necessary corrections.
4. Determine if and by what means each property has been mitigated.
5. Map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).
6. Determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

Hurricane

Goal: Mitigate the impact of hurricanes.

Responsible Department(s): Emergency Services

Strategy:

1. Research and consider participating in the National Weather Service *"Storm Ready"* program.

Landslide

Goal: Improved Hazard Mapping and Assessments for landslides.

Responsible Department(s): Engineering

Strategies:

1. Delineating susceptible areas and different types of landslide hazards at a scale useful for planning and decision-making, led by USGS and State geological surveys.
2. Work with state and Federal agencies to develop data that will assist in reducing and eliminating impacts from landslides.
3. Develop steep slope ordinance/guidelines for development in steep slope/marginal soils areas.

Tornado

Goal: Mitigation of the impact of tornados.
Responsible Department(s): Emergency Services
Strategy:

1. Conduct a series of public workshops about how to protect yourself during a tornado in case you are at home, in a car, at the office, or outside.

Wildfire

Goal: Mitigation of the impacts of wildfire to life and property.
Responsible Department(s): Emergency Services
Strategies:

1. Encourage residents and developers to use FireWise building design, siting, and materials for construction.
2. Conduct Community Wildfire Assessments in cooperation with VDOF staff using the Wildland Urban Interface Fire Protection Program's *Woodland Community Wildfire Hazard Assessment* form.
3. Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas.

Winter Storms

Goal: Mitigate the effects of extreme weather by implementing programs that provide early warning and preparation.
Responsible Department(s): Emergency Services
Strategy:

1. Research and consider participating in the National Weather Service *"Storm Ready"* program.
2. Participate in special statewide outreach/awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc.

Table 83
Roanoke County Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Publish a special section in local newspaper with emergency information on earthquakes	Earthquake	Increased level of knowledge and awareness in citizens	$2,500	High	Low	FEMA, VDEM	Local government	Not started; lack of funding	
Research and consider participating in the National Weather Service "Storm Ready" program	All Hazards	Community will be better prepared through planning and education about hazards	$,2000	Medium	Medium	NWS	Local government	Not started; lack of funding	
Public education workshops for tornado drills (public, businesses and schools)	Tornado	Public informed about how to protect yourself during a tornado in case you are at home, in a car, at the office, or outside	$5,000	High	Medium	Local government	Local government	Not started; lack of funding	
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	Unknown		High	FEMA	Local government	Ongoing	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	Unknown		High	FEMA, VDEM	Local government	Ongoing	Ongoing
Develop and maintain an inventory of flood prone roadways	Flooding	Inventory of flood prone roadways for planning purposes (road improvements, limitation of development)	$25,000	Medium	Medium	FEMA, VDEM, RVARC, VDOT, Local government	RVARC	In progress	Ongoing updates

Project	Hazard Mitigated	Benefit	Cost	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Support Virginia Department of Transportation projects that minimize flooding	Flooding	Clear debris and repair banks along roads to prevent backup, erosion and flooding of existing drainage systems	$1,400,000	N/A	Medium	FEMA, VDEM, VDOT	Local government or VDOT	Ongoing	Ongoing
Seek funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems	Flooding	Possible determination of solutions to repetitive loss properties.	$100,000	High	Medium	Local governments	Local governments	Not started; lack of funding	
Identify locations for additional IFLOWS monitoring and additional stream gauges	Flooding / Heavy Rains	Provide better, more timely information to allow faster, more accurate warnings to be issued to the public	$25,000	High	Medium	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	
Develop and maintain an inventory of flood prone critical facilities	Flooding	Available inventory of critical structures that need additional or unique protection from flooding.	$1,000	Medium	Medium	FEMA, VDEM	Local government	Not started; lack of funding	
Develop and maintain damage assessment information	Flooding	Knowledge of hazard caused damage for planning and disaster recovery efforts	Unknown			VDEM	Local government	Not started; lack of funding	
Revise stormwater management and floodplain management ordinances	Flooding	Up to date hazard related ordinances to provide guidance for planning and development	Unknown			Local government, DCR	Local government	Not started; lack of funding	
Flood hazard mapping update/ modernization	Flooding	Increased accuracy of flood maps and more effective regulation and enforcement of regulations	$50,000	High	High	FEMA, VDEM	Local government	Ongoing	Ongoing
Citizen Warning and Alert	All hazards	Reduced loss through improved warning system	$50,000/ $20,000 annually	High	Medium	FEMA, VDEM, Local Government	CommIT12	Ongoing	Ongoing

Project	Hazard Mitigated	Benefit	Cost	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Communication equipment interoperability	All hazards	Improved coordination among jurisdictions; improved response times	unknown	High	High	FEMA, Local government	FEMA, Local government	Ongoing	Ongoing
Additional hazard related GIS layers/data	All hazards	Increased accuracy of hazard mitigation planning	$100,000	High	High	USGS, NOAA, FEMA, VDEM, VDOT, VDOF	Local government, Engineering Dept.	Ongoing	Ongoing
Additional hazard field data	Flooding	Elevation certificates for residential, business and critical facilities; increased accuracy of hazard mitigation planning	$75,000	High	High	FEMA, VDEM, Local government	Local government, Engineering Dept.	Ongoing	Ongoing
Residential and Commercial Structure acquisition	Flooding	Removal of structures from flood hazard areas; reduce repetitive loss; reduce loss of life and property	$15,000,000	High	High	FEMA, VDEM	Local government, Engineering Dept	Ongoing	Ongoing
Identify funding and resources for delineating landslide hazards	Landslide	Landslide Tool for planning and decision-making; limitation of new development.	$15,000	Low	Medium	VDEM, DCR	DCR	Not started; lack of funding	
Develop steep slope ordinance/guidelines for development in steep slope/marginal soils areas	Landslide	Landslide Tool for planning and decision-making; limitation of new development.	$10,000	Medium	Medium	DCR	Local government	Not started; lack of funding	
Public education	All hazards	Inform public about hazards and mitigation options	$50,000	High	High	FEMA, VDEM, Local government	Local government	In progress	Ongoing
Participate in special statewide outreach/awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc	All Hazards	Inform public about hazards and mitigation options	$10,000	High	High	VDEM, FEMA, NWS	Local government	In progress	Ongoing events
Stormwater facilities construction	Flooding	Reduce frequency and impact of flooding	$15,000,000	High	High	FEMA, VDEM	Local government, Engineering Dept.	Ongoing	Ongoing

Project	Hazard Mitigated	Benefit	Cost	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Upgrade/repairs to stormwater system	Flooding	Reduce frequency and impact of flooding	$10,000,000	High	High	FEMA, VDEM, VDOT	Local government, Engineering Dept.	Ongoing	Ongoing
Drainage system maintenance	Flooding	Clear debris and repair banks to prevent backup, erosion and flooding of existing drainage systems	$1,000,000 annually	High	High	FEMA, VDEM, VDOT	Local government, Engineering Dept.	Ongoing	Ongoing
Update Regional Stormwater Management Master Plan	Flooding	Watershed/mitigation planning and project identification	$750,000	High	High	FEMA, Local government, PDC	Local government, Engineering Dept.	Ongoing	Ongoing
Encourage residents and developers to use Fire-Wise building design, siting, and materials for construction	Wildfire	Reduction in damages from wildfire	$5,000	High	Medium	VA Dept. of Forestry, Local government	Local government	Not started; lack of funding	
Community wildfire assessments	Wildfire	Reduction of loss to wildfire	$25,000	N/A	Medium	VA Dept. of Forestry, Local government	VA Dept. of Forestry, Local government	Not started; lack of funding	
Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas	Wildfire	Available inventory of structures that need additional or unique protection from wildfires.	$10,000	Medium	Medium	VA Dept. of Forestry, US Forest Service, Local governments	Local government, VDOF, USFS	Not started; lack of funding	

TOWN OF VINTON

Current and Past Mitigation Measures

Floodplain Management – The floodplain management regulations were originally adopted in 1982. Vinton has two floodplain districts, one for the floodway and one for the flood fringe. These regulations are designed as overlays and adopted as part of the 1995 Zoning Ordinance and 2007 amendments. The 2007 amendment to Section 4-59(a)(3) of the Vinton Zoning Ordinance requires that new residential structures be at least two (2) feet above flood elevation, and that new non-residential structures be at least one (1) foot above flood elevation.

Roanoke River Corridor Conservation and Overlay District – The Town of Vinton has adopted a Roanoke River Corridor Conservation and Overlay District. Although primarily designed to protect water quality, it also helps reduce siltation, which in turn protects the channel that is carrying floodwaters. In this overlay district, smaller sites (2,500 square feet in lieu of standard 10,000 square feet minimum) must meet erosion and sediment controls standards.

Stormwater Management – The Town has a Stormwater Management Ordinance (updated in 2007) that is part of the Town Code. It was developed to bring the Town into compliance with state laws on stormwater management and erosion and sedimentation control. Vinton uses the Virginia Department of Conservation and Recreation's guidelines as stormwater management standards.

Roanoke Valley Regional Stormwater Management Plan – All four Roanoke Valley jurisdictions participated in the development of the plan that was coordinated through the efforts of the Fifth Planning District Commission (Roanoke Valley-Alleghany Regional Commission). It offers alternative solutions for both flooding and flash flooding problems. These alternatives include clearing stream channels, enlarging drainage openings, constructing regional detention facilities, and flood proofing individual structures. The plan presents a total of 138 individual projects to address flooding in the 16 watersheds. These are ranked in order of priority within each watershed but no overall ranking within the valley is presented. Cost estimates are presented for each project, but neither individual project benefits, nor cumulative benefits are discussed.

It would be essential to analyze the benefits of these projects before the plan can be used as a guideline for specific activities. The identified projects would cost a total of $66 million in 2001 dollars, not including land acquisition or efforts to flood proof or move over 2,200 buildings. A formal quantification of the corresponding benefits would go a long way toward justifying this cost, which can initially seem overwhelming to both citizens and community officials. For example, the 1997 plan reports that between 1972 and 1992, floods caused over $200 million in damages in the valley, and resulted in 10 deaths. The plan's Financing Options Report recommends creation of a regional stormwater utility as a means of funding the identified work.

National Flood Insurance Program – The Town participates in, and is in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements. This program allows property owners to purchase flood insurance from NFIP. There are currently 52 NFIP policies in force in the Town.

Dam Safety – Carvin Cove Reservoir Dam, located on a tributary of the Carvin Creek and owned by the Western Virginia Water Authority could impact the western side of the Town of Vinton.

Erosion and Sediment Control – The Town of Vinton has adopted the regulations, references, guidelines, standards and specifications promulgated by the Virginia Soil and Water Conservation Board (and any local handbook or publication of the board) for the effective control of soil erosion and sediment deposition to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources. Such regulations, references, guidelines, standards and specifications for erosion and sediment control are included in, but not limited to, the Virginia Erosion and Sediment Control Regulations and the Virginia Erosion and Sediment Control Handbook, as amended from time to time. Roanoke County administers the Vinton program under the handbook guidelines.

IFLOWS – The Town participates in a flood warning system developed by the National Weather Service called Integrated Flood Observing and Warning System (IFLOWS). Through the use of radio-transmitted information, this system provides advanced flood forecasting to the Town Emergency Operation Center Roanoke County/Town of Vinton Communications Center and to the Town Emergency Operation Center. There are no IFLOW stations located in the Town.

Project Impact Roanoke Valley – Project Impact Roanoke Valley was a partnership of FEMA, Roanoke County, the cities of Roanoke and Salem and the Town of Vinton to reduce destruction to life and property during disasters through planning and mitigation. The Project Impact Roanoke Valley Steering Committee and its work groups evaluated hazard mitigation needs from 1998 to 2001. The four work groups were: Hazard Mitigation, Public Information and Community Education, Stormwater Management and Partnership and Resource group. The Stormwater Management group was responsible for the preparation of over 1,500 floodplain elevation certificates. The Public Information and Community Education and Partnership and Resource groups met with community organization, civic groups, businesses and the general public to promote hazard mitigation activities. The Land Use group focused on how local plans and ordinances relate to hazard mitigation and published Hazard Mitigation through Land Use Planning in 2001. The Hazard Mitigation group addressed flooding, wildfire, meteorological events, and hazardous materials incidents in its report Hazard Analysis.

Town of Vinton Mitigation Goals and Strategies

During the late 1990s, under the Project Impact initiatives, the Roanoke Valley Project Impact Steering Committee and its work groups actively addressed hazard mitigation needs. The Steering Committee and the work groups were composed of representatives from the Cities of Roanoke and Salem, County of Roanoke, and Town of Vinton. The Stormwater Management work group was responsible for the preparation of over 1,500 floodplain elevation certificates for residential structures in flood-prone sections of the community. The Hazard Mitigation work group prepared a report identifying potential hazards including wildfires and flooding, and maps identifying hazard areas from the report were distributed through the local newspaper. The Public Information and Community Education work group and the Partnership and Resource Development work group met with community organizations, businesses, and decision makers to promote cooperative hazard mitigation activities. The Land Use work group focused on the analysis of how local plans and ordinances relate to hazard mitigation and how these documents might be changed to protect the community more effectively. The goal of the work group was to ensure that local land use, development, and building codes minimize the potential impact of floods and other disasters on the natural and built environment.

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural

hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified hazard, applicable local government departments will be the lead in making sure that each project or action will be implemented in a timely manner with other departments, other local government's representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since mitigation projects are an investment of public funds to reduce damages, localities selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

Earthquake

Goal: Increase public awareness of the probability and potential impact of earthquakes.
Responsible Department(s): Administration, Planning, Emergency Services, and Roanoke County Department of Community Development
Strategies:

1. Publish a special section in local newspaper with emergency information on earthquakes. Localize the information by printing the phone numbers of local emergency services offices, the American Red Cross, and hospitals.
2. Develop "critical area" maps based on geotechnical information to identify locations where damage potential is high.

Flood

Goal: Mitigation of loss of life and property from flooding and flood related disasters.

Responsible Department(s): Administration, Public Works, Planning, Emergency Services, and Roanoke County Department of Community Development

Strategies:

1. Support a comprehensive, regional public information and education program on flooding, living in the floodplain, flood risks, low cost simple flood mitigation measures, flood insurance, stream remediation, hydrology, floodplain ordinances, and NFIP. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.
2. Utilize existing documents and programs from FEMA, NFIP, VDEM, and the National Weather Service to educate the public about hazards and mitigation opportunities.
3. Coordinate with and support Community Emergency Response Team (CERT) information distribution activities in the community.
4. Develop and maintain an inventory of flood prone roadways in cooperation with local governments and the Virginia Department of Transportation.
5. Develop and maintain an inventory of flood prone critical regional facilities such as hospitals, public utility sites, airports, etc.
6. Maintain an inventory of flood prone residential properties and repetitive loss properties.
7. Develop and maintain damage assessment information.
8. Continue the acquisition of elevation certificates for flood prone properties.
9. Continue the flood proofing/acquisition of flood prone properties.
10. Revise stormwater management and floodplain management ordinances.
11. Obtain Community Rating System (CRS) classification, which will allow residents and business owners to receive a discount on their flood insurance premiums.
12. Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements.
13. Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.

Goal: Update existing GIS data layers related to natural hazards.

Responsible Department(s): Planning and Roanoke County Department of Community Development

Strategies:

1. Consider seeking funding and support programs that update FEMA's Flood Insurance Rate Maps (FIRM). Continue participation in FEMA's Cooperating Technical Partners (CTP) program that establishes partners with local jurisdictions to develop and maintain up-to-date flood maps.
2. Utilize GIS to inventory at risk infrastructure and public and private structures within flood prone areas.
3. Continue participate in FEMA's Digital Flood Insurance Rate Maps (DFIRM) program.
4. Support FIRM remapping projects that address areas in the region that have the most serious mapping problems and where flooding is a repetitive problem.

Goal: Provide early warning of flooding.

Responsible Department(s): Emergency Services, Social Media Administrators, and Roanoke County/Town of Vinton's Communications Center.

Strategies:

1. Identify areas with recurring flood problems and request additional IFLOW stream/rain gauges as appropriate to ensure that these areas are adequately covered and monitored.
2. Consider a reverse 911 early warning system.
3. Consider on-site notification of flood prone properties.
4. Implement early warning system using social media (webpage, Facebook, Twitter, etc.). (Strategy completed)

Goal: Identification of structural projects that could mitigate the impact of flooding.

Responsible Department(s): Planning, Administration, Public Works

Strategies:

1. Consider seeking funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems.
2. Support Virginia Department of Transportation and adjoining jurisdictions projects that call for improved ditching, replacement of inadequate and undersized culverts, enlargements of bridge openings and drainage piping needed to minimize flooding.
3. Update the Roanoke Valley Regional Stormwater Master Plan.

4. Expand the number of watersheds studied in the master plan and develop watershed plans for each.

Goal: Maintain an accurate database and map of repetitive loss properties

Responsible Department(s):

Strategies:

A. Work with VDEM and FEMA to update list of repetitive loss properties annually.
B. Obtain updated list of repetitive loss properties annually from VDEM/FEMA.
C. Review property addresses for accuracy and make necessary corrections.
D. Determine if and by what means each property has been mitigated.
E. Map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).
F. Determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

Hurricane

Goal: Mitigate the impact of hurricanes in the Roanoke Valley-Alleghany Region.

Responsible Department(s): Emergency Services, Social Media Administrators, and Roanoke County/Town of Vinton's Communications

Strategies:

1. Research and consider participating in the National Weather Service *"Storm Ready"* program.
2. Encourage voluntary use of the National Weather Service or private warning mechanisms, such as The Weather Channel NOTIFY! and the Specific Area Message Encoding (SAME).
3. Develop reverse 911 warning systems to activate by National Weather Service.
4. Educate the public regarding the need to pre-plan for weather emergencies.
5. Implement early warning system using social media (webpage, Facebook, Twitter, etc.). (Strategy completed)

Landslide

Goal: Improved Hazard Mapping and Assessments for landslides.

Responsible Department(s): Planning and Roanoke County Department of Community Development

Strategies:

1. Encourage the delineation of susceptible areas and different types of landslide hazards at a scale useful for planning and decision-making by USGS and State geological surveys.
2. Work with state and Federal agencies to develop data that will assist in reducing and eliminating impacts from landslides risk to life and property.
3. Develop steep slope ordinance/guidelines for development in steep slope/marginal soils areas.

Tornado

Goal: Mitigate the impact of tornados.

Responsible Department(s): Administration and Emergency Services, Social Media Administrators, and Roanoke County/Town of Vinton's Communications.

Strategies:

1. Conduct a series of public workshops about how to protect yourself during a tornado in case you are at home, in a car, at the office, or outside.
2. Educate the public regarding the need to pre-plan for weather emergencies and provide an informational brochure or handout on emergency planning.
3. Encourage voluntary use of the National Weather Service or private warning mechanisms, such as The Weather Channel NOTIFY! and the Specific Area Message Encoding (SAME).
4. Implement early warning system using social media (webpage, Facebook, Twitter, etc.). (Strategy completed)

Wildfire

Goal: Mitigation of the impacts of wildfire to life and property.

Responsible Department(s): Emergency Services, Planning, and Roanoke County Department of Community Development, Social Media Administrators, and Roanoke County/Town of Vinton's Communications

Strategies:

1. Encourage residents and developers to use FireWise building design, siting, and materials for construction.
2. Conduct Community Wildfire Assessments in cooperation with VDOF staff using the Wildland Urban Interface Fire Protection Program's *Woodland Community Wildfire Hazard Assessment* form.
3. Identify buildings or locations vital to the emergency response effort and buildings or locations that, if damaged, would create secondary disasters in forested areas.
4. Implement early warning system using social media (webpage, Facebook, Twitter, etc.). (Strategy completed)

Winter Storms

Goal: Mitigate the effects of extreme weather by implementing programs that provide early warning and preparation.

Responsible Department(s): Emergency Services, Social Media Administrators, and Roanoke County/Town of Vinton's Communications

Strategies:

1. Research and consider participating in the National Weather Service *"Storm Ready"* program.
2. Develop reverse 911 warning systems to be activated by National Weather Service input.
3. Participate in special statewide outreach/awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc.
4. Provide an informational brochure or handout on emergency for weather events.
5. Encourage voluntary use of the National Weather Service or private warning mechanisms, such as The Weather Channel NOTIFY! and the Specific Area Message Encoding (SAME).
6. Implement early warning system using social media (webpage, Facebook, Twitter, etc.). (Strategy completed)

Table 84
Town of Vinton Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Publish a special section in local newspaper with emergency information on earthquakes	Earthquake	Increased level of knowledge and awareness in citizens	$2,500	High	Low	FEMA, VDEM	Local government	Not started; lack of funding	
Develop "critical area" maps for earthquake zones	Earthquake	Identification of earthquake hazard locations	$75,000	Medium	Medium	FEMA	Local government	Not started; lack of funding	
Public education workshops for tornado drills (public, businesses and schools)	Tornado	Public informed about how to protect yourself during a tornado in case you are at home, in a car, at the office, or outside	$5,000	High	Medium	Local government	Local government	Not started; lack of funding	
Implement early warning system using social media	All Hazards	Public made aware of impending danger	Unknown	High	High	Local government	Local government	In Progress	Ongoing
Encourage voluntary use of the National Weather Service or private warning mechanisms, such as The Weather Channel NOTIFY! and the Specific Area Message Encoding (SAME)	All Hazards	Public able to receive warnings from appropriate sources	Unknown	High	High	Local government	Local government	In Progress	Ongoing
Participate in special statewide outreach/awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc	All Hazards	Inform public about hazards and mitigation options	$10,000	High	High	VDEM, FEMA, NWS	Local government	In progress	Ongoing events

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Provide an informational brochure or handout on emergency for weather events	All Hazards	Public better informed about hazards.	Unknown	Medium	Medium	Local government VDEM FEMA	Town of Vinton	Not started; lack of funding	
Reverse 911	All Hazards	Reduced loss through improved warning system	$100,000	High	Middle	FEMA, VDEM, Local Government	Town of Vinton and RVARC	Not started; lack of funding	2011-2013
Communication equipment interoperability	All Hazards	Improved coordination among jurisdictions; improved response times	$100,000	High	High	FEMA, Local government	Town of Vinton, Fire & Emergency Services, & Police Department	Not started; lack of funding	Ongoing
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	Unknown	High	High	FEMA	Local government	In Progress	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	Unknown	High	High	FEMA, VDEM	Local government	Not started; lack of funding	
Seek funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems	Flooding	Possible determination of solutions to repetitive loss properties.	$15,000	High	Medium	Local governments	Local governments	Not started; lack of funding	

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Identify locations for additional IFLOWS monitoring and additional stream gauges	Flooding / Heavy Rains	Provide better, more timely information to allow faster, more accurate warnings to be issued to the public	$25,000	High	Medium	VDEM / FEMA / LOCAL GOVT	Local Government	Not started; lack of funding	
Additional hazard related GIS layers/data	All Hazards	Increased accuracy of hazard mitigation planning	$100,000	Medium	High	USGS, NOAA, FEMA, VDEM, VDOT, VDOF	RVARC, County of Roanoke, and Town of Vinton	Ongoing	Ongoing
Flood hazard mapping update/ modernization	Flooding	Increased accuracy of flood maps and more effective regulation and enforcement of regulations	$50,000	Medium	High	FEMA, VDEM	RVARC, County of Roanoke, and Town of Vinton	Complete	Completed
Develop and maintain an inventory of flood prone roadways	Flooding	Inventory of flood prone roadways for planning purposes (road improvements, limitation of development)	$25,000	Medium	Medium	FEMA, VDEM, RVARC, VDOT, Local government	RVARC	In progress	Ongoing updates
Support Virginia Department of Transportation projects that minimize flooding	Flooding	Clear debris and repair banks along roads to prevent backup, erosion and flooding of existing drainage systems	$1,400,000	N/A	Medium	FEMA, VDEM, VDOT	Local government or VDOT	Not started; lack of funding	
Maintain an inventory of flood prone residential properties and repetitive loss properties	Flooding	Available inventory of repetitive loss properties that could be used for planning purposes	Unknown	Unknown	Unknown	VDEM	Local government	Not started; lack of funding	
Develop and maintain damage assessment information	Flooding	Knowledge of hazard caused damage for planning and disaster recovery efforts	Unknown	High	Medium	VDEM	Local government	Ongoing	Ongoing
Coordinate with and support Community Emergency Response Team (CERT)	All Hazards	Coordinated information distribution	Unknown	Unknown	Unknown	Unknown	Unknown	Ongoing	Ongoing

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Additional hazard field data	Flooding	Elevation certificates for residential, business and critical facilities; increased accuracy of hazard mitigation planning	$50,000	Medium	High	FEMA, VDEM, Local governments	Town of Vinton	Ongoing	Ongoing, as funding become available
Structure acquisition – single family and commercial units	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	$10,000,000	High	High	FEMA, VDEM	Town of Vinton Planning and Zoning Department	Ongoing	Purchased 2 in 2006 and as funding become available
Public education	All hazards	Inform public about hazards and mitigation options	$50,000	Medium	High	FEMA, VDEM, Local government	Town of Vinton and RVARC	Ongoing	Ongoing
Update Regional Stormwater	Flooding	Watershed/mitigation planning and project identification	$500,000	Medium	High	FEMA, VDEM, Local government	Town of Vinton and other Valley governments	Ongoing	As funding becomes available
Stormwater facilities construction	Flooding	Reduce frequency and impact of flooding	$10,000,000	Medium	High	FEMA, VDEM	Town of Vinton	Ongoing	2011-2015, as funding become available
Upgrade/repairs to stormwater system	Flooding	Reduce frequency and impact of flooding	$20,000,000	Medium	High	FEMA, VDEM, VDOT	Town of Vinton	Ongoing	2006-2010, as funding becomes available
Drainage system maintenance	Flooding	Clear debris and repair banks to prevent backup, erosion and flooding of existing drainage systems	$100,000, Annually	Medium	High	FEMA, VDEM, VDOT	Town of Vinton Public Works Department	Ongoing	Ongoing
Determine the need for generators at public infrastructure facilities, emergency shelters, and public buildings	All hazards	Ensure that water and sewer service can be operational during hazard events. Needed services can be provided during emergency events.	$20,000	High	High	FEMA, Local government	Town of Vinton Public Works Department and Police Department	Ongoing	As funding becomes available

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Evaluate public utilities for floodproofing	Flooding	Evaluation of public utilities for retrofitting or floodproofing to prevent failure during disasters	$50,000	High	Medium	FEMA, Local government	Town of Vinton Public Works Dept.	Ongoing	2 projects completed. Additional projects as funding becomes available.
Participate in CRS	Flooding	Reduction in flood insurance rates; reduction in flood loss	$10,000, Annually	Medium	High	FEMA, Local government	Town of Vinton Planning and Zoning Department	Ongoing	As staff and funding becomes available
Local codes review	All hazards	Review development codes to evaluate need for changes that would improve disaster mitigation	$100,000	Medium	High	FEMA, Local government	Town of Vinton Planning and Zoning Department	Ongoing	Ongoing
Identify funding and resources for delineating landslide hazards	Landslide	Landslide Tool for planning and decision-making; limitation of new development.	$15,000	Low	Medium	VDEM, DCR	DCR	Not started; lack of funding	
Develop steep slope ordinance/guidelines for development in steep slope/marginal soils areas	Landslide	Landslide Tool for planning and decision-making; limitation of new development.	$10,000	Medium	Medium	DCR	Local government	Not started	
Encourage residents and developers to use Fire-Wise building design, siting, and materials for construction	Wildfire	Reduction in damages from wildfire	$5,000	High	Medium	VA Dept. of Forestry, Local government	Local government	Not started; lack of funding	
Community Wildfire assessments	Wildfire	Reduction of loss to wildfire	$50,000	Medium	Medium	VDOF	Town of Vinton	Ongoing	As funding becomes available

CITY OF ROANOKE

Current and Past Mitigation Measures

Floodplain Management – The City of Roanoke has adopted a Floodplain Management Ordinance that requires new residential buildings to be elevated to or above the base flood elevation. The City has a floodplain overlay district corresponding to areas identified on Flood Insurance rate Maps prepared by FEMA.

Roanoke Valley Regional Stormwater Management Plan - All four Roanoke Valley jurisdictions participated in the development of the plan that was coordinated through the efforts of the Fifth Planning District Commission (Roanoke Valley-Alleghany Regional Commission). It offers alternative solutions for both flooding and flash flooding problems. These alternatives include clearing stream channels, enlarging drainage openings, constructing regional detention facilities, and flood proofing individual structures. The plan presents a total of 138 individual projects to address flooding in the 16 watersheds. These are ranked in order of priority within each watershed but no overall ranking within the valley is presented. Cost estimates are presented for each project, but neither individual project benefits, nor cumulative benefits are discussed. It would be essential to analyze the benefits of these projects before the plan can be used as a guideline for specific activities. The identified projects would cost a total of $66 million in 2001 dollars, not including land acquisition or efforts to flood proof or move over 2,200 buildings. A formal quantification of the corresponding benefits would go a long way toward justifying this cost, which can initially seem overwhelming to both citizens and community officials. For example, the 1997 plan reports that between 1972 and 1992, floods caused over $200 million in damages in the valley, and resulted in 10 deaths. The plan's Financing Options Report recommends creation of a regional stormwater utility as a means of funding the identified work.

Stormwater Management - The City has a Stormwater Management Ordinance that is part of the City Code. It was developed to bring the City into compliance with state laws on stormwater management and erosion and sedimentation control.

National Flood Insurance Program – The City participates in, and is in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal

requirements. This program allows property owners to purchase flood insurance from NFIP. There are currently 668 NFIP policies in force in the City.

Community Rating System - The Community Rating System (CRS) is a voluntary program for NFIP-participating communities. The goals of the CRS are to reduce flood damages to insurable property, strengthen and support the insurance aspects of the NFIP, and encourage a comprehensive approach to floodplain management. The CRS has been developed to provide incentives in the form of flood insurance premium discounts for communities to go beyond the minimum floodplain management requirements to develop extra measures to provide protection from flooding. The City of Roanoke entered the CRS program in 1996 and has a rating of 7 (15% discount).

Storm Ready – The City of Roanoke was designated a Storm Ready community in February 2010 by the National Weather Service. The City was certified based on it level of emergency preparedness including: a 24-hour warning point and emergency operations center; development of at least four methods by which weather warnings can be received and disseminated; creation of a system to monitor local weather conditions; conducting community seminars to promote disaster readiness; and development of a formal hazardous weather plan, including spotter training and emergency exercises. An additional benefit of the designation to the residents and business owners in the City is reduced rate for flood insurance.

Dam Safety – Spring Hollow Reservoir Dam, located on a tributary of the Roanoke River and owned by the Western Virginia Water Authority, could impact properties in the City of Roanoke if it failed. Carvin Cove Reservoir Dam, located on a tributary of the Carvin Creek and owned by the Western Virginia Water Authority, could impact properties in the City if it failed. Two other smaller private lakes in the City are designated high hazard by the DCR; Windsor Lake and Spring Lake, both in SW City.

Erosion and Sediment Control – The City of Roanoke has adopted the regulations, references, guidelines, standards and specifications promulgated by the Virginia Soil and Water Conservation Board (and any local handbook or publication of the board) for the effective control of soil erosion and sediment deposition to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources. Such regulations, references, guidelines, standards and specifications for erosion and sediment control are included in, but not limited to, the Virginia Erosion and Sediment Control Regulations and the Virginia Erosion and Sediment Control Handbook, as amended from time to time.

IFLOWS – The City participates in a flood warning system developed by the National Weather Service called Integrated Flood Observing and Warning System (IFLOWS). Through the use of radio-transmitted information, this system provides advanced flood forecasting to the City Emergency Operation Center. There are five IFLOW stations located in the City.

Project Impact Roanoke Valley – Project Impact Roanoke Valley was a partnership of FEMA, Roanoke County, the cities of Roanoke and Salem and the Town of Vinton to reduce destruction to life and property during disasters through planning and mitigation. The Project Impact Roanoke Valley Steering Committee and its work groups evaluated hazard mitigation needs from 1998 to 2001. The four work groups were: Hazard Mitigation, Public Information and Community Education, Stormwater Management and Partnership and Resource group. The Stormwater Management group was responsible for the preparation of over 1,500 floodplain elevation certificates. The Public Information and Community Education and Partnership and Resource groups met with community organization, civic groups, businesses and the general public to promote hazard mitigation activities. The Land Use group focused on the how local plans and ordinances relate to hazard mitigation and published Hazard Mitigation through Land Use Planning in 2001. The Hazard Mitigation group addressed flooding, wildfire, meteorological events, and hazardous materials incidents in its report Hazard Analysis.

City of Roanoke Mitigation Goals and Strategies

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified pre-disaster, applicable local government departments will be the lead in making sure that each project or action will be implemented in a timely manner with other departments, other local government representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since the mitigation projects are an investment of public funds to reduce damages, localities have selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

Flooding

Goal: Mitigation of loss of life and property from flooding and flood related disasters.
Responsible Department(s): Engineering, Emergency Management
Strategies:

1. In cooperation with local governments, support a comprehensive public information and education program on flooding, living in the floodplain, flood risks, low cost simple flood mitigation measures, flood insurance, stream remediation, hydrology, floodplain ordinances, and NFIP. This can be accomplished through regional workshops and educational materials for citizens, business, local staff, and elected officials.
2. Develop and maintain an inventory of flood prone roadways in cooperation with the Virginia Department of Transportation.
3. Develop and maintain an inventory of flood prone critical facilities such as hospitals, public utility sites, airports, etc.
4. Participate in The Community Rating System.
5. Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements.
6. Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.

Goal: Update existing GIS data layers related to natural hazards.

Responsible Department(s): Engineering, Department of Technology

Strategies:

1. Consider seeking funding and support programs that update FEMA's Flood Insurance Rate Maps (FIRM). Consider participation in FEMA's Cooperating Technical Partners (CTP) program that establishes partners with local jurisdictions to develop and maintain up-to-date flood maps.
2. Utilize GIS to inventory at risk infrastructure and public and private structures within flood prone areas.
3. Participate in FEMA's Digital Flood Insurance Rate Maps (DFIRM) program.
4. Support FIRM remapping projects that address areas in the region that have the most serious mapping problems and where flooding is a repetitive problem.

Goal: Identification of structural projects that could mitigate the impact of flooding.

Responsible Department(s): Engineering

Strategies:

1. Consider seeking funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems.
2. Support Virginia Department of Transportation projects that call for improved ditching, replacement of inadequate and undersized culverts, enlargements of bridge openings and drainage piping needed to minimize flooding.

Goal: Maintain an accurate database and map of repetitive loss properties

Responsible Department(s):

Strategies:

A. Work with VDEM and FEMA to update list of repetitive loss properties annually.
B. Obtain updated list of repetitive loss properties annually from VDEM/FEMA.
C. Review property addresses for accuracy and make necessary corrections.
D. Determine if and by what means each property has been mitigated.
E. Map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).

F. Determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

All Hazards

Goal: Provide early warning for terrorism events and natural disasters and emergencies.
Responsible Department(s): Emergency Management
Strategies:

1. Purchase and maintain the Reverse 911 system. Funding annual maintenance and upgrade costs. Identify likely targets and develop call out list for quick activation. Identify flood prone areas and incorporate those numbers in a flood notification database.
2. In cooperation with VDEM, FEMA, the Red Cross and other localities support comprehensive public information and education program dealing with citizen preparedness for acts of terrorism as well as manmade disasters.

Goal: Develop Disaster Pet Sheltering capabilities through equipment procurement, plans, and Community Animal Response Team (CART) development.
Responsible Department(s): Emergency Management, Animal Control
Strategies:

1. Secure grants to purchase and maintain mobile pet sheltering equipment for temporarily housing, caring, and ensuring accountability of pets.
2. Develop annex for City Emergency Operations Plan, Standard Operating Guidelines for pet shelter deployment, and Community Animal Response Team Plan.
3. Develop Roanoke Community Animal Response Team to support outreach, staffing, registration, and care of animals during pet shelter activation.

Goal: Develop Disaster Volunteer Management and Reception capabilities
Responsible Department(s): Emergency Management, Council of Community Services, other supporting jurisdictions
Strategies:

1. Secure grants to purchase and maintain Volunteer Management and Reception capabilities.

2. Develop annex for City Emergency Operations Plan, Standard Operating Guidelines for pet Volunteer Reception deployment, and plan to support volunteers in supporting operations.

Goal: Develop Disaster Family Assistance Center capabilities through planning, and volunteer outreach and development, and exercise.

Responsible Department(s): Emergency Management, Health Department

Strategies:

1. Develop Family Assistance Center Plan, Standard Operating Guidelines for Family Assistance Center deployment, and identify staffing needs.
3. Identify personnel for staffing and develop guidelines that identify skill set, training, and requirements.

Table 85
City of Roanoke Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Reverse 911	All Hazards	Reduced loss of life and property through improved warning system.	$50,000	High	High	FEMA, VDEM, Local Government	Local Government	Switched to hosted service	Ongoing
Structure acquisition	Flooding	Removal of structures from flood hazard areas; reduce repetitive loss; reduce loss of life and property.	$50,000 per year	High	High	FEMA, VDEM, Local Government	Local government	Ongoing	Ongoing
Public Education	All Hazards	Inform public about hazards and mitigation options and NFIP	$50,000	Medium	Medium	FEMA, VDEM, Local Government	Local government	Ongoing	Ongoing
Flood Hazard mapping update / modernization	Flooding	Increased accuracy of flood maps and more effective regulation and enforcement of regulations	$100,000	High	High	FEMA, VDEM	Local government	Ongoing	Ongoing, incumbent upon flood reduction project completion.
Additional Hazard related GIS layers / data	All hazards	Increased accuracy of hazard mitigation planning.	$100,000	High	Medium	USGS, NOAA, FEMA, VDEM, VDOT	Local government	Ongoing	Ongoing
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	Unknown	High	High	FEMA, VDEM, Local government	Local government, Engineering & Building Inspections	Ongoing	2013-2018
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	0	High	High	FEMA	Local government	Ongoing	Ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	Unknown	High	High	FEMA, VDEM	Local government, RVARC, VDEM	Ongoing	GIS Layers created-floodprone areas

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Support Virginia Department of Transportation projects that minimize flooding	Flooding	Clear debris and repair banks along roads to prevent backup, erosion and flooding of existing drainage systems	$1,400,000	N/A	Medium	FEMA, VDEM, VDOT	Local government or VDOT	Not started; lack of funding	
Participate in CRS	Flooding	Reduction in flood insurance rates; reduction in flood loss	$10,000	High	High	VDEM	Local government; Engineering Dept	Participating Community	Ongoing
Develop and maintain an inventory of flood prone critical facilities	Flooding	Available inventory of critical structures that need additional or unique protection from flooding.	$10,000	Medium	Medium	FEMA, VDEM	Local government	Not started; lack of funding	
Continue participation in FEMA's DFIRM program	Flooding	Updated flood hazard mapping	$15,000	High	High	FEMA, local government	Local government	In progress	Ongoing
Develop Family Assistance Center Plan, Standard Operating Guidelines for Family Assistance Center deployment, and identify staffing needs	All Hazards	Supporting government and private employers in Roanoke by developing SOGs to implement Family Assistance Center	0	High	Medium	City & private partner agencies	City of Roanoke	Developed	maintenance
Secure grants to purchase and maintain Volunteer Management and Reception capabilities	All Hazards	Supporting spontaneous volunteers in a disaster	$25,000 (100% grant funded)	High	Medium	City/FEMA	Roanoke Valley governments	Implemented	Ongoing
Standard Operating Guidelines for pet Volunteer Reception deployment	All Hazards	Supporting spontaneous volunteers in a disaster	0	High	Medium	City Emergency Management	City EM & Police Department	Developed	Ongoing
Develop Disaster Pet Sheltering capabilities	All Hazards	Supporting Pets in Disaster by developing Community Animal Response Team	$25,000 (100% grant funded)	High	Medium	City Emergency Management	City EM & Police Department	Developed	Ongoing

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Upgrade / repairs to storm water system	Flooding	Reduce frequency and impact of flooding	$57,000,000	High	High	FEMA, VDEM, Local government	Local government	Ongoing	Ongoing
Drainage System Maintenance	Flooding	Clear debris and repair banks to prevent backup, erosion and flooding of existing drainage systems.	$500,000	High	High	FEMA, VDEM, Local government	Local government	Ongoing	Annually
Update Regional Storm Water Management Master Plan	Flooding	Watershed / mitigation planning and project identification	$750,000	High	High	FEMA, Local government, PDC	Local government	Not Started; lack of funding	Unknown

CITY OF SALEM

Current and Past Mitigation Measures

Floodplain Management – The City of Salem adopted a Floodplain Management Ordinance in 1993 (revised in 2007) that requires new residential buildings to be elevated to a minimum of one foot (1') above the base flood elevation. The City has a floodplain overlay district corresponding to areas identified on Flood Insurance Rate Maps prepared by FEMA.

Roanoke Valley Regional Stormwater Management Plan – All four Roanoke Valley jurisdictions participated in the development of the plan that was coordinated through the efforts of the Fifth Planning District Commission (Roanoke Valley-Alleghany Regional Commission). It offers alternative solutions for both flooding and flash flooding problems. These alternatives include clearing stream channels, enlarging drainage openings, constructing regional detention facilities, and flood proofing individual structures. The plan presents a total of 138 individual projects to address flooding in the 16 watersheds. These are ranked in order of priority within each watershed but no overall ranking within the valley is presented. Cost estimates are presented for each project, but neither individual project benefits, nor cumulative benefits are discussed. It would be essential to analyze the benefits of these projects before the plan can be used as a guideline for specific activities. The identified projects would cost a total of $66 million in 2001 dollars, not including land acquisition or efforts to flood proof or move over 2,200 buildings. A formal quantification of the corresponding benefits would go a long way toward justifying this cost, which can initially seem overwhelming to both citizens and community officials. For example, the 1997 plan reports that between 1972 and 1992, floods caused over $200 million in damages in the valley, and resulted in 10 deaths. The plan's Financing Options Report recommends creation of a regional stormwater utility as a means of funding the identified work.

Stormwater Management – The City has a Stormwater Management Ordinance that is part of the City Code. It was developed to bring the City into compliance with state laws on stormwater management and erosion and sedimentation control. The City will modify this ordinance to be consistent with the statewide Stormwater Management Model Ordinance in 2013.

National Flood Insurance Program – The City participates in, and is in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal

requirements. This program allows property owners to purchase flood insurance from NFIP. There are currently 523 NFIP policies in force in the City.

Dam Safety – Spring Hollow Reservoir Dam, located on a tributary of the Roanoke River and owned by the Western Virginia Water Authority, could impact properties in the City of Salem if it failed.

Erosion and Sediment Control – The City of Salem has adopted the regulations, references, guidelines, standards and specifications promulgated by the Virginia Soil and Water Conservation Board (and any local handbook or publication of the board) for the effective control of soil erosion and sediment deposition to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources. Such regulations, references, guidelines, standards and specifications for erosion and sediment control are included in, but not limited to, the Virginia Erosion and Sediment Control Regulations and the Virginia Erosion and Sediment Control Handbook, as amended from time to time. Salem's ordinance, in addition to referencing the handbook, states in Section 30-117 that the erosion and sediment control plan must consider "Peak runoff from a ten year or 100-year frequency storm, based on present and future developed conditions …" and "If the watershed is greater than one square mile in area, a peak runoff study of the 100-year frequency storm shall be prepared."

IFLOWS – The City participates in a flood warning system developed by the National Weather Service called Integrated Flood Observing and Warning System (IFLOWS). Through the use of radio-transmitted information, this system provides advanced flood forecasting to the City Emergency Operation Center. There is one IFLOW station located in the City.

Project Impact Roanoke Valley – Project Impact Roanoke Valley was a partnership of FEMA, Roanoke County, the cities of Roanoke and Salem and the Town of Vinton to reduce destruction to life and property during disasters through planning and mitigation. The Project Impact Roanoke Valley Steering Committee and its work groups evaluated hazard mitigation needs from 1998 to 2001. The four work groups were: Hazard Mitigation, Public Information and Community Education, Stormwater Management and Partnership and Resource group. The Stormwater Management group was responsible for the preparation of over 1,500 floodplain elevation certificates. The Public Information and Community Education and Partnership and Resource groups met with community organization, civic groups, businesses and the general public to promote hazard mitigation activities. The Land Use group focused on the how local plans and ordinances relate to hazard mitigation and published Hazard

Mitigation through Land Use Planning in 2001. The Hazard Mitigation group addressed flooding, wildfire, meteorological events, and hazardous materials incidents in its report Hazard Analysis.

City of Salem Mitigation Goals and Strategies

In developing mitigation strategies for the region and each locality, a wide range of activities were considered in order to achieve the goals and to lessen the vulnerability of the area to the impact of natural hazards. **All goals, strategies and projects are dependent on the availability and timeliness of non-local funding.**

Goals and Strategies were prioritized by each locality. Prioritization was completed in order of relative priority – high, medium or low – based on the benefit to cost criteria and the strategy's potential to mitigate the impact from natural hazards. Consideration was also given to availability of funding, the department/agency responsible for implementation, and the ability of the locality to implement the project. Under each identified pre-disaster, applicable local government departments will be the lead in making sure that each project or action will be implemented in a timely manner with other departments, other local governments' representatives and/or other regional agencies.

The anticipated level of cost effectiveness of each measure was a primary consideration when developing the list of proposed projects. Since the mitigation projects are an investment of public funds to reduce damages, localities have selected and prioritized projects based on the benefit to cost of each project in hopes of obtaining the maximum benefit. Projects were categorized as high, medium or low benefit to cost based on the available information for each proposed project. Reduced damages over the lifespan of the projects, the benefits, are likely to be greater than the project cost in all cases. Although detailed cost and benefit analysis was not conducted during the mitigation action development process, these factors were of primary concern when prioritizing and selecting the proposed projects.

Flooding

Goal: Mitigation of loss of life and property from flooding and flood related disasters.

Responsible Department(s): Engineering and Inspections, Emergency Services

Strategies:

1. In cooperation with local governments, support a comprehensive public information and education program on flooding, living in the floodplain, flood risks, low cost simple flood mitigation measures, flood insurance, stream remediation, hydrology, floodplain ordinances, and NFIP. This can be accomplished through regional workshops and educational materials for citizens, businesses, local staff, and elected officials.
2. Develop and maintain an inventory of flood prone roadways in cooperation with the Virginia Department of Transportation.
3. Develop and maintain an inventory of flood prone critical facilities such as hospitals, public utility sites, airports, etc.
4. Participate in FEMA Hazard Mitigation Programs such as SRL, FMA, PDM, RCL, and HMGP for acquisition/demolition projects, structure elevation, relocation, flood-proofing critical facilities, infrastructure upgrades, and technology upgrades.
5. Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP) by enforcing floodplain management regulations that meet federal requirements.
6. Acquisition of flood prone properties followed by the appropriate mitigation action of demolition or relocation.

Goal: Update existing GIS data layers related to natural hazards.

Responsible Department(s): Engineering and Inspections

Strategies:

1. Consider seeking funding and support programs that update FEMA's Flood Insurance Rate Maps (FIRM). Consider participation in FEMA's Cooperating Technical Partners (CTP) program that establishes partners with local jurisdictions to develop and maintain up-to-date flood maps.
2. Utilize GIS to inventory at risk infrastructure and public and private structures within flood prone areas.
3. Participate in FEMA's Digital Flood Insurance Rate Maps (DFIRM) program.
4. Support FIRM remapping projects that address areas in the region that have the most serious mapping problems and where flooding is a repetitive problem.

5. Map locations for swift water rescue launch sites along Roanoke River.
6. Use HEC-GeoRAS and HEC-GeoHMS software to model potential flood scenarios and identify high-hazard areas.
7. Annual review of floodplain ordinances and make any necessary changes to remain in compliance with NFIP regulations.

Goal: Provide early warning of flooding.
Responsible Department(s): Emergency Services, Department of Technology
Strategies:

1. Identify areas with recurring flood problems and request additional IFLOW stream/rain gauges as appropriate to ensure that these areas are adequately covered and monitored.
2. Identify areas with recurring flood problems and incorporate the addresses and phone numbers into an early warning database, specifically the Reverse 911 system.

Goal: Identification of structural projects that could mitigate the impact of flooding.
Responsible Department(s): Engineering and Inspections
Strategies:

1. Consider seeking funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems.
2. Support Virginia Department of Transportation projects that call for improved ditching, replacement of inadequate and undersized culverts, enlargements of bridge openings and drainage piping needed to minimize flooding.
3. Identify congested streams and remove debris to enhance flow and mitigate flooding.

Goal: Maintain an accurate database and map of repetitive loss properties
Responsible Department(s):
Strategies:

A. Work with VDEM and FEMA to update list of repetitive loss properties annually.
B. Obtain updated list of repetitive loss properties annually from VDEM/FEMA.
C. Review property addresses for accuracy and make necessary corrections.
D. Determine if and by what means each property has been mitigated.

E. Map properties to show general site locations (not parcel specific in order to maintain anonymity of the property owners).

F. Determine if properties have been mitigated and inform FEMA/VDEM through submission of an updated list/database and mapping.

All Hazards

Goal: Provide early warning for terrorism events and natural disasters and emergencies.

Responsible Department(s): Emergency Services, Department of Technology

Strategies:

1. Purchase and maintain the Reverse 911 system. Funding annual maintenance and upgrade costs. Identify likely targets and develop call out list for quick activation. Identify flood prone areas and incorporate those numbers in a flood notification database.
2. In cooperation with VDEM, FEMA, the Red Cross and other localities support comprehensive public information and education programs dealing with citizen preparedness for acts of terrorism as well as manmade disasters.

Goal: Improved Communications Interoperability.

Responsible Department(s): Department of Technology

Strategies:

1. Improved communications interoperability:
   - 1.1. This would include possibly upgrading our current radio system to new digital technology, but if not, we could install a special Cisco router that would handle the translation from different technologies.
   - 1.2. Cellular/Data services would be included here as well.
     - 1.2.1. AirCards/data services in emergency responder vehicles that allows access to real-time data (GIS, Pictometry, etc.)
     - 1.2.2. Cellular/data services for mobile monitoring tools to allow real-time notification to dispatch/field personnel.
   - 1.3. Extend current communications infrastructure to include outdoor mesh access points at strategic locations. This would involve leveraging existing fiber, installing new fiber, and putting ruggedized switches in traffic signal cabinets.
     - 1.3.1. Mesh APs can be connected via ruggedized switches at traffic signal locations.

1.3.2. IP cameras can also be connected via the same ruggedized switch at these locations to monitor traffic patterns/incidents/etc. in dispatch via the new video monitoring software.

1.3.2.1. The video management software is going to be integrated with the new CAD software scheduled to go live in June/July 2012.

1.4. Our Cisco phone infrastructure can integrate with communication technologies to include the existing radio system and our cellular data devices.

1.4.1. IPcelerate is third party software that integrates with the phone system for paging/intercom/panic buttons/notifications/etc.

1.4.2. Currently working with Roanoke College on IP based paging/overhead speakers in public areas (i.e., downtown, Elizabeth Campus, Civic Center, stadiums, etc.) IPcelerate allows for these global-type broadcasts including speakers/etc. at the school system if they choose to use the technology during future renovations/expansions.

2. Funding to cover the existing Citizen Alerting System.

2.1. This system allows for end user notification via phone, text, etc.

Wildfire

Goal: Mitigation of loss of life and property from wildfires.

Responsible Department(s): Engineering and Inspections, Emergency Services, Streets and General Maintenance

Strategies:

1. Defensible Space for Wildfire – Create perimeters around homes, structures, and critical facilities through the removal or reduction of flammable vegetation.
2. Application of Ignition-resistant Construction – Apply ignition-resistant techniques and/or non-combustible materials on new and existing homes, structures, and critical facilities.
3. Hazardous Fuels Reduction – Remove vegetative fuels proximate to the at-risk structures and critical facilities that pose a significant threat to human life and property

Table 86
City of Salem Hazard Mitigation Projects

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Flood hazard mapping update/ modernization	Flooding	Increased accuracy of flood maps	N/A	High	Medium	FEMA, VDEM	Local government	N/A	N/A
Reverse 911	All hazards	Reduced loss through improved warning system	$85,000	High	High	FEMA, VDEM, Local Government	Local government, Fire & Emergency Services, Police, IT	N/A	2011-2016
Communication equipment interoperability	All hazards	Improved coordination among jurisdictions; improved response times; citizen alerts	$1,000,000 to 3,000,000	N/A	High	FEMA, Local government	Local government, Fire & Emergency Services, Police, IT	N/A	2011 - ?
Additional hazard related GIS layers/data	All hazards	Increased accuracy of hazard mitigation planning	$50,000	High	High	USGS, NOAA, FEMA, VDEM, VDOT, VDOF, local	Local government, Engineering & Inspections	ongoing	ongoing
Participate in, and remain in good standing with, the National Flood Insurance Program (NFIP)	Flooding	Reduction of future flood damage through enforcement of floodplain ordinances and availability of discounted flood insurance for property owners	N/A	High	High	FEMA	Local government, Engineering & Inspections	ongoing	ongoing
Maintain an accurate database and map of repetitive loss properties	Flooding	Identification of repetitive loss properties that should be mitigated	N/A	High	High	FEMA, VDEM	Local government, Engineering & Inspections	ongoing	ongoing

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Support Virginia Department of Transportation projects that minimize flooding	Flooding	Clear debris and repair banks along roads to prevent backup, erosion and flooding of existing drainage systems	$1,400,000	N/A	Medium	FEMA, VDEM, VDOT	Local government or VDOT	Not started; lack of funding	N/A
Seek funding to prepare site-specific hydrologic and hydraulic studies that look at areas that have chronic and repetitive flooding problems	Flooding	Possible determination of solutions to repetitive loss properties.	$15,000	High	Medium	FEMA, VDEM, Local government	Local government, Engineering & Inspections	Not started; lack of funding	N/A
Identify congested streams and remove debris	Flooding	Improved stream flow and mitigation of flooding	$100,000	Medium	Medium	FEMA, VDEM, Local government	Local government, Engineering & Inspections, Street Department	Not started; lack of funding	N/A
Identify locations for additional IFLOWS monitoring and additional stream gauges	Flooding / Heavy Rains	Provide better, more timely information to allow faster, more accurate warnings to be issued to the public	$10,000	High	Low	FEMA, VDEM, Local government	Local government, Engineering & Inspections	Not started; lack of funding	N/A
Map locations for swift water rescue launch sites along Roanoke River	Flooding	Provide localities with locations for swift water boats to launch from along the Roanoke River	$960	Medium	Medium	FEMA, VDEM, Local government	Local government, Fire & Emergency Services	Completed in 2012	Complete
Use HEC-GeoRAS and HEC-GeoHMS software to model potential flood scenarios and identify high-hazard areas	Flooding	Use software to model potential flood areas and identify high risk areas to help mitigate flooding	$10,000	Medium	Low	FEMA, VDEM, Local government	Local government, Engineering & Inspections	Not started; lack of funding	N/A

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Continue participation in FEMA's DFIRM program	Flooding	Updated flood hazard mapping	$10,000	High	High	FEMA, local government	Local government, Engineering & Inspections	In progress	Ongoing
Develop and maintain an inventory of flood prone critical facilities	Flooding	Available inventory of critical structures that need additional or unique protection from flooding.	$10,000	Medium	Medium	FEMA, VDEM	Local government, Engineering & Inspections	Not started; lack of funding	N/A
Participate in CRS	Flooding	Reduction in flood insurance rates; reduction in flood loss	$20,000	High	Low	VDEM	Local government, Engineering & Inspections	Not started; lack of funding	N/A
Participate in FEMA Hazard Mitigation Programs such as SRL, FMA, PDM, RCL, and HMGP.	Flooding	Possible sources of funding for acquisition/demolition projects, structure elevation, flood-proofing critical facilities, infrastructure upgrades, and technology upgrades	$250,000	High	High	FEMA, VDEM, Local government	Local government, Engineering & Inspections	New projects to start in 2013	2011-2016
Annual review of floodplain ordinance	Flooding	Up to date floodplain ordinance to provide guidance for development	N/A	N/A	Low	Local government	Local government, Engineering & Inspections	In progress	Yearly Review
Additional hazard field data	All hazards	Elevation certificates for residential, business and critical facilities; increased accuracy of hazard mitigation planning	$25,000	High	Medium	FEMA, VDEM, Local government	Local government, Engineering & Inspections.	As needed per project	ongoing

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Acquisition of flood prone properties	Flooding	Removal of households from flood hazard areas; reduce repetitive loss; reduce loss of life and property	$1,000,000	High	High	FEMA, VDEM, Local government	Local government, Engineering & Inspections	New project to start in 2013	2011-2016
Public education	All hazards	Inform public about hazards and mitigation options	$25,000	High	High	FEMA, VDEM, Local government	Local government	ongoing	ongoing
Stormwater facilities construction	Flooding	Reduce frequency and impact of flooding	$1,000,000	High	High	FEMA, VDEM, local match	Local government, Engineering & Inspections.	Not started; lack of funding	2011-2016
Upgrade/repairs to stormwater system	Flooding	Reduce frequency and impact of flooding	$1,000,000	High	High	FEMA, VDEM, Local government	Local government, Engineering & Inspections	Not started; lack of funding	2011-2016
Drainage system maintenance	Flooding	Clear debris and repair banks to prevent backup, erosion and flooding of existing drainage systems	$1,000,000 annually	High	High	FEMA, VDEM, VDOT	Local government, Engineering & Inspections, Street Department	ongoing as needed	ongoing
Flood proofing critical facilities	Flooding	Install flood gates to reduce flooding	$285,0000	High	High	FEMA, local match	Local government, Engineering & Inspections	Completed one project 2011, began new project 2013	2011-2016
Elevation of flood prone properties	Flooding	Elevate flood prone structure 1’ above Base Flood Elevation	N/A	High	Low	FEMA, VDEM, Local government	Local government, Engineering & Inspections	Not started; lack of funding	2011-2016
Acquisition/ Relocation project	Flooding	Acquire and Relocate flood prone facilities from flood hazard areas; reduce repetitive loss; reduce loss of life and property	$150,000	High	Low	FEMA, VDEM, Local citizen match	Local government, Engineering & Inspections	New project to start in 2013	2011-2016

Project	Hazard Mitigated	Benefit	Cost Estimate	Benefit-to-Cost	Priority	Funding Partners	Implementation/ Lead Agency	Status	Proposed Schedule
Defensible Space	Wildfire	Project to remove combustible material near structures	N/A	High	Low	FEMA, VDEM, Local government	Local government, Engineering & Inspections, Fire & Emergency Services, Streets and General Maintenance	Not started; lack of funding	2011-2016
Application of Ignition-resistant Construction	Wildfire	Apply ignition resistant techniques to new or existing structures and critical facilities	N/A	High	Low	FEMA, VDEM, Local government	Local government, Engineering & Inspections, Fire & Emergency Services, Streets and General Maintenance	Not started; lack of funding	2011-2016
Hazardous Fuels Reduction	Wildfire	Removal of vegetative fuels in proximity to at-risk structures and critical facilities	N/A	High	Low	FEMA, VDEM, Local government	Local government, Engineering & Inspections, Fire & Emergency Services, Streets and General Maintenance	Not started; lack of funding	2011-2016

Chapter 7
Plan Maintenance

The Plan Maintenance section of this document details the process that will ensure that the Mitigation Plan remains an active and relevant document. The process includes a schedule for monitoring the Plan on an annual basis and producing the required plan revision every five years. This section describes how the localities will integrate the plan into their overall planning efforts.

The Plan Maintenance section of the plan was reviewed by the Regional Pre-Disaster Mitigation Plan Committee. No changes were made during the 2012 update.

Evaluating and Updating the Plan

The Mitigation Plan will be evaluated on an annual basis to review progress that has been made on implementing the projects and to identify changes that could affect mitigation priorities. The convener, Roanoke Valley-Alleghany Regional Commission, will be responsible for contacting the Mitigation Advisory Committee members and organizing the annual meeting. Committee members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan. The Committee will determine at the annual meeting if an update of the plan is needed. At a minimum, the plan will be updated every five years.

The committee will review the projects to determine if they are addressing current and expected conditions. The review will also consider state and Federal legislation that could affect the implementation of the plan. The committee will also review the risk assessment portion of the Plan to determine if this information should be updated or modified, given any new available data. The coordinating organizations responsible for the various action items will report on the status of their projects, the success of various implementation processes, difficulties encountered, success of coordination efforts, and which strategies should be revised.

Monitoring activities will include periodic reports by agencies involved in implementing projects or activities; site visits, phone calls, and meetings conducted by the Roanoke Valley-Alleghany Regional

Commission; and the preparation of an annual report that captures the highlights of the previously mentioned activities.

The evaluation will utilize the following criteria:

1. That goals and objectives address current and expected conditions.
2. Changes in the nature, magnitude, and/or type of risks.
3. That resources were appropriate for implementing the plan.
4. Existence of implementation problems, such as technical, political, legal, or coordination issues with other agencies.
5. That outcomes have occurred as expected.
6. That agencies and other partners have participated as originally proposed.

The Hazard Mitigation Advisory Committee will also notify all holders of the regional plan when changes have been made. Every five years the updated plan will be submitted to the Virginia Department of Emergency Management and the Federal Emergency Management Agency for review.

Public Involvement

Roanoke Valley-Alleghany Regional Commission and the local governments of the region are dedicated to involving the public directly in review and updates of the Hazard Mitigation Plan. The public will also have the opportunity to provide feedback about the Plan. Copies of the Plan will be catalogued and kept at all of the appropriate agencies.

In addition, copies of the plan and any proposed changes will be posted on the Roanoke Valley-Alleghany Regional Commission website. This site will also contain an email address and phone number to which people can direct their comments and concerns. Public meetings will also be held in conjunction with each annual evaluation or when deemed necessary by the Hazard Mitigation Advisory Committee. The meetings will provide the public a forum for which they can express its concerns, opinions, or ideas about the Plan. Local Public Information Officers will be responsible for publicizing the annual public meetings and maintaining public involvement through the public access channel, web page, and newspapers.

Coordinating Body

The Regional Hazard Mitigation Committee will be responsible for coordinating undertaking of the formal annual and five-year review and update process. Each locality will designate the appropriate representatives to the committee.

In order to make this committee as broad and useful as possible, the Roanoke Valley-Alleghany Regional Commission will encourage other organizations and agencies to become involved in hazard mitigation. Possible additional representatives include: elected officials, insurance representative, Home Builders Association, Virginia Department of Transportation, railroad industry, gas and electrical utilities, and a local Red Cross representative.

The Hazard Mitigation Advisory Committee will meet on an annual basis. These meetings will provide an opportunity to discuss the progress of projects and identify updates that may need to be made. The Roanoke Valley-Alleghany Regional Commission will serve as coordinator for the Committee.

Plan Adoption

The governing body of each locality will be responsible for adopting the Mitigation Plan. Each governing body has the statutory authority to promote actions to prevent the loss of life and property from natural hazards. The Roanoke Valley-Alleghany Regional Commission will be responsible for submitting the document to the Virginia Department of Emergency Management (VDEM). The VDEM will then submit the plan to the Federal Emergency Management Agency (FEMA) for review and approval. The review will be based on the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201. Following FEMA review and approval, each participating jurisdiction will be required by FEMA and VDEM to formally adopt the plan.

Implementation through Existing Programs

Local governments have the statutory authority to implement many planning and mitigation goals through the comprehensive plan, capital improvement plan, and building and zoning codes. The Pre-Disaster Mitigation Plan provides a series of recommendations, which could be incorporated into the goals, and objectives of existing planning programs.

Upon adoption of the mitigation plan, localities will be able to utilize the Pre-Disaster Mitigation Plan as a baseline of information on the natural hazards that impact the region. These projects and action items identified in the Plan will help local governments develop planning documents that assist in protecting life and property from natural disasters. Local jurisdictions can use the annual Plan review as an avenue to update relevant sections of the capital improvements plan and incorporate mitigation activities.

The local building officials are responsible for administering the building codes. The Pre-Disaster Mitigation Plan Committee will work with other agencies at the state level to review, develop and ensure building codes that are adequate to mitigate or prevent damage by natural hazards.

Local governments should incorporate the relevant data, goals, actions and projects into their comprehensive plans. This can be accomplished through development of a hazard mitigation chapter for the plan or a series of sections in the plan that addresses specific hazards. A separate hazard mitigation chapter in the plan would provide a readily accessible source of hazard information for citizens and officials. Addressing hazards in each relevant section of the plan, such a flood prone roadways in the transportation chapter, would also be an effective method for documenting risk, potential loss and projects relating to hazard mitigation.

In the planning region, several localities have either utilized or discussed the information in the Regional Pre-disaster Mitigation Plan as part of their local comprehensive plans. Alleghany County included loss estimates and mitigation project listings in their 2007 and 2013 Comprehensive Plan updates. The Town of Clifton Forge mentions its participation in the Regional Hazard Mitigation Plan efforts in its 2012 Comprehensive Plan. The City of Covington has included mitigation goals, projects and loss estimates in its 2013 Comprehensive Plan update. Other localities in the region address flooding in various ways in their comprehensive plans and development ordinances but do not address all natural hazards.

APPENDICIES

Appendix A
Planning Process and Public Participation

Appendix B
Locality Flood Hazard Maps

Appendix C
Locality Adoption Resolutions