Local Hazard Mitigation Planning Manual

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I. Introduction

A. Natural Hazards and Disasters

Natural hazards are part of the world around us, and their occurrence is inevitable. Floods, hurricanes, tornadoes, winter storms, earthquakes, wildfires and other hazardous events are natural phenomena which we cannot control. These events can result in much damage to the ecological environment: fire can destroy forests, coastal storms can create and fill inlets and move barrier islands, high winds and wave surge can wreak havoc in wetlands, tornadoes can uproot trees, earthquakes can alter the landscape. However, despite their destructiveness, these occurrences are part of the natural system. The natural environment is amazingly recuperative from the forces of wind, rain, fire and earth, and can regenerate with resiliency, restoring habitat and ecosystems in time for the next generation of plant and animal life to begin anew.

It is when the man-made environment intersects with these natural phenomena that "disasters" result. Disasters occur when human activity, such as buildings, infrastructure, agriculture, and other land uses take place in the path of the forces of nature. The human environment, particularly the built environment, is not nearly as indestructible nor as recuperative as the natural one, and the occurrence of a natural hazard can result in the debilitation of an entire community for many years following the event.

Unfortunately, in this country the frequency of disasters is rising at an alarming rate, not necessarily because natural hazards have become more frequent (although such phenomena do occur in cycles of more and less frequency)[*] , but because more and more people have chosen to live and work in locations that put them at risk. Since the 1960s, tremendous numbers of Americans have chosen to live in areas at risk from coastal storms, repeated flooding, and seismic activity, often with little or no attention to the need for sound building practices or land use policy. As a result, risk of disasters occurring in the wake of natural hazards has grown exponentially. For instance, by the year 2010 the number of people residing in the most hurricane-prone counties throughout the nation will have doubled. Likewise, while floods have caused a greater loss of life and property and have disrupted more families and communities than all other natural hazards combined, the rate of development in flood-prone areas continues to escalate, putting more and more people and property in danger.

While we cannot prevent natural hazards, we do have some means at hand to reduce some of their adverse consequences. We have tools and techniques which, when put into effect in a timely fashion, allow us to avoid the worst-case scenario when a hazard does occur. By

[*] There is growing scientific evidence that global warming and the resulting climatic changes occurring around the world will contribute to increasingly volatile weather patterns. Projections have also been made that prospective rising sea levels will only exacerbate the problems of coastal flooding, as the world's oceans encroach upon the shoreline.

managing the characteristics of the existing and *future* human environment in a community before a hazardous event occurs, we can mitigate many of its negative impacts so that a *disaster* is less likely to result or will at least be of diminished magnitude.

This manual is intended to serve as a guide to local policy makers, business leaders, planners, builders and developers, environmental and conservation groups, private citizens, and others who wish to make use of available mitigation measures in order to decrease the vulnerability of their communities to future disasters. By following the steps outlined in the manual, a local community can create an effective plan for mitigating the impacts of the natural hazards that occur in its area.

B. The Four Elements of Comprehensive Emergency Management

Comprehensive emergency management is a widely used approach at the local, state and federal levels to deal with the inevitability of natural hazards and their potential to cause disasters in a given community. The components of a comprehensive emergency management system include:

1. Preparedness activities, which are undertaken to improve the ability to respond quickly in the immediate aftermath of an incident. Preparedness activities include development of response procedures, design and installation of warning systems, exercises to test emergency operational procedures, and training of emergency personnel.
2. Response activities occur during or immediately following the disaster, and include such time-sensitive items as search and rescue operations, evacuation, emergency medical care, food, and shelter programs. Response activities are designed to meet the urgent needs of disaster victims.
3. Recovery activities are emergency management actions which begin after the disaster, as urgent needs are met. These actions are designed to put the community back together, and include repairs to roads, bridges, and other public facilities, restoration of power, water, and other municipal services, and other activities that help restore normal operations to a community.
4. Mitigation activities reduce or eliminate the damages from hazardous events. These activities can occur before, during, and after a disaster, and overlap all phases of emergency management. Structural mitigation pertains to actions such as dam and levee projects to protect against flooding, constructing disaster-resistant structures, retrofitting existing structures to withstand events, etc. Non-structural mitigation activities include development of land use plans, zoning ordinances, subdivision regulations and tax incentives and disincentives to discourage development in certain high-hazard areas. Mitigation also includes education programs for members of the public about the hazards to which their community is vulnerable, as well as the importance of mitigation and how to prepare their property to withstand a disaster.

Currently, there are a wide variety of government programs that provide financial and technical assistance covering all phases of emergency management. Under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (the Stafford Act), a Governor may request the President to issue a major disaster declaration or an emergency for an area stricken by a natural hazard. Regulations define a *major disaster* as any natural catastrophe or, regardless of cause, any fire, flood, or explosion that causes damage of sufficient severity and magnitude to warrant assistance supplementing state, local, and disaster relief organization efforts to alleviate damage, loss, hardship, or suffering. An *emergency* is defined as any occasion or instance for which Federal assistance is needed to supplement state and local efforts to save lives and protect property and public health and safety, or to lessen or avert the threat of a catastrophe. A Stafford Act declaration triggers a range of assistance available from federal agencies, some of which may be used for mitigation activities. One of the most significant of these is the Hazard Mitigation Grant Program (HMGP), authorized by Section 404 of the Stafford Act. The HMGP provides funds to communities for eligible mitigation activities in the wake of a declared disaster.

C. The Concept of Mitigation and Its Importance

The tension between natural hazards and the decisions people make regarding land use and the built environment is mounting every day. We must take steps to significantly reduce the vulnerability of Americans and their communities to natural hazards; this can only be done through mitigation. *Hazard mitigation* involves recognizing and adapting to natural forces, and is defined by the Federal Emergency Management Agency (FEMA) as *any sustained action taken to reduce long-term risk to human life and property from natural hazards.* This definition highlights the long-term impact that effective mitigation can produce. While the actions involved in the preparatory, response and recovery phases of emergency management are related to specific events, mitigation activities have the potential to produce repetitive benefits over time, and should concern events that may occur in the future.

In fact, hazard mitigation can be viewed as the foundation of emergency management, and should be interwoven with all the other phases of a comprehensive emergency management system. The aftermath of a disaster provides a unique window of opportunity to assess the damage that has befallen a community and to elucidate its causes. This allows members of the community to take action during re-building to prevent or diminish the same disaster when the next natural hazard occurs. Whether applied in post-disaster reconstruction or during pre-disaster planning efforts, hazard mitigation provides planners with guidelines for reducing vulnerability to future disaster-related damages. By developing mitigation programs that affect the impact of future disasters, planners can break the cycle of damage, reconstruction, and repeated damage.

A fundamental premise of mitigation strategy is that current dollars invested in mitigation will significantly reduce the demand for future dollars by reducing the amount needed for emergency recovery, repair and reconstruction following a disaster. Mitigation also calls for conservation of natural and ecologically sensitive areas (such as wetlands, floodplains, dunes) which enables the environment to absorb some of the impact of hazard events. In this manner, mitigation programs can help communities attain a level of *sustainability*, ensuring long-term economic vitality and environmental health for the community as a whole.

D. Hazard Mitigation and Sustainable Communities

In many areas of the United States, including North Carolina, communities are growing faster than their natural surroundings can support them. Americans are notorious for using natural resources and producing wastes at ever-increasing rates. Non-renewable resources are being used faster than renewable substitutes are being found, and pollutants and toxins are building up beyond our capacity to contain them. Even our choices of where we live have begun to push the limit; development is occurring in areas which are inappropriate or even dangerous for human settlement. Flat, dry construction sites are long gone in many communities, yet the pressure to build more commercial venues, production facilities, employment centers, and residential units continues to be steady and strong in much of the country. Left to develop are only previously untamed lands - wetlands, ocean front beaches and dunes, floodplains, steep slopes, fault zones, fire-prone areas, and other wild spaces. Many are altered to suit the builders' needs - wetlands are drained, dunes are leveled, vegetation is planted in fire-break zones - and the natural integrity of the area is forever impugned. In choosing these building sites and changing the landscape, we not only lose the inherent value of these areas, but we also expose ourselves to forces beyond our control.

In the past two decades, the concept of *sustainable development* has emerged as a means to help us regain a balance with the Earth's natural systems. By applying the principles of this theory to our daily decision-making, we can change our current eco-destructive habits. Sustainable development calls for efficient and fair allocation of resources, and wise use of our natural, cultural, and economic capital. *Hazard mitigation* is one of the ways we can accomplish this, by making the built environment more resilient to the impacts of natural hazards, thereby decreasing the future vulnerability of human life and property while bolstering the long-term viability of natural ecosystems and human communities.

While there are many definitions of sustainable development, the one that is nearly universally accepted today emanates from the report published in 1987 by the United Nation's World Commission on Environment and Development entitled *Our Common Future* (also referred to as the Brundtland Report). *Sustainable development* is "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*." This definition highlights the future orientation of sustainable development theory, an approach that mirrors that of hazard mitigation. Hazard mitigation requires that we build, rebuild and plan for today's development while considering the impact of natural hazards yet to come on inhabitants in the years ahead. A community's future vulnerability to natural hazards can be determined by: (1) projecting various development scenarios; and (2) assessing both the number of people that would experience harm, and the amount of property that would be damaged were a hazard event to occur. Armed with such knowledge, proactive community members can take action to reduce this level of vulnerability, strengthening the community as a whole for today and tomorrow.

It is important to note that neither the principle of sustainable development nor of hazard mitigation necessarily propose a "no growth" policy for communities to become less vulnerable and more sustainable. Rather, these concepts advocate for the safe accommodation of future population rise through conscientiously controlled growth and development. These are *qualitative* concepts, and do not always involve quantitative measures. Sustainable development communicates a concern *with what* kind of development, rather than how much, while hazard mitigation encourages development that is built to standards designed to withstand likely hazard impacts and is located in areas that have minimal exposure to those impacts.

Sustainable development recognizes that our economic structure and the natural environment are not in conflict, but instead are irrevocably interconnected and interdependent. Economies that are faltering do not allow people the "luxury" to invest wisely and consider the long-term, which can often put natural resources in peril as they are exploited for immediate gain. In turn, natural ecosystems that are not operating at optimum levels due to pollution or other human-induced trauma do not produce the staples of a firm economy. Hazard mitigation can play a role in maintaining a balance between the human and the natural systems and ensuring the health of both. By investing in mitigation measures before a hazard occurs, a community can significantly reduce the need for large expenditures for emergency response, recovery, repair and reconstruction following a disaster. Mitigation can also provide a degree of socio-economic continuity in the community by reducing the social and economic disruption that often accompanies a hazardous event through damage to transportation and communication systems, dislocation of people, loss or interruption of jobs, and closing or disabling of businesses, schools, and social centers.

One of the roadblocks to local implementation of the principles of sustainability and mitigation is the fact that much of the land within local jurisdictions has already been developed according to practices and traditions that are far from sustainable. Ironically, the time immediately following a natural disaster provides a community with a unique window of opportunity for inserting an ethic of sustainability in guiding development and redevelopment in high-risk areas. With forethought and planning, communities that are rebuilt in the aftermath of a natural hazard can be built back so that they are more resilient to future hazards, breaking the pattern of hazard-destruction-rebuilding. At the same time, the community is given the opportunity to incorporate other attributes of sustainability into its "second chance" development, such as energy efficiency, affordable housing, use of recycled building materials, reduction of water use, and environmental protection.

II. The Hazard Mitigation Plan

A. Rationale for Local Mitigation Planning

Mitigation is the only component of comprehensive emergency management that has the potential to break the cycle of damage and reconstruction that can occur when a community is subjected to repeated natural hazards. A local hazard mitigation plan can be an effective vehicle for establishing the community's commitment to mitigation goals, objectives, policies and programs. By articulating what the community hopes to achieve, the plan can serve to establish an important connection between the public interest and mitigation measures to be employed. It is important that this connection be made at the local level; local participation in hazard mitigation planning is essential because the regulation and control of development, as well as the provision of much of the infrastructure that supports development, occurs in large part at the local level. It is crucial, therefore, that local communities not rely solely on state or federal-level planning initiatives to implement hazard mitigation measures. Rather, each local community should strive to create its own unique hazard mitigation plan that will address the issues and concerns particular to that community's level of vulnerability to hazard risks.

A local hazard mitigation plan also provides a medium to inform the community about natural hazards and about mitigation, increasing public awareness of the risks present in the community, as well as the resources available to reduce those risks. Achieving widespread public awareness of natural hazards will enable citizens to make informed decisions on where to live, purchase property or locate a business, and how to protect themselves and their property from the impact of natural hazards. In the public sector, decision-makers who are well-informed and well-guided by a mitigation plan can carry out their official daily activities in a manner that will encompass mitigation concepts. The plan, then, guides the implementation of goals, objectives, policies and programs as it educates the community.

A meaningful mitigation plan also provides the impetus for a local government to become a "good leader" in the forefront of mitigation strategy. Governments at all levels must, through their own activities in the built environment, set a good example in terms of mitigation. All new public facilities should be sited away from hazardous areas, and should be built to meet or exceed model building codes and standards. Existing public structures should be retrofitted to withstand the impact of natural hazards, protecting public investment. By demonstrating first-hand the efficacy of mitigation, as well as the level of commitment the local government is willing to put forth, local governments will provide incentive to private owners and builders to carry out the goals and policies of the hazard mitigation plan as well.

When prepared carefully, a local hazard mitigation plan can also satisfy statutory requirements imposed on local governments, such as those contained in the Stafford Act. However, while the Stafford Act is a major impetus for hazard mitigation planning, it is not the only governmental program which either mandates or provides incentives for local governments to engage in hazard mitigation planning, and this manual includes reference to these other programs as well. For instance, the North Carolina Coastal Area Management Act requires that local governments in the twenty counties that comprise the coastal zone of North Carolina prepare a land use plan that contains an element addressing hazard mitigation and preparedness issues in that community. The National Community Rating System (CRS) encourages hazard mitigation planning activities by offering insurance cost savings to local residents whose communities participate in the National Flood Insurance Program (NFIP). Other government programs are easier to access or are more effectively utilized when local governments have prepared a hazard mitigation plan. Some of these programs include the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMAP), the Public Assistance Program, the Small Business Administration Disaster Assistance Program, the Community Development Block Grant Program, the Hurricane Program, and the National Earthquake Hazards Reduction Program. (These programs are described in an Appendix to this manual.) While local governments are urged to research the specific requirements peculiar to each hazard mitigation or disaster assistance program in which it wishes to participate, this manual will provide a general guideline for meeting the criteria of many programs. In this way, a local community should be able to prepare a plan which will satisfy most of the programs that either mandate or encourage hazard mitigation planning.

B. What is a Plan?

1. Section 409 Approach

There is ample evidence that the impacts of natural hazards on the human environment can be lessened or even avoided altogether by appropriate action taken well before the hazardous event occurs. The most effective way to ensure that this action takes place is through the preparation and implementation of a comprehensive hazard mitigation plan. Plans are developed as guides, and when implemented, affect the future by *not* leaving it to chance.

While there are many valid approaches to the planning process, this manual emphasizes the planning procedures that emanate from the Federal Stafford Disaster Relief and Emergency Assistance Act. Section 409 of the Stafford Act is the major catalyst at the national level for involvement of state and local governments in the hazard mitigation planning process. Governments are required to evaluate and plan for natural hazards as a condition of receiving federal disaster assistance. Because of this major role that Section 409 plays in the procurement of federal disaster aid, we have used the Section 409 planning requirements as a framework of analysis in this manual, and will refer to Section 409 and the implementing regulations as we discuss the hazard mitigation planning process as it is carried out at the local level.

The Stafford Act regulations emphasize a plan-before-the-disaster approach, and encourage governments to incorporate mitigation into daily government operations (44 CFR 206.405(b)):

> Hazard mitigation plans should be oriented toward helping state and localities to develop hazard management capabilities and programs as part of *normal governmental functions*. All states are encouraged to develop a basic mitigation plan *prior to the occurrence of a disaster* so that the basic plan can simply be expanded or updated to address specific issues arising from the disaster. (Emphasis added).

This section of the manual highlights the elements and characteristics of an effective hazard mitigation plan, within the context of FEMA's post-disaster hazard mitigation planning requirements.   Most of these elements and characteristics will also meet criteria for other types of government-assistance programs available to local communities. Each local government must, however, take care to tailor its mitigation plan to its own unique set of circumstances. Furthermore, while this chapter and the following chapter (discussing the process of plan-making) are based on statutorily-imposed criteria, local governments preparing hazard mitigation plans are urged to become familiar with the legislation and regulations themselves in order to meet every legal requirement. Local governments should also attain a copy of the North Carolina Section 409 Hazard Mitigation Plan; the local plan should parallel the framework of the State plan to assure consistency.

2. Background Studies

In order to develop an effective plan, we must understand the problems which the plan is to address. This is done through careful data collection and analysis. This section of the manual will introduce the steps that provide a sound informational background to the hazard mitigation plan. (How these steps are carried out is described in the next chapter of this manual).

The first background study logically involves an accurate *identification and analysis* of the natural hazards that could potentially affect a local community, along with the impacts those hazards might have upon the people and the built environment. Such an analysis is crucial to an effective hazard mitigation plan, for while we know in general terms which broad geographic areas are subject to which natural hazards, we need a clear understanding of the specific type and extent of the potential impacts of hazards on individual communities in order to make decisions about which mitigation actions should be undertaken. At a minimum, the major natural hazards to which a community is or may be subject should be described in terms of frequency, magnitude, and distribution. Ideally, a community should identify *all* natural hazards that may occur in that area. The identification must be as site-specific as possible—what areas are affected by what hazards, and in what way?

The *probability analysis* determines the likelihood of a given hazard occurring in the community, as well as its probable level of intensity. This is a critical step that allows the community to focus on hazards that are most likely to occur, targeting scarce resources to the greatest need.

The *vulnerability* analysis is an assessment of the number of lives and the value of property in those areas identified as being at risk. A community's degree of vulnerability depends upon the risk of a natural hazard occurring in that area (including such factors as probability, frequency, and severity), as well as the amount and type of development or potential development that is or could be located there.

The *capability* analysis is an important background study because it identifies and evaluates existing systems that either reduce or increase a jurisdiction’s vulnerability to natural hazards. The capability analysis also provides critical information on which types of actions are feasible in terms of financial resources, political willpower, institutional framework, technical ability, and legal authority. Furthermore, the capability assessment can provide a mechanism to cite and take credit for those systems that already exist and are successful in the community. This is important to foster community support for continuing or increasing mitigation efforts. Documentation of successful mitigation systems is also necessary for receipt of some forms of government disaster assistance.

The hazard identification, probability analysis, vulnerability analysis, and capability assessment all provide critical background information to plan makers. While the regulations implementing Section 409 of the Stafford Act characterize these analyses as "elements" of a 409 hazard mitigation plan (see regulations at 44 CFR 206), we suggest that this data be presented in an appendix to the hazard mitigation plan, rather than as part of the plan itself. This approach emphasizes the appropriate role of the assessments as baseline surveys for developing program initiatives, identifying resources, and providing an informed basis for developing the plan's goals, priorities, and objectives.

3. Elements of the Hazard Mitigation Plan

a. Section 409 Requirements

While a local hazard mitigation plan should be tailored to reflect the community's unique mitigation needs, there are certain common elements that should be included in most mitigation plans. This section of the manual describes these elements briefly, using Section 409 regulations as a framework. The regulations implementing Section 409 of the Stafford Act specify the following essential elements for a 409 hazard mitigation plan:

> 44 CFR 206.405 Elements
>
> (a) General. In order to fulfill the requirement to evaluate natural hazards within the designated area and to take appropriate action to mitigate such hazards, the State shall prepare and implement a hazard mitigation plan or plan update. At a minimum the plan shall contain the following:
>
> - An evaluation of the natural hazards in the designated area;
> - A description and analysis of the state and local hazard mitigation policies, programs and capabilities to mitigate the hazards in the area;
> - Hazard mitigation goals and objectives and proposed strategies, programs and actions to reduce or avoid long-term vulnerability to hazards;
> - A method of implementing, monitoring, evaluating and updating the mitigation plan. Such evaluation is to occur at least on an annual basis to ensure that implementation occurs as planned, and to ensure that the plan remains current.

These elements are described briefly below.

b. Rationale/Statement of the Problem

Although this element is not a requirement of Section 409 plans, a local community would be wise to include an introductory section explaining the rationale behind its local hazard mitigation plan. This element should include a generalized statement of the problem to be solved by the plan, and what the community hopes to achieve in broad terms. More concrete and detailed expressions of the community's aspirations in terms of hazard mitigation, and how they will be fulfilled will be articulated in other elements of the plan (e.g., Goals; Objectives; and Policies, Programs and Actions), but the main points should be introduced up front.

The rationale section of the plan should also highlight the essential purposes of the plan: to influence decision-making in both the public and private sectors, as well as to prove community eligibility for government grant, loan, and aid programs.

c. Goals

Regulations found at 44 CFR 206.406(f) mandate that goals and objectives be set for all Stafford Act hazard mitigation plans:

> The participants in the planning process shall develop the basic mitigation goals and objectives from which the proposed hazard mitigation strategies, programs, and actions shall be drawn.

Hazard mitigation goals should be broad in scope and far-reaching in application. This part of the plan should present the vision of the government for mitigation in the community. The goals should also serve to set the community's priorities.

d. Objectives

Objectives are developed as a means of realizing a community's hazard mitigation goals. Objectives are more specific and tangible than goals. Rather than being long-term and general, objectives should be achievable in a finite period of time, and the results should be measurable against benchmarks and indicators. Since objectives need to be attainable, they should be soundly based on the background studies prepared earlier and documented in the plan appendices.

e. Policies, Programs and Actions/Strategies

44 CFR 206.405(a)(3) states:

> The plan shall contain ... proposed strategies, programs and actions to reduce or avoid long-term vulnerability to hazards.

44 CFR 206.406(f) states that the plan's proposed hazard mitigation strategies, programs, and actions shall be "drawn from" the goals and objectives. In other words, the strategies developed as part of the plan are mitigation measures designed to implement the objectives of the plan. Policy statements establish the directions the community wishes to pursue in achieving its mitigation goals. Together, these elements are the "To Do" section of the plan.

The policies, programs, and actions that are made part of the plan itself should include both ongoing as well as post-disaster mitigation measures. These include programs that are constantly and consistently being implemented in the community, including those mitigation measures which are insinuated into the government's day to day operations. This section of the plan should also identify projects to be done on an "as-need" basis, and projects, strategies, or programs which may be needed to implement the plan after a disaster.

C. Characteristics of the Hazard Mitigation Plan

1. Comprehensive

a. Multi-Hazard

The hazard mitigation plan should be as comprehensive as possible in order to cover all potential mitigation opportunities. An "all-hazards" basis for a mitigation plan makes the most efficient use of limited resources. The plan should, therefore, deal with all possible natural hazards throughout the entire local jurisdiction. At a minimum, the major natural hazards in the disaster area should be examined in terms of probability, frequency, magnitude, and distribution. Some other known hazards, or "secondary" hazards should also be included in the analysis. For example, mudslides often accompany severe flooding, and should be recognized for their potential impact in addition to that of the catalytic hazards.

In addition to primary and secondary natural hazards, FEMA has encouraged governments to assess technological hazards and the potential impacts on human beings and their environment. Mitigation strategy cannot deal exclusively with natural hazards and ignore technological hazards if it is to be truly comprehensive. Furthermore, natural hazard events often trigger technological hazards such as ruptured pipelines and building fires, clearly linking the natural and technological risks. Under Section 409, hazard evaluation refers to an evaluation of state and local vulnerability to natural hazards. However, it is FEMA's intent that if a declaration is made for a technological hazard, state and local governments will be expected to evaluate the hazard(s) which caused the disaster. This supports FEMA's goal of comprehensive multi-hazard mitigation planning.

Comprehensive planning also dictates that as many of the impacts of hazards as possible be identified. For instance, a post-disaster section of a local community's plan regarding the socio-economic implications of a particular disaster could prove invaluable in assessing the entire disaster scenario. Elements of such an analysis should include potential impacts due to the loss of jobs, recovery rate of destroyed and damaged businesses, property tax revenue shortfalls, disrupted real estate markets, migration, and disruption of family lives. While many of these variables are subject to fluctuations due to factors other than disaster occurrences, the economic indicators are still useful for the selection and initiation of appropriate mitigation action.

In addition to making the hazard mitigation plan a comprehensive document, the use of the all-hazard approach may have tangible benefits as well. Under new rules codifying current Hazard Mitigation Grant Program (HMGP)* policy, eligible HMGP projects may address any identified hazard in the declared area, regardless of the type of hazard causing the particular disaster at hand. For example, a state highly vulnerable to flooding may fund a flood mitigation project using funding from a declaration for tornadoes. Because Section 409 requires the government to evaluate all identified natural hazards, the measures selected for funding through Section 404 do not necessarily need to address the hazards listed in the declaration.

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* The Hazard Mitigation Grant Program, authorized by Section 404 of the Stafford Act, is a significant source of funds following a Presidentially declared disaster.

b. Multi-Objective

The goals and objectives articulated in the hazard mitigation plan need to be comprehensive in scope and cover a wide range of potential mitigative action. However, goals and objectives need not be competing. In fact, hazard mitigation has a much greater likelihood for success when goals are effectively combined. Common hazard mitigation goals which can be simultaneously achieved include securing public safety, reducing hazard losses, reducing unnecessary expenditures, eliminating redundancy, lessening exposure to liability, and speeding economic recovery.

Furthermore, many mitigation objectives can be accomplished by dovetailing other types of goals or joining forces with other programs and authorities. For example, rezoning a vulnerable floodplain area for open-space, recreational use, reservoir area, or public park can achieve hazard reduction objectives as well as provide a community asset. In this way, basic environmental and social/recreational goals can be combined with those of hazard mitigation. Not only does accomplishing multiple goals through a single initiative protect human lives, the built environment, and the natural environment, it also results in more cost-effective government. Communities that successfully combine cross-cutting goals and objectives can also come closer to being sustainable for the long term in multiple ways.

c. Long-Term

In order to be truly comprehensive, a hazard mitigation plan must have a long-range horizon. While particular plan objectives and specific projects and actions may have a fixed time period within which they are to be achieved or carried out, the scope of the hazard mitigation plan as a whole must be broader than the time frame dictated by individual component parts.

Section 409 of the Stafford Act emphasizes this long-range approach to hazard mitigation planning in the regulations:

> The plan shall contain hazard mitigation goals and objectives and proposed strategies, programs, and actions to *reduce or avoid long-term vulnerability* to hazards. (44 CFR 206.405(a)(3) (Emphasis added).

A long-range vision is one of the hallmarks of sustainable development, and a community that strives for this ideal will be well on the way with a mitigation plan that looks ahead not only to the typical planning range of five to ten years, but beyond to the time when future populations will live in the area generations from now.

d. Internally Consistent

We have discussed the importance of mitigation plans being multi-hazard and multi-objective. However, the pursuit of comprehensiveness should not be undertaken at the expense of internal consistency. Risk reduction measures for one natural hazard must be compatible with risk reduction measures for other natural hazards to which the community is also subject. For example, certain techniques for elevating flood prone structures may make a structure more susceptible to damage from earthquake. Similarly, retrofitting a building to reduce earthquake damage may be a poor investment if the building is flood prone. On the other hand, tying down a manufactured home can be an effective technique for mitigating wind, flood *and* seismic hazards.

Furthermore, risk reduction measures for natural hazards must also be compatible with risk reduction measures for technological hazards and vice versa. When hazard mitigation options are considered, care must be taken to avoid solutions that may increase the risk of technological events, such as elevating chemical storage facilities to mitigate flood hazard without addressing seismic risk.

2. Windows of Opportunity

Mitigation plans typically seek to identify the optimum points for implementing mitigation actions within the comprehensive emergency management cycle. Strategies for including mitigation as part of the activities carried out during the preparation, response and recovery phases of a disaster are critical for victims of that particular event, as well as help ensure these disaster victims will not be victims again when the next natural hazard occurs. The aftermath of a disaster can provide a unique opportunity to alert the public to the dangers inherent in natural hazards, and the value of mitigating against their impacts. Public acceptance of mitigation policies will be highest while the reality of a disaster is fresh in citizens' minds. The re-building phase following a hazard event is a prime time to ensure that the community will become less vulnerable and more resilient to future hazards.

While mitigative action taken during phases of comprehensive emergency management are significant in reducing potential losses, a truly comprehensive mitigation plan also includes strategies for incorporating mitigation into the day to day operations of the local government. The local mitigation plan should specify a process for identifying all such windows of opportunity, so that mitigation concepts can be considered when carrying out routine government business. Mitigation should be addressed as an aspect of local land use policy, including zoning and subdivision regulations, building inspections, environmental impact review, highway and street planning, capital improvement planning, tax and spending policies, and all other relevant activities of local government, rather than solely as an issue of emergency management.

The integration of mitigation concepts into the normal function of government is particularly important in the areas of local land use policy and construction and building regulations. For instance, local communities should take care that future land use elements and future land use maps of local comprehensive plans include policies for post-disaster density-reduction and land use modifications in areas subject to hazardous conditions. In addition, hazard mitigation planning efforts should be coordinated with enforcement authorities, including land use and construction codes, regulations, and ordinances to ensure compliance with mitigation (and therefore public safety) principles.

3. Cost-Effective

Every mitigative action proposed in the mitigation plan must address the question of cost-effectiveness: will the proposed measure reduce future disaster response and recovery costs more than the cost of implementing the measure? Though it is difficult to factor in the monetary value of human life when calculating the cost-effectiveness of a mitigation measure, certain costs can, and must, be examined. The local hazard mitigation plan should incorporate protocol for establishing the cost-effectiveness of proposed mitigation measures.

One available cost/benefit method involves calculating the value of the damages incurred in a recent disaster that could have been prevented by a particular mitigative measure, and use that value as a basis for comparison against the cost of the proposed measure. Next, the magnitude and probability of the event's recurrence interval should be factored in. If the damages received were from a relatively small, and more frequent, earthquake, hurricane, or flood, then it is reasonable to expect that these damages might be repeated several times over the life of a given structure. Thus, a mitigation measure could cost more than the current damages, but still be justifiable. Historical loss data can also be used. For instance, paid insurance claims and previous outlays for disaster assistance should be considered when evaluating cost effectiveness. Normal maintenance costs can be used if the situation is a chronic one. There are also economic and cost-benefit models available that can be used.*

4. Environmentally Sound

The hazard mitigation plan should incorporate environmental principles into its text. Care must be taken that policies intended to foster mitigation are not undertaken at the expense of the local or regional area's environmental integrity. As the connections between networks of streams, rivers, adjacent wetlands, soils, vegetation, dunes, beaches and other features of the natural environment are increasingly studied and understood, natural resource and environmental management are being recognized as vital for emergency management. This "natural infrastructure" can perform a mitigative function in the human environment, protecting lives and structures from the full impact of natural hazards by providing flood control, wind resistance, minimization of storm surge, and other beneficial functions.

Unfortunately, land use practices in some areas have impaired the ability of floodplains and other natural areas to fully assimilate the impact of storms and flooding, causing more harm to the built environment than would otherwise have occurred. Communities should consider undertaking efforts to enhance rather than hinder the mitigative ability of the natural environment before all such areas are developed.

In addition to preserving floodplains, dunes, wetlands, and other such naturally occurring mitigative resources, communities should take steps to avoid the environmental contamination that can occur as a result of hurricanes and other natural hazards. Instances of pollutants and hazardous substances being released into flood waters following a natural hazard have led to contamination of public drinking water supplies, causing extreme danger to public health and safety. Environmental degradation also weakens the natural system's ability to absorb

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*One of the eligibility requirements for HMGP projects is cost-effectiveness, based on the following criteria (44 C.F.R. 206.434(b)):

- Be cost-effective and substantially reduce the risk of future damage, hardship, loss, or suffering resulting from a major disaster. The grantee must demonstrate this by documenting that the project:
    1. Addresses a problem that has been repetitive, or a problem that poses a significant risk to public health and safety if left unsolved.
    2. Will not cost more than the anticipated valued of the reduction in both direct damages and subsequent negative impacts to the area if future disasters were to occur. Both costs and benefits will be computed on a net present value basis.

contaminants, leading to further risks to health and safety.

Not only should environmental protection be central to the theme of the hazard mitigation plan, but individual projects and actions proposed under the hazard mitigation plan should be scrutinized for their “environmental soundness.” Not only is this a sensible planning approach, it is a specified eligibility requirement for all HMGP projects (see 44 C.F.R. 206.434(b)(5)(iii)). The regulations of Subpart N also specify that in order to be eligible for the HMGP, a project must:

> Be in conformance with 44 C.F.R. Part 9, Floodplain Management and Protection of Wetlands, and 44 C.F.R. Part 10, Environmental Considerations (44 C.F.A. 206.434(b)(3)).

In addition to the requirement imposed by the Stafford Act that all HMGP projects be “environmentally sound,” the National Environmental Policy Act (NEPA) requires that all activities of the federal government (including those funded by the federal government) meet certain environmental criteria. Specifically, an Environmental Impact Statement (EIS) or its equivalent is required for all federal grantors of funds to be used for projects that may have an impact on the environment. While FEMA, as federal grantor of disaster relief moneys, is responsible for carrying out NEPA’s EIS requirement, the local government proposing the mitigation project in its mitigation plan would be well-advised to perform its own analysis of the environmental implications of the project. This may help expedite the environmental review process by gathering critical information for use by FEMA, as well as maintain a degree of local involvement in the process.

5. Readable

Despite the emphasis on comprehensiveness, if the local hazard mitigation plan is to achieve its purpose, it must be a “readable” document. It must be written in clear, unambiguous language so that its intent and direction are obvious. The format of the plan must be straight-forward and simple. Often, following the statutory language of the legislation that is the driving force behind the mitigation plan can help provide an organizational framework for the local plan. Such an approach may help to expedite the review and approval process of some regulatory requirements. However, local communities are urged to “customize” their plans to meet the needs of that community, not just to fulfill all the requirements of a particular grant-in-aid statute with a generic, by-the-book plan.

The text of the local hazard mitigation plan must be concise, without minimizing the significance of any one particular segment of the plan. The body of the plan is not to be made up of lists of sources of legal authority, past hazards and disaster figures, or proposed projects and activities. The text should be supported by extensive appendices, where various elements and issues can be described in depth for purposes of background analysis. The plan itself should be an expression of that community’s approach to hazard mitigation, and a description of how, where, and when that approach will be carried out in the local arena.

The plan must speak to local residents, as well as inform local officials of their responsibilities in terms of initiating, implementing, and enforcing hazard mitigation measures in the community. The plan must also be intelligible to an audience wider than the residents and officials of the jurisdiction where it applies. The plan may be reviewed and applied by readers who have never visited the area, such as state emergency management officials, FEMA representatives, charitable organizations, and others with an interest in mitigation activities in that community.

Often maps, illustrations, and other graphics can provide the visual dimension necessary for comprehension of how the mitigation plan is to apply in a particular area. Useful maps and graphics could include those showing recommended strategies and project areas, as well as maps indicating which geographic areas are to receive priority attention during plan implementation. Useful background data would include maps depicting flood insurance rates, floodway and flood boundary maps, NFIP areas, seismic risk zones, community street and critical facilities maps, and land use (current and future) maps.

D. Types of Plans

Local hazard mitigation plans can be one of a wide variety of types of plan; the particular format chosen by a local community should best suit the role the hazard mitigation plan is expected to fulfill for that community. Some communities may choose to create a hazard mitigation plan that is a stand-alone, single purpose plan. In this instance, care should be taken that all the statutory requirements for local plan creation and adoption are followed so that the plan can operate as a free-standing document.

Communities have traditionally prepared stand-alone mitigation plans in the wake of a disaster, a practice which has the advantage of generating public support for mitigation while the obvious need for it is so readily apparent. Unfortunately, these post-disaster plans are often prepared without adequate background studies and under tremendous time pressures, and may not adequately address mitigation issues outside the context of the immediate disaster.

Other communities may include the hazard mitigation plan as a component of the local emergency management plan. These plans deal with all four components of emergency management, and include directions for the community's responsibilities during preparation, response, recovery, and mitigation phases. These plans tend to be programmatic in nature, and focus on specific courses of action to be taken in the event of a disaster. Emergency management plans can also emphasize policy, however, and provide guidelines for implementing particular plan components.

Still other communities may decide to make the mitigation plan part of the local comprehensive plan. Comprehensive plans tend to have a wider scope than stand-alone plans, setting general principles to guide future activity. This type of plan tends to be policy oriented, and deals with a whole range of community issues, including land use, economic development, capital improvements, transportation, housing, natural resource protection, and emergency management. Mitigation concepts can either be included in the comprehensive plan as a separate element or chapter, or can be incorporated into the other plan components. This latter approach has the advantage of highlighting mitigation as a necessary component of all other government operations, and calls for integration of mitigation into day-to-day decision making processes.

Whatever its place in the planning arena, the local hazard mitigation plan may be an incremental document that grows and evolves from year to year as the community's experience with hazard mitigation grows, and as resources become available. It is not necessary to have a "complete" document that addresses every conceivable aspect of mitigation before a community implements its plan. The plan may be done in pieces, for example, region by region, or by type of hazard

(<u>not</u>, however by individual disaster). By its very nature planning is a dynamic process, and the plan produced should not be viewed as a static, unchanging document. As the community's needs change, so must its hazard mitigation plan. Despite this inherent dynamism, however, it is vital that in each year, at every point in time, there be a viable approved plan in place, one that is being used day to day throughout the government and in the private sector.

III. Formulating the Plan

A. The Planning Process

Because each local community is different, each local hazard mitigation plan will be different. Every local community will make use of its own unique institutional framework for hazard mitigation plan formulation. Who is responsible for preparing the plan, who actually writes the plan, and who is involved in the formulation process will vary from jurisdiction to jurisdiction depending upon the anticipated role of the hazard mitigation plan in the area, as well as the financial, technical, and political resources that are available.

While there are numerous ways to go about formulating a hazard mitigation plan, certain steps are essential to creation of an effective plan that will allow the community to optimize its use of all the resources at its disposal. The regulations in Subpart M that implement the Stafford Act specify certain steps that must be included in plans, as do the CAMA Land Use Plan guidelines for coastal North Carolina communities. In addition, the Community Rating System (CRS) provides credit for preparing floodplain management plans according to a standard planning process. Therefore, there is much incentive for local communities to prepare their mitigation plans according to a process that is designed to select the best measures for the community and its hazards.

Planning is to guide the community through its hazard problem(s) by disclosing several options for solving the problems and identifying the most appropriate solutions. Basic planning steps include the following:

- Complete background studies: identify and analyze those hazards which affect the planning area, complete an analysis of the probability of those hazards occurring in the area, estimate the vulnerability of the area to those hazards, and evaluate the capabilities of the area to effectively mitigate their impacts.
- Draw conclusions about the acceptability of the area's vulnerability to natural hazards and actions that are currently being taken to mitigate the effects of natural hazards which affect the area.
- Develop goals and objectives for the hazard mitigation plan.
- Brainstorm alternative means to accomplish goals and objectives.
- Develop policies, programs, actions and strategies to achieve those goals and objectives.
- Adopt and implement the plan.
- Monitor the plan and continually evaluate its effectiveness and efficiency using a series of indicators and benchmarks to gauge success.
- Revise and update the hazard mitigation plan at regular intervals.

Some communities may assign responsibility for formulating the hazard mitigation plan to the local emergency management division; others may allot the task to the planning department or other agency. Either of these options may involve internal staff writing the plan, or the hiring of an outside consultant to write the plan according to the local community's dictates. The CRS gives credit points when the planning process is under the supervision or direction of a "professional planner" who may be a community employee, consultant, or an advisor from a state agency or regional planning agency.

Whatever entity or individual is put in charge of plan formulation, it is wise to include a wide range of participants in the planning process. By involving those who will be most affected by the plan, the community will get a more realistic product that will have a much better chance of being adopted and implemented. The regulations implementing Section 409 hazard mitigation planning requirements emphasize this inclusive approach:

> <u>44 C.F.R. 206.406 Hazard Mitigation Planning Process</u>
>
> (a) General. A sound planning process is essential to the development and implementation of an effective hazard mitigation plan. A critical element of successful mitigation planning is the involvement of key state agencies, local units of government and other public or private sector bodies or agencies that influence hazard management or develop policies within a state or local unit of government.

CRS guidelines also recommend that a wide variety of participants be involved in the planning process. Credit points are given if the planning process is conducted through a committee composed of staff from those community departments that will be implementing the majority of the plan's recommendations. Community departments that should be represented on the committee include:

- Building Department/Code Enforcement
- Land Use Planning/Zoning
- Emergency Management/Public Safety
- Environmental Protection/Health
- Engineering
- Public Works
- Public Information
- Parks/Recreation

The CRS also encourages coordination with other agencies during plan formulation. Other agencies should be contacted to see if they are doing anything that may affect the community's mitigation program and to see if they could support the community's efforts.

CAMA also requires that local coastal governments engage in intergovernmental coordination and implementation of their local land use plans. Local policy is to serve as the basic tools for coordinating numerous policies, standards, regulations, and other governmental activities at the local, state and federal levels. Each local government must also ensure that issues and concerns of adjoining planning jurisdictions be discussed, and that meaningful attempts to resolve inconsistent policies be made. (T15A N.C.A.C. 07B .0206)

The private sector should also be involved in the mitigation plan formulation process, as recognized in 44 C.F.R. 206.406(e) for all Stafford Act plans:

> When appropriate, a State or local government may choose to involve the private sector in the planning process. Support from the private sector is often essential to successful implementation of mitigation strategies at the local level. Involvement of the private sector in the early stages of the planning process may facilitate understanding and support for mitigation.

Private sector participants should include realtors, representatives of the insurance industry, lenders, builders, architects, and business leaders. Consolidating private-sector expertise and influence will enable plan-makers to multiply the benefits of mitigation strategies by strengthening the plan's base of support.

Citizen input into the plan formulation process is also essential. The CRS gives credit points to show the importance of involving the public in the planning process, especially as members of the planning committee. CAMA land use plan guidelines also call for public participation in the planning process. According to regulations at T15A N.C.A.C. 07B 0207:

> Local governments are required to employ a variety of educational efforts and participation techniques to assure that all segments of the community have a full and adequate opportunity to be informed and to effectively participate in planning decision-making. Educational efforts may include, but are not limited to, newspaper articles, television and radio shorts, etc. and participation techniques can include, but are not limited to, neighborhood advisory groups, questionnaires, newsletters, and public meetings.

The term public can include residents of hazardous areas, managers of critical facilities, farmers, landowners, even commuters and tourists. The community may also want to include owners of land outside the floodplain or other hazard area because often off-site activities can cause flooding or other negative impacts elsewhere. Public participation involves including these groups in developing local mitigation strategy from the beginning. This will help to guarantee that the public is aware of and committed to the policies. Some members of the community may even be able to assist with data collection and plan writing, making the planning process more efficient and reflective of local concerns.

While final policy decisions will be made by local officials, citizen participation is designed to give the public the opportunity to voice its views on policy items. The general public often bears the brunt of policies and projects designed to reduce disaster costs, and usually at the worst time - after the disaster event. Early public support of the local mitigation strategy will also help stop the tide of requests from members of the community for special exemptions after a disaster to rebuild their property just like it was before the storm.

B. Background Analyses

Basic studies that must be performed before a mitigation plan can be formulated include identifying and analyzing the hazards which affect the area, performing a rudimentary analysis to identify the relative threat to the area posed by each type of natural hazard, assessing the present and future vulnerability of people and property to each type of applicable hazard, performing an assessment of the capability of the area to effectively mitigate those hazards, and performing an acceptability analysis to evaluate at what level of risk the community will take action. This section of the manual will describe how to carry out these essential background steps.

1. Hazard Identification and Analysis

Prior to formulating a local hazard mitigation plan, those hazards which affect the planning area must be identified, and the threats which those hazards pose must be analyzed. Hazard identification and analysis involves determining *what* natural hazards affect the area, the *frequency* of the occurrence of each of those hazards, the *strength* of those hazards when they affect the local area, *where* effects are most likely to do the greatest harm to people or damage to property, and the *impacts* of each of the natural hazards on the area.

The hazard identification and analysis should include a description of *all* the hazards to which a community is subject. This step involves gathering and reviewing existing hazard studies (e.g., flood insurance studies), SLOSH and SPLASH models, and GIS applications, if such sophisticated computerized resources are available. An historic overview of past hazards that have occurred in the area is also useful. Maps that show the hazardous areas within the planning jurisdiction are essential to graphically illustrate the hazards.

CAMA guidelines require that the Storm Hazard Mitigation component of the local land use plan include a description of the likely conditions that the community will experience during a coastal storm, such as high winds, storm surge, flooding wave action, erosion, etc. (T15A NCAC 07B.0212(a)(5)(A)(i)(I)). The CRS gives credit points for assessment of flooding hazards in the community if the plan includes a description of the known flood hazards, including source of water, depth of flooding, velocities, warning times, as well as a discussion of past floods. Extra points are given if the CRS plan includes a map and description of other natural hazards, such as erosion, earthquakes, and hurricanes.

Since many of the users of the mitigation plan will not be geologists, meteorologists, or natural hazards experts, it can be useful to include in an appendix to the plan a brief discussion of the characteristics of each hazard that has been identified as relevant to the local community. However, because the hazard mitigation plan is to address the mitigation needs of the local community, the hazards assessment must go beyond a generic definition of hazard types.

Each hazard should also be described in terms of its *local* impact. For example, while some hazards such as hurricanes have affected an entire state, most hazards are much more limited in the area they affect. Tornadoes generally produce a narrow path of destruction; lightning strikes a particular point, and floods occur in fairly predictable areas. Some natural hazards, such as nor'easters, may have dramatically different impacts at different locations though out a state. For instance, in coastal areas, the effects of nor'easters are often similar to those from hurricanes. However, a nor'easter occurring during winter months may produce hazards and effects similar to those associated with severe winter storms in other parts of the state. Effects of natural hazards are likely to vary at different locations even within a county.

The hazard description should also include information regarding the typical timing of each type of hazard in the area. Some hazard events may be more likely to occur at specific times of the year, such as tornadoes and thunderstorms. Tornadoes are most likely to occur in the spring, during the months of March, April, May and June. The tornadoes during these months have also been strongest and have resulted in the greatest amount of harm or damage. The greatest chance of death or injury from lightning occurs during the summer months, from May through September. Hurricane season is typically September through November.

Some natural hazards may occur with fairly regular frequency, others are more unpredictable. The frequency of occurrence varies greatly by hazard. Research has shown that hurricanes follow a cyclic pattern, occurring with greater frequency and at greater strength during an approximate 30-40 year cycle. Earthquake activity tends to occur in extremely long cycles. North Carolina has not experienced a major earthquake for over 100 years, but some geologists warn that this does not imply that the hazard is non-existent at this time. Lightning and flash flooding, on the other hand, occur with much greater frequency than most other hazards.

It is also important to assess the strength with which natural events are likely to occur. A relatively strong hurricane will present a greater and more far-reaching series of impacts than those from a relatively weak hurricane. A blizzard may shut down transportation and communications in the mountains for days, as compared to the inconvenience caused by a minor snowfall. It is important to assess the range of strength of each natural hazard which could affect the planning area, in order to prepare plans to successfully mitigate the effects of those hazards.

Finally, it is important to determine the impacts which each natural hazard is likely to have on the local area. Some hazards may occur in conjunction with, or as a result of, other hazards. For example, flooding may occur during or following hurricanes, nor'easters, thunderstorms, or severe winter storms. When planning a mitigation strategy, it is essential to account for the full range of hazard events and effects which may occur.

Obviously, it is impossible to predict precisely what may happen from a particular hazard event, but scenarios likely to result from the occurrence of each hazard should be formulated. Developing scenarios provides a means to understand not only the types of natural hazards which will affect the planning area, but also how those hazards will impact the area.

When identifying hazards:

- identify all natural hazards which are likely to affect the area;
- define where each hazard is most likely to occur;
- determine where those hazards are most likely to occur within the planning area;
- determine the relative frequency of occurrence of each type of hazard;
- determine the range of strength of the hazard which the planning area is likely to experience;
- determine and analyze the impacts from those hazards to the planning area.

2. Probability Analysis

After identifying the hazards which affect the local area and analyzing the impacts from those hazards, a probability analysis should be undertaken. Such an analysis determines how likely each type of hazard is to occur in the local area. Given the amount of data accumulated for various hazards, a sound estimate of the probability of the occurrence of a given hazard type and its likely level of strength is possible.

A chart showing the relative probability of each hazard can be constructed fairly easily. This type of analysis does not necessarily require a detailed quantitative analysis of the risk of each type or hazard event, but can be constructed after careful consideration of the data gathered and analyzed in the preceding step. For example, relative risk from each natural hazard (hurricanes, nor'easters, flooding, thunderstorm, tornado, earthquake, wildfire, and severe winter storm) can be categorized as low, medium or high. A chart, such as shown on the following page, can be constructed to show the relative probability of all natural hazards of varying strengths under consideration.

Relative Probability of Natural Hazards

Hazard	Low	Moderate	High
Hurricane			
Nor'easter			
Flooding			
Thunderstorm			
Tornado			
Earthquake			
Wildfire			
Severe Winter Storm			

To complete this table, it is necessary to select appropriate measures to evaluate each hazard. Such measures could include:

- the location of the area with respect to exposure to past hazard events;
- the frequency with which each hazard is likely to occur in the area, based on historical records and trends;
- the relative strength of a typical hazard event which has affected the area.

For instance, coastal areas are known to experience hurricanes and nor'easters fairly regularly. A major hurricane has made landfall or passed close offshore numerous times during the past century in North Carolina. In general, coastal areas can expect to experience a major hurricane at least once every eight to nine years, on average. This would place most coastal areas at relatively high risk to hurricane hazard. Similar evaluations of the likelihood of occurrence of each type of hazard in the planning locality should be constructed.

Complete the table by determining the appropriate category for the probability of each hazard type. Once this process has been completed, those hazards which pose the greatest relative risk will be evident. This will enable local hazard mitigation efforts to be targeted to those hazards which pose the greatest threat to the area.

3. Vulnerability Analysis

Hazards are natural occurrences. A hazard area may or may not pose problems to people; a hazard area is only a problem when human activity gets in the way of the impacts that occur as a matter of course during and after a hazard. Vulnerability to a natural hazard can be defined as the extent to which people will experience harm and property will be damaged from that hazard. Hazards may result in loss of life or injury to people and livestock; loss of or damage to homes, businesses, and industries; loss or damage to automobiles, furnishings, records and documents; damages or interruptions to power and telephone lines, damage or closing of roads, railroads, airports, and waterways; and general disruption of life. It is important to know where and to what extent the community is susceptible to the impacts of natural hazards.

CAMA guidelines require an existing land use inventory for each of the most hazardous areas be included in the storm hazard mitigation section of the local land use plan. The inventory must portray the amount of existing development at risk, which can be achieved by overlaying each hazard area upon the existing land use map. (T15A N.C.A.C. 07B.0212(5)(A)(i)(III)).

The CRS gives credit points for an assessment of the impact of flooding on a community if it includes an inventory of the number and types of buildings (e.g., residential, commercial, industrial, with or without basements, etc.) subject to the hazards identified in the hazard assessment. The plan should also identify critical facilities, such as hospitals, fire stations, and chemical storage companies; describe areas that provide natural and beneficial functions, such as wetlands, riparian areas, sensitive areas, and habitat for rare or endangered species and other items.

Vulnerability to natural hazards exists both at the present time and in the future. The present level of development and infrastructure generates a set of conditions which result in every area having some degree of vulnerability to natural hazards. That degree of vulnerability will change in the future as an area experiences an increase or decrease in development and whether the community implements or ignores hazard mitigation. Therefore, we can speak of both present vulnerability and future vulnerability.

<u>Present Vulnerability</u>: Present vulnerability can be defined as the degree of harm to people and damage to property an area would experience were a natural hazard to occur today. This vulnerability is calculated as a result of the risk or likelihood of various types and strengths of hazards affecting an area (as determined by the probability analysis performed earlier), and the

current level and quality of development in that area. Current development affects an area's vulnerability in the following ways:

- *The population of the area*: the greater the population, particularly in locations susceptible to impacts from hazard events, the greater the vulnerability due to injury and loss of life;
- *The quantity and type of development in the area*: the greater the amount and density of development, the greater the vulnerability due to damage and destruction of property;
- *The communications networks in the area*: the greater the number of communications networks, and the more sophisticated the equipment involved in those networks, the greater the vulnerability due to loss of communications and interruptions of services;
- *The transportation and utility networks in the area*: the greater the volume of people and goods transported through the area, the greater the vulnerability due to the interruption of travel and loss of infrastructure. Also, the more dependent an area is on a single transportation or utility line, the greater the vulnerability due to lack of parallel systems.

Data useful in performing vulnerability analysis include:

- historical or average frequency of each type of hazard event;
- population of the area: be sure to include seasonal fluctuations, if applicable;
- number of people or properties particularly susceptible to damage from each type of hazard event;
- special communications, transportation, or utility facilities which could sustain crippling damage from a hazard event;
- other critical facilities located in hazard areas;
- unique circumstances which may increase or decrease the planning area's susceptibility to harm or damage from a hazard event;
- the degree of local mitigation efforts already in place for a given natural hazard.

Assessing present vulnerability can be complex task. However, it is not necessary to perform a detailed quantitative analysis of the number of people who live in a flood plain or the exact dollar value of real property that may be damaged or destroyed in a particular area. A qualitative analysis using a few indicators can serve as an effective means of developing a vulnerability assessment. For instance, an indication of the assessed value of property in an area may be gained quickly by examining tax base valuation maps. Population density can be classified according to relative terms such as very high, high, average, below average, or much below average relative to the state's overall population density.

A chart can be constructed to show relative present vulnerability to each natural hazard, demonstrating the community's vulnerability to each hazard in a qualitative, rather than a quantitative, sense. This chart will identify those hazards to which the area has the greatest present vulnerability. An example is shown on the following page.

Relative Present Vulnerability to Natural Hazards

Present Vulnerability			
Hazard	Low	Moderate	High
Hurricane			
Nor’easter			
Flooding			
Thunderstorm			
Tornado			
Earthquake			
Wildfire			
Severe Winter storm			

Future Vulnerability. Future vulnerability can be thought of as a measure of the extent to which people will experience harm and property would be damaged by a hazard event were a projected scenario of development to occur.

An area’s vulnerability will change with time. For instance, if current development patterns are projected into the future, it is possible to develop estimates of the population and amount of development that will exist in an area at some future point. If an area’s population is currently growing at a given percentage rate, it is possible to project the population five or ten years in the future. If current development patterns were assumed to continue, the number of additional housing units, commercial establishments, and employment centers could also be projected for similar time periods. Transportation, utility, and communications infrastructure is likely to increase also. Thus, given an increasing population and increasing development, it might appear that an area would have a greater vulnerability to hazards in the future.

Vulnerability will increase markedly if development occurs in areas particularly susceptible to adverse impacts from natural hazards. A good indicator of potential areas of future vulnerability lies in the local land use regulatory scheme. Areas of the community which have a relatively low present level of vulnerability because they are vacant or low-density properties may become highly vulnerable if the community's land use regulations (such as the local zoning ordinance) allow for improvements or increases in density for that area.

The presence or absence of other effective mitigation measures in the community may also predict future vulnerability. For example, in the absence of strict enforcement of hurricane standards in the building code, an area's vulnerability to hurricane hazard may increase dramatically, even if development is limited to those areas considered at relatively low risk to hurricane occurrence.

Planning for redevelopment in the wake of a natural disaster can also reduce an area's future vulnerability. Policies should be formulated that will allow and encourage redevelopment in a manner which will result in a lower vulnerability in the future, i.e., plans should be made that would allow for the correction of what may be considered current development "mistakes" from a hazard mitigation perspective.

In assessing vulnerability, it is important to look not only at the immediate area, but also to the surrounding region, to account for factors which could have an impact from outside the jurisdiction. For instance, some areas have implemented flood control measures such as dams or stream channelization. While these measures may serve to mitigate the effects from hazards in that particular area, such structural measures may adversely impact other communities by increasing flooding downstream. Local communities must be aware of how outside activities may impact their own vulnerability, as well as remember to be a "good neighbor," and avoid policies and actions that may increase the vulnerability of other communities.

The chart on the following page illustrates how information on a community's future vulnerability may be tabulated.

Relative Future Vulnerability to Natural Hazards

Future Vulnerability			
Hazard	**Low**	**Moderate**	**High**
Hurricane			
Nor'easter			
Flooding			
Thunderstorm			
Tornado			
Earthquake			
Wildfire			
Severe Winter Storm			

4. Capability Assessment

The capability assessment describes the legal authority vested in local governments to pursue measures to mitigate the impact of natural hazards. The assessment also evaluates the community's political willpower, institutional framework, technical know-how, and ability to pay for mitigation. The capability of all levels of government (local, state, federal, and regional), as well as the contributions made by non-governmental organizations (churches, charities, community relief funds, the Red Cross, hospitals, for profit and non-profit businesses) should be included, with a description of their utility to the local community in terms of hazard mitigation.

The capability assessment is more than a mere inventory of existing mitigation measures and organizations with hazard mitigation responsibility. It should include evaluation of the "de facto" mitigative measures - those which may be designed for another purpose, but which, nevertheless, have an effect (either positive or negative) on mitigation. The capability assessment can, therefore, provide a mechanism to cite and take credit for those systems that exist and are working in the community to reduce hazard vulnerability (whether such measures were designed for hazard mitigation purposes or not). This list of "success stories" helps avoid duplication of effort when new systems and programs are recommended. It is also important when FEMA is assessing the community's past performance for purposes of granting new disaster relief funds.*

In addition to citing success stories, the capability assessment must also identify and analyze any existing local policies or practices which may weaken existing mitigation efforts or even exacerbate the risk facing the local community from natural hazards. These may include formally adopted policies (e.g., relaxation of building code requirements following a flood or hurricane to speed recovery), or political directives concerning allocation of public resources.

a. Legal Capability

As a general rule, local governments have only that legal authority which is granted to them by their home state. This principle, that all power is vested in the State and can only be exercised to the extent it is delegated, is known as "Dillon's Rule," and applies to all North Carolina's political subdivisions. It is important to note that it is State, not Federal law that controls what a local government can legally do. While various Federal laws and regulations affect local government activities, without proper delegation from the State, a local government may not act.

Enabling legislation in North Carolina grants a wide array of powers to its cities, towns and counties. The capability section of the local hazard mitigation plan should analyze each of the powers available to local governments enumerated in the North Carolina General Statutes to identify which can be wielded to craft hazard mitigation measures at the local level, and also assess legislation that may impose limits on certain mitigation efforts.

Local regulations which are enacted within the bounds of the State's enabling authority do not automatically meet with judicial acceptance, and the capability section should also consider the constitutional framework within which all acts of government take place. Federal and state constitutions establish a series of mandates which must be followed during any governmental undertaking. For instance, the Fifth Amendment to the U.S. Constitution, and its State

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* The Stafford act regulations pertaining to pre-disaster declaration activities require FEMA to evaluate information concerning the status of hazard mitigation efforts in the impacted area (44 C.F.R. 206.403(b)):

> Mitigation evaluation. The mitigation review of state and local government activities in the impacted area shall include:
>
> (1) The status of statewide comprehensive hazard mitigation plans, programs, or strategies;
> (2) The status of any hazard mitigation plans or plan updates required as a condition of any previous declaration;
> (3) The status of any actions which the State or localities agreed to undertake as a condition of past disaster assistance;
> (4) The status of any mitigation measures funded under Section 404 of the Stafford Act for nay previous declaration;
> (5) The status of nay other hazard evaluation and mitigation projects funded under other FEMA or other Federal agency programs;
> (6) An evaluation of the impact of the hazard(s) and any corresponding mitigation issues pertinent to the area for which Federal disaster assistance is being requested;
> (7) Any other hazard evaluation and mitigation information available and considered relevant.

counterpart, require that private property be taken for a public purpose only upon payment of just compensation. This constraint on government powers applies to condemnation of property (eminent domain) *and* to regulations that may "take" an owner's property if they are too restrictive. The Fourteenth Amendment requires that all governmental activity be undertaken only with due process of law. Any restrictions which local governments impose on land use or building practices must follow the procedural requirements of the Fourteenth Amendment, or risk invalidation.

These and other constitutional mandates apply to federal and state governments, and all their political subdivisions. Any mitigation measures that are undertaken by the local government in its regulatory capacity must be worded and enforced carefully within the parameters established by the state and federal Constitutions, even when such measures are authorized by the General Statutes of North Carolina, and even when such measures are enacted in order to protect public health and safety by protecting the community from the impacts of natural hazards.

Within the limits of Dillon's Rule and the federal and state Constitutions, local governments in North Carolina have a wide latitude within which to institute mitigation programs, policies, and actions. All local government powers fall into one of four basic groups (although some governmental activities may be classified as more than one type of power): regulation, acquisition, taxation, and spending. Hazard mitigation measures can be carried out under each of the four types of powers (described more fully in the Appendix), and the capability assessment should enumerate the local version of these powers.

b. Institutional Capability

The capability of the local government to develop and implement a hazard mitigation program is affected by the institutional framework within which it will operate. Therefore, a description of the type of government, including an "inventory" of key decision-making positions (both long-range and day-to-day), is an essential component of the hazard mitigation plan's capability assessment. For instance, the assessment should indicate whether the unit of local government is a chartered municipality or an unincorporated county, whether there is an elected Board of Commissioners, or a Mayor and Town Council. The assessment should include all local governmental agencies, departments, and offices with responsibility for the various stages of emergency management (preparation, response, and recovery) as well as for mitigation. The responsibilities of both elected and appointed officials, as well as career governmental workers should be noted. The assessment should specify who is responsible for police, fire, sanitation, roads, parks, planning, zoning, building code enforcement, tax assessment, water and sewer, etc. The capability section should also analyze state and local government relationships (e.g., while the State of North Carolina is responsible for enacting a Statewide Building Code, local governments are responsible for enforcing the Code within their respective jurisdictions).

c. Political Capability

The institutional capability of a local community is obviously linked to its political capability. Many of the officials listed in the institutional framework analysis will be politicians, whose decisions are sometimes swayed by the political climate of the moment rather than by the long-range benefit to the community. Analyzing how mitigation can be inserted into everyday decision-making as a routine course can go a long way to de-politicizing the issue. If mitigation comes to the forefront of the community's important issues, local politicians cannot do otherwise than promote mitigation. Public education and awareness campaigns about the economic efficiency and social utility of mitigative measures in the long run can help foster its general acceptance by citizens, and in turn by politicians.

d. Fiscal Capability

There are many diverse sources of funding available to communities to implement local hazard mitigation plans, including both government and private programs. Often an organization with a particular focus will fund only part of a project. However, with coordination, the community can combine the funding efforts of one program with those of another, thereby serving multiple missions. The grant and loan programs described in this manual are a significant, although certainly not a sole source of funding options. (See the Appendix for a description of disaster assistance and other government programs).

While federal and national programs carry out the bulk of disaster relief programs that provide funds for mitigation, local governments are encouraged to open the search field as widely as possible, and include alternative funding sources to supplement the local hazard mitigation budget. For instance, local businesses and organizations will frequently support projects that benefit their customers or employees, or which constitute good "P.R." Other groups or individuals may be willing to donate "in-kind" services, eliminating the need for cash. Often the in-kind and volunteer services of local community members can be counted toward the local share that is typically needed to match an outside source of funds.

Local governments may also engage in their own "fund-raising" efforts to pay for mitigation programs that benefit the community at large. In North Carolina, local governments are granted limited powers to raise revenue for public purpose. The General Assembly has conferred upon cities, towns and counties the power to levy property taxes for various purposes, including: "ambulance services, rescue squads, and other emergency medical services; beach erosion and natural disasters (including shoreline protection, beach erosion control and flood and hurricane protection); civil defense; drainage projects or programs; fire protection; hospitals; joint undertakings with other county, city, or political subdivisions; planning; sewage; solid waste; water; water resources; watershed improvement projects." N.C.G.S. §16A-209. These statutorily enumerated purposes make it clear that local governments are empowered to finance certain emergency management activities, including mitigation activities, with property taxes.

City councils are also empowered to establish Municipal Service Districts. Such districts may be designed for (among other purposes): beach erosion control and flood and hurricane protection works; drainage projects; and watershed improvement projects. The use of taxes and bonds for these purposes is also authorized." (N.C.G.S. §160A-536). Through this authorization, cities may delineate an area or areas in the community which are particularly vulnerable to the impacts of natural hazards, and look to the property owners in those areas to fund protective works.

e. Technical Capability

If the concept of hazard mitigation is being introduced to a local community for the first time, or if a more experienced community wishes to upgrade its level of mitigation, technical know-how may be at a premium.

Fortunately, as described in FEMA's Post-Disaster Hazard Mitigation Planning Guide for State and Local Governments, there are many manuals and other documents available that describe mitigation techniques for a variety of hazards, including hurricanes, floods, wildfires, landslides, and debris-flows, earthquakes, ice-jams, and tornadoes. These technical manuals detail the forces that mitigation actions are engineered to withstand, construction methods, costs (complete with formulas to make adjustments to current values), options and alternatives, cost/benefits, the pros and cons of each technique, and even suggestions of how they can be financed, adopted, or implemented. Many other Federal agencies, including the U.S. Army Corps of Engineers, the Soil Conservation Service, and the National Weather Service provide similar services. In addition, university research institutes are good sources to investigate.

f. Analysis and Evaluation of Capability Data

After gathering capability information, the data must be analyzed and evaluated. Since the capability assessment will provide the framework for developing recommendations for specific mitigative actions in the hazard mitigation plan, it is essential that the assessment both identify shortfalls in a jurisdiction's capability, as well as draw attention to special opportunities that should be capitalized upon while they remain viable.

By referring to the capability assessment, the local government will be able to rank all recommended activities according to the capability of the community to actually institute them. The proposed activities must be evaluated against the backdrop of what is feasible in terms of that community's legal, institutional, political, fiscal, and technical capacity. Proposed activities should be classified as those which:

1. Can be carried out easily, without a change in the law;
2. Require only a change in the regulations;
3. Can be implemented with only a change in practice; or
4. Require new authorization.

C. Acceptability Assessment (Conclusions)

An *acceptability assessment* is a useful analytical step which can help a community prioritize and focus limited resources on the most critical of its mitigation needs. The community may wish to include documentation of this assessment in an appendix to the hazard mitigation plan. After reviewing which natural hazards pose the greatest threats, the capability of the community to respond, and the particular areas of the community that are most vulnerable, the community can then decide whether this level of risk is acceptable. Local officials and planners can use these conclusions to focus local mitigation efforts on those areas where they are most critically needed, thus making the most of limited financial, personnel, and material resources. Conclusions can also help determine whether it is necessary to increase the area's capability in certain areas to reduce its vulnerability.

The chart on the following page shows how the previously completed analyses of probability, vulnerability, and capability may be used to generate conclusions, or complete an acceptability assessment.

The spaces under probability, vulnerability, and capability should be completed from the evaluations made in previous steps.

Summary Chart to Determine Acceptability/Conclusions

HAZARD	**RISK**	**VULNERABILITY**		**CAPABILITY**		**ACCEPTABILITY/ CONCLUSIONS**
		Present	**Future**	**Present**	**Future**	
Hurricanes						
Nor'easters						
Flooding						
Thunderstorms						
Tornado						
Earthquake						
Wildfire						
Severe Winter Storms						

For example, assume that the analysis thus far has determined that hurricanes pose a high risk to the planning area, that the present vulnerability is moderate, the future vulnerability is likely to be high, the present capability is moderate, and that the future capability is likely to be low. The acceptability would likely be low or moderate, because this scenario shows conditions worsening and capability decreasing for a hazard with a high likelihood for causing harm and damage. In another example, assume that analyses have determined that earthquakes pose low risk, the present vulnerability is moderate, the future vulnerability is likely to remain moderate, the present capability is moderate and will likely remain at that level in the future. In this case, the community's acceptability would probably be determined to be moderate to high.

In short, by reading across the rows for each hazard, the community comes to an assessment of where the planning area lies in terms of each hazard. The community can now make a judgment of that position - i.e., is that an acceptable situation for the community? In some cases, the answer may be “yes,” in other cases, the answer is likely to be “no.” If the answer is “yes” then there is no need to implement additional mitigation measures for that hazard at that time. However, the acceptability should be reviewed periodically as it may change with time. If the answer is “no,” then the mitigation plan will need to develop goals, objectives, and policies and actions to improve the situation to a point which is judged acceptable.

The acceptability assessment acts as a bridge between gathering information about existing and future conditions and capabilities, and developing the local hazard mitigation plan itself, the process of which is described below.

D. Formulating Goals

Goals are statements of desirable future conditions that are to be achieved. Goals should be expressed in general terms, and are usually descriptive rather than quantified statements. A goal is not an instrument to achieve something else. Goals should be structured as positive statements that are attainable rather than negative observations about the community.

Goals may originate from several sources. These sources include:

- community concerns and desires, reflecting a participatory goal setting process;
- needs for accommodating change such as increased population and development, and adjustments to infrastructure;
- good mitigation and planning philosophy and practices (e.g., equity of costs and benefits, protection of constitutional rights, protection of environmental quality, public health and safety, and quality of life);
- mandates from state and federal governmental legislation, rules, and guidelines, and from judicial interpretation of statutes and regulations;
- previously adopted local government policies which may be contained in current ordinances and plans.

Goals should be developed on a case by case basis for each locality to reflect local conditions, needs, and desires. For example, one goal for a hazard mitigation plan could be: to manage development so the locality’s future vulnerability does not exceed its present degree of vulnerability. Another goal could be: to enable all residents to safely evacuate the area if faced by a hurricane threat. Another possibility is: to improve communications capability between local, county, and state emergency management personnel and local law enforcement personnel.

Goals should also be cross-cutting in areas of public interest in addition to hazard mitigation. For instance, hazard mitigation plan goals can support such principles as improving water quality, sustaining farmland, preserving natural areas, and creating open space.

E. Formulating Objectives

Objectives provide intermediate steps toward achieving a goal. Objectives are more tangible and specific than goals, and may be quantified. Objectives may be used as a checklist. When an objective is accomplished, it may be checked off and progress oriented toward accomplishing another objective. Whereas goals are general statements that may never be fully realized, objectives should be capable of being accomplished. Typically, several objectives are identified for each goal.

As an example, consider the goal of restricting future vulnerability to hurricane threat to the level of present vulnerability. Objectives to accomplish that goal might include some of the following:

- revising local building and development ordinances to require construction practices which have been determined to result in decreased damages from hurricanes;
- prohibiting development in areas particularly vulnerable to storm surge, high winds, and flooding;
- tying new development to provision of additional highway travel lanes, to maintain a particular level of emergency evacuation capacity.

Again, objectives will be developed for each local mitigation plan to reflect local needs, capabilities, and desires. Objectives can and should be structured so that they serve multiple community interests. The objective of prohibiting development in high hazard areas, for instance, accomplishes the goal of restricting future vulnerability as well as preserving natural areas.

F. Alternative Means to Accomplish Goals and Objectives

In most cases there is not a single means to best accomplish goals and objectives of a local mitigation plan. There may be several methods to accomplish a given end. Some methods may involve a high financial cost, other methods may require volunteer contributions of time and effort. Still other methods may require a high degree of intergovernmental cooperation. There is no one method that can be applied universally. Therefore, each local mitigation plan will have to develop and evaluate a unique series of actions and policies to implement its plan and accomplish its goals.

To generate a field of mitigative action and make specific recommendations in the plan regarding hazard mitigation opportunities immediately following an actual disaster, the local community can rely on Hazard Mitigation Survey Team members for help. Hazard Mitigation Survey teams are authorized by 44 C.F.R. 206.404(b):

> Hazard Mitigation Survey teams shall be activated by the Regional Director, immediately following a declaration to conduct hazard mitigation surveys. In the case of flood declarations, the Interagency Hazard Mitigation Team will serve the purposes of the Hazard Mitigation Survey Team.

The Team is made up of FEMA, state, and local representatives, and other federal agencies as appropriate. The Team must distribute a report within fifteen days following a disaster declaration. (44 C.F.R. 206.404(c)).

As a group, the Local Hazard Mitigation Team can provide a wide and varied perspective, and there is opportunity for debate on the relative merit or feasibility of the action. The Team members are generally aware of a wide range of programs and financial resources that might be able to support the proposed effort.

While Hazard Mitigation Teams provide a useful service in the disaster context, local governments are encouraged to consider various implementation devices *before* a disaster occurs. Communities should carefully explore *all* available alternatives to determine those which will work best for that particular area. A series of brainstorming sessions may be necessary to gather a wide range of possibilities. The community should weigh local needs, capabilities, commitments of financial, personnel and material resources, and decide on the best methods to use to accomplish the plan's objectives. Potential methods should be discussed with everyone involved in the mitigation planning effort. In this way, not only will a consensus of opinion develop, there will also be a sense of ownership of the plan by all the stakeholders involved in developing, implementing, and contributing to the plan.

Each possible mitigation measure should be reviewed, and discarded only after these questions have been adequately addressed:

- Is the measure technically appropriate for the particular hazard for which it is proposed?
- Does the measure support or hinder any of the plan's goals or objectives?
- Do the measure's benefits equal or exceed its cost?
- Is it affordable?
- Is there available funding?
- Will it comply with all local, state and federal regulations?
- Does it have a beneficial or neutral impact on the environment?

Select those alternatives judged most effective in terms of mitigating multiple hazards and accomplishing multiple objectives.

G. Formulating Policies, Programs and Actions/Strategies

Once goals have been developed and objectives for each goal have been identified, then policies, programs, and actions may be developed and implemented. These should appear in the plan itself; in fact, this is the heart of any plan that is meant to "do" something. Think of policies, programs and actions as interrelated, concurrent activities. Each of these activities should be given parallel consideration.

Policies. Policies are principles of hazard mitigation, derived from goals, but targeted more directly at what local government can do to attain its goals. Policies are typically stated as actions, using verbs, rather than simply statements of goals or objectives. Policies may be adopted in a wide range of planning areas, including:

- *growth and/or development management* - where and how growth and development will be encouraged or discouraged to take place, to best serve local mitigation efforts;
- *environmental protection* - what critical environmental areas merit special protection from development, to reduce future vulnerability to natural hazards;
- *fiscal* - how will the costs of mitigation strategies be distributed among various populations, including existing residents, future residents, those moving to the area, landowners, industry, etc.;
- *transportation* - where should transportation improvements be implemented to enhance the ability to mitigate hazards. For example, what highways should be targeted for increased capacity to allow for quicker evacuation from areas at high risk to flooding;
- *communications* - how should private and public development be coordinated to assure that an effective communications network is developed and implemented to assure communication between local and state officials and the public during hazard events; and
- *the planning process* - what time frame(s) will be adopted for accomplishing specific local actions, what should be the degree of public involvement in the planning process, how could local efforts be coordinated into regional mitigation efforts in the future.

<u>Programs, Actions and Strategies</u> A program of actions is the heart of any plan. Programs of action are made up of strategies that have been developed as specific methods to accomplish goals and objectives. The following programs could be incorporated into a comprehensive natural hazard mitigation plan:

- A program of recommendations for changes to local development codes to lessen damage from natural hazard events which impact the area. Such recommendations might include changes to existing subdivision, zoning, and other development regulations, or recommendations for adoption of a newly developed unified code guiding development. Recommendations could address: hazard mitigation measures to be required as part of development approval; procedures for reviewing and approving development permit applications; tailoring standards for the type, density, and allowable impacts of development to the sensitivity of the proposed development location; site plan, and construction practice requirements, perhaps incorporating performance standards; and possibly requirements for exactions and impact fees, to encourage particular types, site designs, and construction practices of development to achieve development that will not increase the area's future vulnerability to natural hazards.
- A program to control the rate of growth in environmentally sensitive areas, or areas with limited evacuation capacity. Recommended strategies could include delineating preferred growth areas, and development of small area plans for special environmental areas.
- An infrastructure program, specifying the locations, sequence, timing, and distribution of improvements and additions to transportation, utility, and communications networks to assist in mitigating the effects of hazards and reduce future vulnerability to such hazards. Recommendations developed as part of this program should be integrated into local capital improvement plans for transportation and communication facilities, and protection of critical environmental areas.

- A program to acquire property rights to critical pieces of property either in fee simple or through easements to protect sensitive areas from development and to prevent a dramatic increase in the area's future vulnerability. This program should also be integrated into the local public sector investment plan.
- A program to increase local capability to respond to natural hazard events. Such programs could include training activities, increased preparedness planning actions, and preparation of a multi-year budget for acquiring equipment used in mitigation efforts.

Responsibility must be designated for designing specific standards and procedures, as well as overseeing adoption and implementation of policies and programs. The lead agency for each program or action should be specified, and shared responsibilities should be stated explicitly.

<u>Windows of Opportunity</u>. When developing policies, programs, and actions, several windows of opportunity should be considered. There are many different times at which hazard mitigation efforts can be integrated with other community planning and development activities. A chart like the one which follows can be an integral part of determining such windows of opportunity. By identifying opportunities in this manner, local officials and planners can make maximum use of *all* potential mitigation opportunities.

Plan makers should develop appropriate means of mitigating each of the different natural hazards under each window of opportunity. Concentrate on developing strategies to mitigate those hazards which pose the greatest risk to the planning area, to which the area is most vulnerable, and to which the local response capability is in need of greatest improvement.

Means of Achieving Goals and Objectives

Hazard	Windows of Opportunity				
	Day-to-Day Activities	Projects	Preparation	Response	Recovery
Hurricanes Present					
Future					
Nor'easters Present					
Future					
Flooding Present					
Future					
Thunderstorm Present					
Future					
Tornado Present					
Future					
Earthquake Present					
Future					
Wildfire Present					
Future					
Winter Storm Present					
Future					

When considering *day-to-day activities*, the window of opportunity is *always* open, except during hazard events. Typical actions which could be included in this category would be administration of the local building or development code, keeping drainage ditches clear of debris, and ensuring emergency communication devices are in proper working order.

When considering *projects*, the primary question to address is: how will this project affect the future vulnerability of the locality? Projects are most effective if they will result in a reduction of vulnerability to hazard events in the future. Examples of this type of action include: siting public structures in areas with a relatively low vulnerability to natural hazards; promoting the use of underground utility lines in new development; stabilizing sand dunes in coastal areas; and implementing programs to assist mobile home owners to anchor their homes to achieve added protection in areas prone to tornadoes.

Preparation activities involve at least two types. Structural activities include actions to prepare for the imminent arrival of a hazard event, such as putting up storm shutters, sandbagging, and putting tarps over roofs. Non-structural activities involve taking steps to minimize damage to personal property and to minimize harm to individuals. For instance, anchoring boats and storing yard furniture in sheds prior to the arrival of a hurricane will lessen the chance of damage to personal property. Following recommendations to evacuate an area will lessen the chance of harm to individuals.

Response activities are those actions that occur during the hazard event or immediately following. While these actions may be planned events, specific actions will depend on the severity, location, effects, and details of a particular hazard event. Response activities are those practiced during emergency preparedness for emergency and response actions during this time.

Recovery activities are those activities that take place in the aftermath of a hazard event. Years of natural hazard disasters have demonstrated that it is easy to implement many ad hoc projects whose sum is less than the total of their parts because of a lack of a comprehensive plan of action. If a comprehensive mitigation strategy has been developed slowly, building on a series of day-to-day activities to create a deliberate plan, recovery efforts may result in achieving not only immediate restoration of normal activity in the area, but also changes to procedures which will result in a reduction of the vulnerability of the area to, and an increase in its capability to deal with future hazard events.

During periods of recovery, an area's capability changes markedly. There is typically a dramatic increase in political will to address problems, relatively large sums of money are available for restoration and mitigation activities, and there is a greater amount of technical assistance available than during normal times. The FEMA Section 404 Hazard Mitigation Grant Program and the Section 406 Disaster Assistance program, along with other public and private assistance programs can be extremely effective tools to reduce an area's vulnerability to future natural hazard events. In the wake of a natural disaster it may be possible to achieve dramatic reductions in vulnerability, *if plans are in place to redevelop according to best hazard mitigation practices.* Therefore, local capability is very different during recovery than at other times. Communities should take advantage of those short periods of increased capability.

The hazard analysis which was completed earlier should feed into the community's decisions when completing the means of achieving goals and objectives chart. For instance, hazards which were identified as posing a low risk to the locality would not have many, if any, actions included in the chart. Hazards which pose a high risk, to which the area is particularly vulnerable, or for which the area has little capability, would receive the greatest attention and would generate the greatest number of activities to be accomplished. All too often, immediate restorative actions take place following a severe hazard event. Rather than *react* to an event, local planners and officials should proactively *plan* for all hazards which are likely to affect the area. Mitigation efforts should not be targeted to a specific event; rather, mitigation strategies and actions should improve the community's capability to respond to related events.

IV. Adoption and Implementation

In order to become enforceable policy, a local hazard mitigation plan must be adopted by the governing body of the local government. A series of recommendations made by planning staff will not have nearly the impact as will an official document that lays out the government's policies regarding mitigation. The local government should adopt the plan officially through the standard legal process for adoption of regulations and policy, including any required public notice and hearings.[*] Documentation of the adoption process should be included in the plan.

Once the plan is adopted, the real challenge of hazard mitigation planning involves converting the plan into action. The intent of the implementation section is to intervene in the traditional reactive processes of response and recovery. It is the proactive nature of mitigation planning that leads to successful reduction of hazard vulnerability.[*]

Implementation strategies include holding post-disaster meetings, use of special task forces, integration of hazard mitigation activities in the work plan of other agencies or departments, and involving the media to garner support and serve as an impetus for implementation. Activities to be carried out should be specifically budgeted for. A chart designating what local department, agency, or official is responsible for carrying out each action, sources of funds, and a time line for completing these activities is useful to keep implementation on track. A series of benchmarks to gauge progress will also aid in assessing implementation progress, as indicated in the next step described in this manual, "Monitoring and Evaluation".

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[*] In order to receive credit under the Community Rating System, the plan must be an official plan of the community, not an internal staff proposal. State and regional plans are not adequate unless they specifically address the community's hazards, and the community's governing body adopts the plan.

[*] CAMA requires that the land use plans prepared for coastal communities contain a description of proposed implementation methods for achieving the policies that have been adopted (T15A N.C.A.C. 07B.0203(b)(4)(A)).

V. Monitoring and Evaluation

After a local hazard mitigation plan has been developed and adopted, it is important to continually track the progress of mitigation actions and evaluate how the proposals contained in the plan work in practice. Planners and other local officials involved in hazard mitigation must monitor the implementation of the plan and evaluate its effectiveness, in order to recommend additional mitigation actions and make periodic revisions to the plan.

44 CFR 206.405(a)(4) requires that a hazard mitigation plan contain:

> A method of implementing, monitoring, evaluating, and updating the mitigation plan. Such evaluation is to occur at least on an annual basis to ensure that implementation occurs as planned, and to ensure that the plan remains current.

These are critical elements of an effective hazard mitigation plan, and emphasize the dynamic nature of the plan. The completed document is not an end result; rather, completion of the plan is the beginning of the process of reducing future losses from natural hazards.

Monitoring and evaluation are the ongoing processes of compiling information on the outcomes resulting from implementation of the hazard mitigation plan. This process measures progress in achieving goals, objectives, and policies. Through the monitoring and evaluation process, revisions needed to respond to changes in regional and local conditions may be identified. Local conditions are constantly changing. Local mitigation plans must also change in response to changes brought about through increased development, changes in technology, and changes in local mitigation capability. Effective monitoring and evaluation will also provide information on local compliance with state and federal mandates.

The primary question to be addressed in monitoring and evaluating hazard mitigation plans is: has the area's vulnerability increased or decreased as a result of planning and mitigation efforts? Where vulnerability has decreased, planners should determine if other methods could be used to achieve even greater improvement in reducing the area's vulnerability. Where vulnerability has increased, or has not decreased as projected, mitigation efforts must be evaluated to determine if other mitigation strategies might provide greater effectiveness than those currently in use.

Evaluation should also include a look at the original problem statement made in the introduction to the hazard mitigation plan to assess its current accuracy. The adequacy of available resources to carry out the plan should also be examined. Is there any redundancy that can be eliminated, thereby freeing up resources from one area? Are funds for certain programs or projects inadequate; if so, should more funding be sought? The evaluation section should also trouble shoot any problems being experienced with implementation (i.e., technical, political, legal, coordination, etc.) Finally, the plan should be checked against its time frame - has it been implemented on schedule? Are all windows of opportunity being fully taken advantage of?

In designing a monitoring and evaluation system, select the plan objectives that will be tracked. Those objectives should include indicators which will track mitigation efforts that have the greatest local importance. For example, a coastal area might decide to carefully track the number of development permits granted on barrier islands, since development in those locations is most prone to damage from flooding, winds, and wave action and has the greatest impact on evacuation plans. A locality in the mountains might track the number of development permits granted for areas above a given altitude, since development in those locations impacts fragile ecosystems and is most difficult to service in times of emergency.

An important step of an effective monitoring and evaluation system is to identify data sources, select pieces of data that will be collected, and establish a procedure to collect and record the selected data. Sources will consist of both data that is locally collected and data available from state and federal publications. For instance, to evaluate the effectiveness of a hazard evacuation route, traffic counts on a local road would be compared to state statistics for the number of vehicles per hour which that type of road is expected to safely carry. Projections for increases in traffic resulting from new development could be added to the existing traffic count, and the viability of the road to serve as an effective evacuation route during a hazard event could then be assessed. As a result of such an assessment, development in areas subject to evacuation during hazard events could be limited, or additional travel capacity added to one or more local roads.

VI. Revisions and Updates

No plan, however perfect in concept, will be perfect in execution. Revisions to the hazard mitigation plan are necessary to correct flaws that are discovered in the plan. There are always some contingencies that cannot be foreseen, or events which cannot be predicted. Revision incorporates those changes necessary to better fit the plan to real-life situations. Periodic revision of mitigation plans will also help to ensure that local mitigation efforts include the latest and most effective mitigation techniques. Periodic revision of the mitigation plan will also keep it in compliance with state and local statutes and regulations.

Updates address changes which have taken place in the local area. Changes may result from additional development, implementation of mitigation efforts, development of new mitigation processes, and changes to state or federal statutes and regulations. Additional development in an area may result in an increase, little change, or a decrease in that area's vulnerability to natural hazards depending on the location, type, and design of that development.

Local governments in the coastal zone of North Carolina are required to update their land use plans, including the storm hazard mitigation section, every five years. In the context of a Federal disaster declaration, state and local governments are allowed to update or expand an existing plan to reflect circumstances arising out of the disaster. An updated plan in this circumstance might include a re-evaluation of the hazards and the jurisdiction's exposure to them, a re-assessment of existing mitigation capabilities, and new or additional mitigation recommendations.

APPENDIX A

DISASTER RELIEF AND OTHER STATUTORY PROGRAMS

This Appendix describes some of the statutory programs that either mandate or encourage hazard mitigation planning. Many of these programs make funds available for a wide variety of activities, including mitigation. Even when not required by law, plans can ensure that grant funds are used in the most effective manner possible, by predetermining that every possibility for mitigation will be pursued at the appropriate time. This is particularly important during the critical period immediately following a disaster, when opportunities for mitigation arise which must be capitalized upon as quickly as possible. This is essential in situations where the community wishes to rebuild or replace structures that have been damaged or destroyed by a natural hazard to comply with construction standards that are more stringent than those that were in place at the time of the disaster. A plan which is already in place and which addresses improving the disaster area can provide a meaningful framework for making sound mitigation decisions the moment funds become available.

- **SECTION 409 OF THE FEDERAL STAFFORD DISASTER RELIEF AND EMERGENCY ASSISTANCE ACT**

Section 409 of the Federal Stafford Disaster Relief and Emergency Assistance Act conditions receipt of federal disaster assistance funds on creation of a plan which specifically addresses hazard mitigation:

> As a further condition of any loan or grant made under the provisions of this Act, the State or local government shall agree that the natural hazards in the areas in which the proceeds of the grants and loans are to be used shall be evaluated and appropriate action shall be taken to mitigate such hazards. . .

The regulations implementing Section 409 make it clear that state and local governments are to prepare and implement hazard mitigation plans as the method for "evaluating the natural hazards" and for "identifying appropriate action" to reduce the risk from these hazards. (Note that although mitigation planning is a requirement for federal disaster assistance, to date FEMA has not withheld disaster assistance from any state that has not prepared a plan. However, FEMA does withhold grant funds that are issued under the Hazard Mitigation Grant Program **(**HMGP) of Section 404 of the Stafford Act.)

- **HAZARD MITIGATION GRANT PROGRAM (HMGP)**

Section 404 of the Stafford Act establishes the Hazard Mitigation Grant Program (HMGP), administered by FEMA's Mitigation Directorate. HMGP provides 75% federal/ 25% state cost-share funding for mitigation measures through the post-disaster planning process. The state (or local) share may be met with cash or in-kind services. HMGP funds (like all federal disaster aid) is supplemental only; the regulations of Subpart N prohibit Section 404 funds from being used as a substitute or replacement to fund projects or programs that are available under other Federal programs except in dire circumstances such as extraordinary threats to lives, public health or safety or improved property (44 C.F.R. 206.43(d)). HMGP funds are often used in combination with other federal, state, local, or private funding sources when appropriate to develop a comprehensive mitigation solution. However, HMGP funds cannot be used by a local or state government as a direct match for another federal project, and other federal funds cannot be used as a match for HMGP funds (44 C.F.R. Subpart N § 206.43(e).[*] The total amount of HMGP funds available for each disaster is equivalent to 15% of the federal funds spent on Public Assistance and Individual Assistance programs, minus administrative expenses.

HMGP funds are available to state and local governments, Indian tribes, and private non-profits following a Presidential disaster declaration. Eligible applicants apply for the program through the State, as the State administers the program; application forms and information on deadlines can be obtained by contacting the State Hazard Mitigation Officer. Applications should be submitted to the state as soon as possible after the disaster occurs so that opportunities to do mitigation are not lost during reconstruction. (Ideally, these mitigation opportunities should be identified before a hazard event occurs as part of a sound mitigation planning process - see discussion below). Each state has a hazard-mitigation administrative plan that explains procedures for administering the HMGP. Pre-disaster planning allows for development of a rational proactive plan to spread the costs over a period of years and should result in an expeditious and well conceived post-disaster mitigation project.

Immediately after a disaster, the following steps must occur:

1. The Federal Emergency Management Agency and the State hold a briefing for community officials to explain Public Assistance and the Hazard Mitigation Grant Program.
2. The State notifies the county emergency coordinators of each community that the communities need to submit a letter of interest in the HMGP to the State Hazard Mitigation Officer.
3. The community notifies the State of their intent to participate in the HMGP within 60 days after the disaster declaration.
4. Community officials form or activate their floodplain planning committee to determine extent of damage; types of feasible projects; land re-sue options; availability of replacement housing; relocation assistance needs; funding sources; and technical assistance needed from FEMA and other Federal agencies, the State, a regional planning commission, local universities, and others.
5. State meets with community officials and the planning committee to explain details of the HGP and, where appropriate, the acquisition/relocation/elevation process.
6. Community officials identify funding sources and submit HMGP application to the state Hazard Mitigation Officer. If the State is not providing the required 25% State/local match, the community seeks other sources for the match, e.g., consider application to Community Development Block Grant (CDBG) program for

[*] An exception to this is that Community Development Block Grant (CDBG) and Small Business Administration (SBA) funds can be used as match for HMGP projects because those funds are considered to lose their federal identity once they are passed on to the State for distribution to communities.

funding relocation assistance.

7. If funds are received, the community prepares a local administrative plan and proceeds with projects.

8. If funds are not received, the community advises residents to buy flood insurance and continues to seek alternative funding.

Regulations at 44 C.F.R. Part 206, Subpart N make the state (with local input) responsible for identifying and selecting hazard mitigation projects. Communities are encouraged to begin identification of potential HMGP projects before a disaster as part of a sound mitigation planning process. If this has not been done, communities, working with the State, should identify opportunities after an event as soon as possible in order to expedite the recovery process. Projects are to be identified through the hazard mitigation planning process, and must be consistent with the State's 409 Plan. Projects may also be identified by other mitigation plans, or by recommendations of the Hazard Mitigation Survey Teams that are activated by FEMA immediately following a declaration to conduct hazard mitigation surveys. Local participation in identification of potential mitigation proposals can be through a regional Council of Governments, a regional planning agency, a local government, or local emergency management office. Note, too, that the reports produced by the Hazard Mitigation Survey Team can also provide substantial guidance for other local mitigation activities, not just those to be carried out through the HMGP process.

Types of projects for which HGP funds can be used include, but are not limited to:

- ♦ Construction activities that will result in protection from hazards
- ♦ Retrofitting of facilities
- ♦ Acquisition or relocation
- ♦ Development of state or local mitigation standards
- ♦ Development of comprehensive hazard mitigation programs with implementation as an essential component
- ♦ Structural hazard control or protection projects
- ♦ The purchase of equipment to improve preparedness and response capability is not an eligible activity.

The minimum criteria for project eligibility are specified in 44 C.F.R. Subpart N §206.434. To be eligible for the HMGP, a project must:

- ♦ Be in conformance with the State Section 409 Hazard Mitigation Plan;
- ♦ Have beneficial impact upon the designated disaster area, whether or not located in the designated area;
- ♦ Be in conformance with applicable floodplain management and wetlands protection and environmental regulations (44 C.F.R. Part 9. Floodplain Management and Protection of Wetlands, and 44 C.F.R. Part 10, Environmental Considerations);
- ♦ Solve a problem independently or constitute a functional portion of a solution where

there is assurance that the project as a whole will be completed;

- ♦ Be cost effective;
- ♦ Substantially reduce the risk of future damage, hardship, loss, or suffering resulting from a major disaster.

The community demonstrates cost effectiveness and reduction of future losses by documenting that the project:

- ♦ Addresses a problem that has been repetitive or a problem that poses a significant risk to public health and safety if left unresolved;
- ♦ Will not cost more than the anticipated value of the reduction in both direct damages and subsequent negative impacts to the area if future disasters were to occur.
- ♦ Has been determined to be the most practical, effective and environmentally sound alternative after consideration of a range of options;
- ♦ Contributes, to the extent practicable, to a long-term solution to the problem it is intended to address.
- ♦ Considers long-term changes to the areas and entities it protects and has manageable future maintenance and modification requirements.

- **THE NORTH CAROLINA COASTAL AREA MANAGEMENT ACT (CAMA)**

The North Carolina Coastal Area Management Act (CAMA) requires that all local governments in each of the twenty counties in North Carolina's coastal zone prepare a land use plan (LUP). Once approved by the Coastal Resources Commission, the local land use plan becomes part of the North Carolina Coastal Management Plan. The plans are then used as a framework that guides local leaders as they make decisions affecting development. Businesses, investors, new residents, and other private individuals, as well as other levels of government also use the plan to guide their land use decisions.

The CAMA LUP Guidelines specify the issues for which the local government must formulate policy statements, including resource protection, resource production and management, economic and community development, continued public participation, and *storm hazard mitigation*. (T15A N.C.A.C. 07B.0212(a)). For each of these policy issues, the LUP must include a discussion of the scope and importance of the issue; alternative policies that were considered; the policy adopted by the local government; and a description of how the local policy (or group of policies) will be implemented. (T15A N.C.A.C. 07B.0212(b)).

The LUP Guidelines state that the purpose of the Storm Hazard Mitigation section of a CAMA land use plan is to develop policies that will guide the development of the community so that the risk of damage to property and the threat of harm to human life from coastal storms is kept to a minimum level. (T15A N.C.A.C. 07B.0212(a)(5)(A)). The LUP must include policies addressing a number of specific storm hazard mitigation issues, including: policies intended to mitigate the effects of high winds, storm surge, flooding, wave action, erosion, and other similar coastal processes; policies intended to discourage development, especially high density or large structures in the most hazardous areas; policies dealing with public acquisition of land in the most hazardous areas; and policies dealing with reducing the impact of the community's land use policies on evacuation problems, such as decreasing density so as to decrease the number of people needing to evacuate, among other concerns. (T15A N.C.A.C. 07B.0212(a)(5)(A)(ii) (I)-(IV)).

Post-disaster reconstruction policies are also required as part of the CAMA land use plan in order to guide development during the reconstruction period following a disaster so that the community, as it is rebuilt, is less vulnerable to coastal storms than it was before the disaster. (T15A N.C.A.C. 07B.0212(a)(5)(B)). The reconstruction policies are to consider issues specified in the Guidelines, including: the county emergency plan, especially the preparation and response sections; long-term reconstruction policies for the community; establishment of a "recovery task force" to oversee the reconstruction process and any policy issues which might arise after a storm disaster; establishment of priorities for permitting repairs and new development; and establishment of policies for repair or replacement of public infrastructure. (T15A N.C.A.C. 07B.0212(B)(I)-(v)).

The storm hazard mitigation section of the land use plan must also include certain background information as specified in the CAMA LUP Guidelines. This information includes: a description of the likely conditions that the community will experience during a coastal storm (e.g., high wind, storm surge, flooding, wave action, erosion, etc.); a composite hazards map showing the hazardous areas within the planning jurisdiction; and an existing land use inventory for each of the most hazardous areas which portrays the amount of existing development at risk. (T15A N.C.A.C. 07B.0212(5)(A)(I)(I)-(III)).

The LUP Guidelines encourage local governments to pay close attention in policy development to the land use trends of particular areas within the community. Such trends include: significant changes from lower intensity to higher intensity uses, conversion of agricultural and forest uses to residential or commercial uses, or from forest to agricultural uses in inland areas. Land use trends in estuarine, river and sound areas that policy makers should be aware of include residential waterfront development and increases in density of waterfront residential uses; marina, moorings, or dry stack facility development and expansion, floating homes and public and private services provided to support higher intensity uses, as well as the cumulative impact of such trends on water quality. (T15A N.C.A.C. 07B.0212(a)(3)(C)).

- **COMMUNITY RATING SYSTEM (CRS)**

Communities that regulate new development in their floodplains may join the National Flood Insurance Program (NFIP). In return, the NFIP provides federally backed flood insurance for existing and new properties in participating communities. The Community Rating System (CRS), administered by FEMA, is a part of the NFIP. The CRS provides flood insurance premium discounts for residents in NFIP communities that undertake floodplain mitigation activities above the minimum NFIP standards. These activities benefit policy holders and the residents of the entire community through reduced claim payments, and reduction of human suffering following a flooding disaster.

The reduction in insurance premiums is in the form of a CRS classification. There are ten classes in the system, each providing an additional five percent premium rate reduction for properties in the community's mapped floodplain. A community's class is based on the number of credit points it receives for its floodplain management activities.

There are eighteen floodplain management activities credited by CRS, grouped into series, including:

- *Public Information*: This series credits programs that advise people about the flood hazard, flood insurance, and ways to reduce flood damage. These activities also provide data needed by insurance agents for accurate flood insurance rating. They generally serve all members of the community, and include elevation certificates, map information, outreach projects, hazard disclosure, flood protection library, and flood protection assistance;
- *Mapping and Regulations*: This series credits programs that provide increased protection to new development, including: developing additional flood data, open space preservation, higher regulatory standards, flood data maintenance, and stormwater management;
- *Flood Damage Reduction*: This series credits programs that reduce the flood risk to existing development, including: repetitive loss projects, acquisition and relocation, retrofitting, and drainage system maintenance;
- *Flood Preparedness*: This series credits flood warning, levee, and dam safety programs.

In addition to regular credit points, activities under the CRS receive additional points if they are initiated in accordance with a local comprehensive floodplain management plan.

FEMA recognizes that there is no one ideal floodplain management plan: each plan must be created to address local issues. The objective of the CRS incentive, therefore, is to ensure that a planning <u>process</u> was followed that enables selection of the best measures for a particular community to combat its unique flood hazard situation. FEMA considers the following six steps essential to a sound planning process under the Community Rating System (see § 241(a)-(f) of the CRS Coordinator's Manual for details):

- *Problem identification*: In this step community planners collect or calculate flood hazard data to define the flood problem. Such data include source of water, depth of flooding, velocities, historical flood damages, repetitive loss areas, and special hazards;
- *Flood hazard area inventory*: Community planners collect data on the number types and elevations of buildings; development trends; development constraints such as bad soils, ownership, and federal and state regulations; critical facilities such as hospitals, fire stations, and chemical storage companies; and community needs, goals and plans for the area;
- *Review of possible activities*: In this step community planners review the various public information, mapping, regulatory, damage reduction, and flood preparedness activities that can prevent or reduce flood losses;
- *Selection of appropriate activities*: Activities appropriate to the community's resources, flood hazard, and vulnerable properties are selected and spelled out in a floodplain management plan that clearly identifies who does what and when. A schedule must be

included for each subsequent year. A budget for those activities which are not financed from normal operating funds must be included;

- *Public input*: One or more public meetings must be held during the planning process;
- *Implementation:* The plan must be officially adopted by the community's governing body and needed funds must be budgeted.

CRS credit is not based on preparing a plan per se, but on implementing it. Continued credit for the floodplain management plan is dependent on the annual progress report that shows how implementation is progressing. The annual report should include the following elements:

- A review of the original plan;
- A review of any floods that occurred during the year;
- A review of each element or objective of the original plan, including how much was accomplished during the previous year;
- A discussion of why any objectives were not reached or why implementation is behind schedule;
- If appropriate, new projects or revised objectives.

Communities with repetitive loss properties must prepare a Repetitive Loss Plan in order to stay eligible for CRS credit. The Repetitive Loss Plan must meet the same minimum criteria as the floodplain management plan of Section 240. The creation of the Repetitive Loss Plan provides bonuses to the credit points for eligible activities.

If a community adopts and implements a floodplain management plan, the credits for the elements implemented in accordance with the plan are increased by ten percent. Communities are reminded that all activities in the community's floodplain plan should meet the community's overall goals and objectives. Communities should not be deterred from including them in their plans merely because the CRS does not give them points. A community's first priority should be to develop a plan that meets its needs, not one designed solely on the basis of CRS credit.

- **FLOOD MITIGATION ASSISTANCE PROGRAM (FMAP)**

The Flood Mitigation Assistance Program (FMAP) is authorized by the National Flood Insurance Reform Act of 1994 (Title V of the Community Development and Regulatory Improvement Act), Sections 553 and 554. The statute is implemented by regulations found at 44 C.F.R. Part 78. FMAP expands FEMA's mitigation assistance to states, communities, and individuals by providing grants for cost-effective measures to reduce or eliminate the long-term risk of flood damage to the built environment and real property, with its priority goal to reduce repetitive losses to the National Flood Insurance Program (NFIP).

Unlike the HMGP, which is available only after a Presidentially declared disaster, FMAP is available to eligible communities every year. To be eligible for FMAP grants, a community must be a participant in the National Flood Insurance Program (NFIP) and must have jurisdiction over a particular area having special flood hazards. (44 CFR 78.3(a)). The FMA Program provides grants for planning assistance to states and communities in determining flood risks and in identifying actions to reduce that risk; provides a process for approving flood mitigation plans;

and provides grants to implement measures to reduce flood losses. (44 CFR 78.1.) Creation and approval of a flood risk mitigation plan is a prerequisite to receiving flood mitigation assistance project grants.

Regulations specify what entails development of a flood mitigation plan for the purposes of the FMA program. Section 78.8(a) describes the plan content, stating, "a Flood Mitigation Plan shall articulate a comprehensive strategy for mitigation activities for the area affected by the plan." At a minimum, the plan must include the following elements:

- description of the existing flood risk;
- identification of repetitive loss properties;
- identification of alternative feasible solutions;
- evaluation of each alternative type of solution;
- presentation of an overall strategy for reducing flood risks;
- strategies for continued compliance with the NFIP;
- summary of the public involvement process; and
- documentation of plan approval by the legal entity submitting the plan. (44 C.F.R. 78.8(a)(1-8)).

The regulations do not mandate that FMAP plans be limited to flood hazards (although funds will only be provided for the flood portion of any mitigation plan (44 C.F.R. 78.7(b)(2)). The FMAP plan is not meant to create an additional planning requirement for states and localities. Communities are encouraged to create multi-hazard plans, and to coordinate with existing plans. The regulations indicate that approved Community Rating System (CRS) plans will meet FMAP requirements, and that local plans that satisfy Section 409 Hazard Mitigation Plan requirements and that include all of the elements described in 44 C.F.R. 78.8(a) (listed in the preceding paragraph) can be approved as Flood Mitigation Plans.

The regulations require that the Flood Mitigation Plan be formally adopted by the community following a public involvement process which allows federal, state, and local officials and private citizens the opportunity to participate in the development of the plan through workshops, public meetings or forums, or public hearings. (44 C.F.R. 78.8(c)).

Once a community has a flood mitigation plan approved by the Regional Director, it is eligible for flood mitigation assistance grants. Examples of types of projects that would be eligible for funding through the Flood Mitigation Assistance Program are listed at 44 C.F.R. 78.12, and include:

- elevation and/or dry flood proofing of pre-FIRM structures;
- acquisition of real property and property rights, including structures;
- relocation or demolition of structures;
- minor structural projects, including flood retention ponds, flood proofing sewers, modifying culverts, and installing or modifying floodgates ;
- beach nourishment activities;
- technical assistance

- **PUBLIC ASSISTANCE PROGRAM (PA)**

Section 406 of the Stafford Act authorizes the Public Assistance (PA) Program, administered by

FEMA under regulations at 44 C.F.R. Part 206. This post-disaster program provides aid to help communities save lives and property in the immediate aftermath of a disaster, and help a community rebuild damaged facilities. Grants cover eligible costs associated with the repair, replacement, and restoration of facilities owned by state or local governments and non-profit organizations.

Four categories of assistance are available after a major disaster declaration:

- *Debris removal* provides 75% of funds to state or local governments or private non-profit organizations to eliminate threats to life, public health, or property. Debris may be removed from private property when in the public interest;
- *Emergency work* or protective measures to eliminate threats to life, public safety, or property. Includes ensuring emergency access; removal of public health and safety hazards; demolition of structures; establishment of emergency communication links; emergency public transportation;
- *Repair, restoration, relocation, or replacement* of damaged facilities to return public and non-profit facilities to their pre-disaster condition. Grantees must comply with certain insurance purchase requirements;
- *Community disaster loans* to units of local government that lose a substantial part of their tax base because of a disaster.

Section 409 of the Stafford Act refers to minimum standards for all repairs and reconstruction done under the PA program. The “standards” referred to are codes, specifications, and standards that are in use and are locally enforced at the time of the major disaster. Under the PA program, the cost of bringing a facility up to current codes, specifications and standards is an eligible cost.

Minimum standards may include hazard mitigation standards, and can be in place at the time of the disaster or can be adopted prior to the approval of a particular reconstruction project. Thus, improved minimum standards that are adopted by a state or local government prior to FEMA’s approval of the repair or replacement of a damaged facility become eligible for Federal funding under the PA program.

The Public Assistance program also authorizes funding for appropriate cost-effective hazard mitigation measures related to damaged public facilities. The Regional Director may authorize hazard mitigation measures that are not required by codes, specifications and standards if the measures are in the public interest, fulfilling the following criteria:

- The mitigation measures must substantially alleviate or eliminate recurrence of the damage done to the facility by the disaster;
- The measures are feasible from the standpoint of sound engineering and construction practices;
- The measures are cost-effective in terms of the life of the structure, anticipated future damages, and other mitigation alternatives;
- Floodplain management and applicable environmental regulations are met.

Hazard mitigation funding for damaged public facilities and minimum standards are covered under PA regulations at 44 C.F.R. 206 Subpart H.

Communities can use the Section 409 hazard mitigation planning process to identify potential mitigation measures for funding under the Public Assistance Program. The Hazard Mitigation Survey Team or Interagency Hazard Mitigation Team can be particularly useful in this regard. In addition, the Damage Survey Reports used by inspectors to make site-specific recommendations for repairs following a disaster can also serve to identify mitigation opportunities.

- **SMALL BUSINESS ADMINISTRATION (SBA) DISASTER ASSISTANCE PROGRAM**

The United State Small Business Administration (SBA) administers the Disaster Assistance Program under Section 7(a)(1) of the Small Business Act (P.L. 85-536, 15 U.S.C. 636(b) et seq.), with regulations at 13 C.F.R. 123.25. The SBA issues physical disaster loans to businesses affected by declared physical-type disasters for uninsured losses. The assistance is in the form of direct loans to businesses to repair or replace uninsured disaster damages to property owned by the business, including real estate, machinery and equipment, inventory and supplies. Businesses of any size are eligible. Also eligible are nonprofit organizations, such as charities, private universities, etc. Loan amounts are limited by law to $1,500,000. The actual amount of each loan is limited to the verified disaster loss minus any insurance or other recovery assistance. Refinancing of existing mortgages or liens on real estate and machinery and equipment repair/replacement are eligible in some cases up to the amount of the loan for real estate and machinery and equipment repair/replacement. The $1,500,000 statutory limit for business loans applies to the confirmation of physical and economic injury, and to all disaster loans to a business and its affiliates arising from any one disaster. If a business is a major source of employment, the SBA has authority to waive the $1,500,000 statutory limit. Loan amounts may be increased by up to 20% for devices that mitigate against damage to real property caused by the same type of disaster.

The SBA also provides loans to the victims of declared physical-type disasters for uninsured losses. Loans to homeowners or renters are made to repair or replace uninsured disaster damages to real estate or personal property owned by the victim. Renters are eligible for their uninsured personal property losses. Loan amounts are limited by regulations to $200,000 to repair/replace real estate and $40,000 to repair/replace personal property. Refinancing of existing mortgages on homes is eligible in some cases up to the amount of the loan for real estate repair/replacement. Loan amounts may be increased by up to 20% for devices that mitigate against damage to real property caused by the same type of disaster.

- **COMMUNITY DEVELOPMENT BLOCK GRANT (CDBG)**

The Community Development Block Grant Program (CDBG) is administered by the Department of Housing and Urban Development (HUD), Community Planning and Development (CPD). The objective of the CDBG is to develop viable urban communities by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for low- to moderate-income individuals. Formula grants to entitlement communities (metropolitan cities and urban counties) are provided. (A State's program of the CDBG provides formula grants to states for non-entitlement communities.)

Upon Presidential declaration of a Major Disaster or Emergency under the Stafford Act, disaster-related assistance is one of numerous areas in which community-development type activities may be eligible under the CDBG program. The most appropriate disaster-related use of funds is for long-term needs, such as acquisition, rehabilitation, or reconstruction of damaged properties and facilities and redevelopment of disaster-affected areas. Funds may also be used for emergency response activities, such as debris clearance and demolition, and extraordinary increases in the level of necessary public services.

Because conditions may change from the time a community develops its plans for how it expects to use its CDBG funds to the time the funds actually get used, program rules authorize amending the planned use to delete activities and substitute others. This means that, when a disaster occurs, a community may elect to amend its planned use of funds instead for those disaster response and recovery activities that do not duplicate activities reimbursable by FEMA or available through the Small Business Administration disaster loan programs, or may reprogram other unexpended CDBG funds for those purposes.

Citizen participation procedures must be followed for CDBG activities; waivers for this requirement are discouraged, although the process may be accelerated. At least 70 percent of funded activities must benefit low and moderate-income persons.

- **THE NATIONAL HURRICANE PROGRAM**

The National Hurricane Program is authorized by Section 201 of the Stafford Disaster Relief and Emergency Assistance Act and is administered by FEMA. The Hurricane Program includes a State Assistance Program as well as a Local Grant Award Program which provide funds through the Comprehensive Cooperative Agreement (CCA) process in support of a negotiated statement of work for certain proscribed activities.

The goal of the Hurricane Program is to significantly reduce the loss of life and property, economic disruption, and disaster assistance costs resulting from hurricanes. The Program addresses population protection/evacuation, and has recently been expanded to include financial and technical assistance to state and local governments to mitigate the impacts of hurricanes and coastal storms on the built environment.

The Hurricane Program provides funding for six priority activities related to reducing loss of life and injury and property damage resulting from high winds and storm surge caused by hurricanes. The six major components of the Hurricane Program are:

- *State and local assistance*: to establish, enhance, and maintain basic levels of preparedness and mitigation capabilities;
- *Property protection*: to promote effective mitigation measures to reduce damage to public and private property;
- *Hazard identification*: to promote population preparedness, study and map evacuation routes, and, with the aid of computer models, identify potential hazards;
- *Post-storm analysis*: to evaluate the effectiveness of mitigation measures and response activities;
- *Training and exercises*: to fine-tune mitigation measures and operations planning; and
- *Public awareness and education*: to enhance public warning capabilities, conduct awareness campaigns, and prepare materials to support state and local activities.

The activities for which eligible states (and through the states, local governments) may apply for funding must fall in these six categories. FEMA provides technical expertise, assistance and guidance to eligible states in developing annual work plans.

- **NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM (NEHRP)**

The National Earthquake Hazards Reduction Program (NEHRP) is authorized by the Earthquake Hazards Reduction Act, P.L. 95-124, as amended in 1990 by NEHRP Reauthorization Act, P.L. 101-614, 42 U.S.C. 7701 et seq., with regulations at 44 C.F.R. Part 361. The NEHRP involves four agencies at the Federal level: FEMA, the U.S. Geological Survey (USGS), the National Science Foundation (NSF), and the National Institute of Standards and Technology (NIST).

The fundamental goal of the NEHRP is to reduce the impacts of earthquakes and subsequent loss of lives, property damage, and economic loss. To this end, the NEHRP provides financial and technical assistance to all levels of government and to the private sector to implement earthquake hazard mitigation measures. The NEHRP has fostered the development and implementation of seismic design and construction standards and techniques, technical assistance materials, education and risk reduction programs, consortia and centers, and information dissemination.

While FEMA acts as the lead agency, and is responsible for planning, coordinating, directing, and stimulating actions to reduce earthquake hazards, the Program combines research, planning, and response activities conducted within each of the four agencies. Eligible states submit work plans annually. A percentage of the total state-federal funding must be used for mitigation activities.

The USGS provides the NEHRP with earth science data and assessments for warnings, land-use planning, engineering design, and emergency preparedness decisions. Assessing and characterizing earthquake zones is one of the first steps toward reducing hazards. USGS funds are available for project grants to universities, profit and non-profit organizations, and state and local governments.

The NSF supports siting and fundamental geotechnical engineering research, structural analysis and design research, research on architectural and nonstructural components, and research facilities. NSF awards grants for earthquake engineering and geosciences research.

NIST and FEMA are responsible for working with state and local officials, model building code groups, architects, engineers, and others to see that scientific and engineering research is translated into improved building codes, standards, and practices for structures and lifelines and post-earthquake studies.

APPENDIX B

LOCAL GOVERNMENT POWERS IN NORTH CAROLINA

- **REGULATION: *GENERAL POLICE POWER***

Local governments in North Carolina have been granted broad regulatory powers in their jurisdictions. North Carolina General Statutes bestow the general police power on local governments, allowing them to enact and enforce ordinances which define, prohibit, regulate or abate acts, omissions, or conditions detrimental to the health, safety, and welfare of the people, and to define and abate nuisances (including public health nuisances). Since hazard mitigation can be included under the police power (as protection of public health, safety and welfare), towns, cities and counties may include requirements for hazard mitigation in local ordinances. Local governments may also use their ordinance-making power to abate "nuisances," which could include, by local definition, any activity or condition making people or property more vulnerable to any hazard. (See, e.g., N.C.G.S. Ch. 160A Art. 8 (Delegation and Exercise of the General Police Power to Cities and Towns); Ch 153A, Art. 6 (Delegation and Exercise of the General Police Power to Counties)).

- **REGULATION: *BUILDING CODES AND BUILDING INSPECTION***

Many structural mitigation measures involve constructing and retrofitting homes, businesses and other structures according to standards designed to make the buildings more resilient to the impacts of natural hazards. Many of these standards are imposed through the building code. North Carolina has a state compulsory building code which applies throughout the state. (N.C.G.S. 143-138(c)). However, municipalities and counties may adopt codes for the respective areas if approved by the state as providing "adequate minimum standards." (N.C.G.S. 143-138(e)). Local regulations cannot be less restrictive than the state code. Exempted from the state code are: public utility facilities other than buildings; liquefied petroleum gas and liquid fertilizer installations; farm buildings outside municipal jurisdictions; no state permit may be required for structures under $20,000. (Note that exemptions apply only to state, not local permits).

Local governments in North Carolina are also empowered to carry out building inspection. N.C.G.S. Ch. 160A, Art. 19. Part 5; and Ch. 153A Art. 18, Part 4 empower cities and counties to create an inspection department, and enumerates its duties and responsibilities, which include enforcing state and local laws relating to the construction of buildings, installation of plumbing, electrical, heating systems, etc.; building maintenance; and other matters.

- **REGULATION: *LAND USE***

Regulatory powers granted by the state to local governments are the most basic manner in which a local government can control the use of *land* within its jurisdiction. Through various land use regulatory powers, a local government can control the amount, timing, density, quality, and location of new development; all these characteristics of growth can determine the level of vulnerability of the community in the event of a natural hazard. Land use regulatory powers include the power to engage in planning, enact and enforce zoning ordinances, floodplain ordinances, and subdivision controls.

Zoning. Zoning is the traditional and nearly ubiquitous tool available to local governments to control the use of land. Broad enabling authority for municipalities in North Carolina to engage in zoning is granted in N.C.G.S. 160A-381; and for counties in N.C.G.S. 153A-340 (counties may also regulate inside municipal jurisdiction at the request of a city (N.C.G.S. 160A-360(d)). The statutory purpose for the grant of power is to promote health, safety, morals, or the general welfare of the community. Land "uses" controlled by zoning include the type of use (e.g., residential, commercial, industrial) as well as minimum specifications for use such as lot size, building height and set backs, density of population, and the like. The local government is authorized to divide its territorial jurisdiction into districts, and to regulate and restrict the erection, construction, reconstruction, alteration, repair or use of buildings, structures, or land within those districts. (N.C.G.S. 160A-382) Districts may include general use districts, overlay districts, and special use districts or conditional use districts. Zoning ordinances consist of maps and written text.

Floodway Regulation: The North Carolina General Statutes declare that the channel and a portion of the floodplain of all the State's streams will be designated as a floodway, either by the local government or by the State. The legislatively declared purpose of designating these areas as a floodway is to help control and minimize the extent of floods by preventing obstructions which inhibit water flow and increase flood height and damage and other losses (both public and private) in flood hazard areas, and to promote the public health, safety and welfare of citizens of North Carolina in flood hazard areas. (N.C.G.S. 143-215.51).

To carry out this purpose, local governments are empowered to grant permits for the use of the floodways, including the placement of any artificial obstruction in the floodway. (N.C.G.S. 143-215.53 - 215.54). No permit is required for certain uses, including agricultural, wildlife and related uses; ground level areas uses such as parking areas, rotary aircraft ports; lawns, gardens, golf courses, tennis courts, parks, open space, and similar private and public recreational uses. (N.C.G.S. 143-251.54(b)). Existing artificial obstructions in the floodway may not be enlarged or replaced without a permit; local governments are empowered to acquire existing obstructions by purchase, exchange, or condemnation if necessary to avoid flood damages. (N.C.G.S. 143-215.55).

The procedures that are laid out for issuing permits for floodway use require the local government to consider the dangerous effects a proposed artificial obstruction may create by causing water to be backed up or diverted; or the danger that the obstruction will be swept downstream to the injury of others; and by the injury or damage that may occur at the site of the obstruction itself. Local governments are to take into account anticipated development in the foreseeable future which may be adversely affected by the obstruction, as well as existing development. (N.C.G.S. 143-215.57 (a))

Planning. In order to exercise the regulatory powers conferred by the General Statutes, local governments in North Carolina are required to create or designate a planning agency. (N.C.G.S. 160A-387). The planning agency may perform a number of duties, including: make studies of the area; determine objectives; prepare and adopt plans for achieving those objectives; develop and recommend policies, ordinances, and administrative means to implement plans; and perform other related duties. (N.C.G.S. 160A-361). The importance of the planning powers of local governments is emphasized in N.C.G.S. 160A-383, which requires that zoning regulations be made in accordance with a comprehensive plan. While the ordinance itself may provide evidence that zoning is being conducted "in accordance with a plan", the existence of a separate planning document ensures that the government is developing regulations and ordinances that are consistent with the overall goals of the community.

Subdivision regulation. Subdivision regulations control the division of land into parcels for the purpose of building development or sale. Flood-related subdivision controls typically require that subdividers install adequate drainage facilities, and design water and sewer systems to minimize flood damage and contamination. They prohibit the subdivision of land subject to flooding unless flood hazards are overcome through filling or other measures and prohibit filling of floodway areas. They require that subdivision plans be approved prior to the sale of land. Subdivision regulations are a more limited tool than zoning and only indirectly affect the type of use made of land or minimum specifications for structures.

Broad subdivision control enabling authority for municipalities is granted in N.C.G.S. 160-371, and in 153-330 for counties outside of municipalities and municipal extraterritorial areas. Subdivision is defined as all divisions of a tract or parcel of land into two or more lots and all divisions involving a new street. (N.C.G.S. 160A-376). The definition of subdivision does not include the division of land into parcels greater than 10 acres where no street right-of-way dedication is involved. (N.C.G.S. 160A-376(2)).

The community thus possesses great power (in theory, anyway) to prevent unsuitable development in hazard-prone areas. (See, e.g., N.C.G.S. Ch. 160A, Art. 8. (*Delegation and Exercise of the General Police Powers to Cities and Towns*); Art. 19 (*Planning*); Part 3 (*Zoning*); and Ch. 153A. Art. 6 (*Delegation and Exercise of the General Police Power to Counties*; Art. 18 *(Planning and Regulation of Development*); Part 2 *(Subdivision Regulation*); Part 3 (*Zoning*).

- **ACQUISITION**

The power of acquisition can be a useful tool for pursuing mitigation goals. Local governments may find the most effective method for completely "hazard-proofing" a particular piece of property or area is to acquire the property (either in fee or a lesser interest, such as an easement), thus removing the property from the private market and eliminating or reducing the possibility of inappropriate development occurring. North Carolina legislation empowers cities, towns, counties to acquire property for public purpose by gift, grant, devise, bequest, exchange, purchase, lease or eminent domain. (See, e.g., N.C.G.S. Ch 153A. Art. 8; Ch. 1600A. Art. 11).

- **TAXATION**

The power to levy taxes and special assessments is an important tool delegated to local governments by North Carolina law. The power of taxation extends beyond merely the collection of revenue, and can have a profound impact on the pattern of development in the community. Many communities set preferential tax rates for areas which are unsuitable for development (e.g., agricultural land, wetlands), and can be used to discourage development in hazardous areas.

Local units of government also have the authority to levy special assessments on property owners for all or part of the costs of acquiring, constructing, reconstructing, extending or otherwise building or improving beach erosion control or flood and hurricane protection works within a designated area (N.C.G.S. §160A-238). This can serve to increase the cost of building in such areas, thereby discouraging development.

Because the usual methods of apportionment seem mechanical and arbitrary, and because the tax burden on a particular piece of property is often quite large, the major constraint in using special assessments is political. Special assessments seem to offer little in terms of control over land use in developing areas. They can, however, be used to finance the provision of services a city deems necessary within its boundaries. In addition, they are useful in distributing to the new property owners the costs of the infrastructure required by new development.

- **SPENDING**

The fourth major power that has been delegated from the North Carolina State General Assembly to local governments is the power to make expenditures in the public interest. Hazard mitigation principles should be made a routine part of all spending decisions made by the local government, including annual budgets and Capital Improvement Plans.

A capital program is usually a timetable by which a city indicates the timing and level of municipal services it intends to provide over a specified duration. Capital programming, by itself, can be used as a growth management technique, with a view to hazard mitigation. By tentatively committing itself to a timetable for the provision of capital to extend municipal services, a community can control its growth to some extent especially where the surrounding area is such that the provision of on-site sewage disposal and water supply are unusually expensive.

In addition to formulating a timetable for the provision of services, a local community can regulate the extension of and access to municipal services.

A capital improvement program (CIP) that is coordinated with extension and access policies can provide a significant degree of control over the location and timing of growth. These tools can also influence the cost of growth. If the CIP is effective in directing growth away from environmentally sensitive or high hazard areas, for example, it can reduce environmental costs.

APPENDIX C

HAZARDS AND VULNERABILITY IN NORTH CAROLINA

This Appendix provides an identification, description and assessment of the major natural hazards that impact North Carolina. Each hazard is assessed in terms of the hazard's likelihood of occurrence, the vulnerability within the State to the hazard, and the hazard's historical impact. In this context, vulnerability is the extent to which people and property will be adversely affected by a given hazard. The State's degree of vulnerability depends upon the risk of a particular natural hazard occurring (including such factors as probability, frequency and severity), as well as the amount and type of development or potential development. Vulnerability levels are also affected by mitigation policies that are in place to reduce hazard impacts, as well as by policies that may exacerbate the State's vulnerability (albeit inadvertently) by facilitating development in hazardous areas.

The climate of North Carolina varies considerably from the mountainous region in the west to the eastern coastline. Average temperatures vary by as much as 20 degrees from west to east. Average annual precipitation is generally around 50 inches statewide, but in the mountains there are significant terrain-induced variations. The minimum statewide average annual precipitation is 39 inches in northwestern Buncombe county, while the maximum statewide average annual precipitation is over 85 inches in southern Jackson county.

In light of the west-to-east gradient in climate variability due to topography (and proximity to the Atlantic Ocean) coupled with the north-to-south gradient in temperature due to latitude, North Carolina has been divided into eight climate divisions for purposes of long-term climatological assessments (Guttman and Quayle, 1996). See *Figure (1).* These climate divisions are considered relatively homogeneous in their long-term climatology and will be referenced where appropriate in addition to county-level data. *Table (10)* identifies the climate division associated with each North Carolina county.

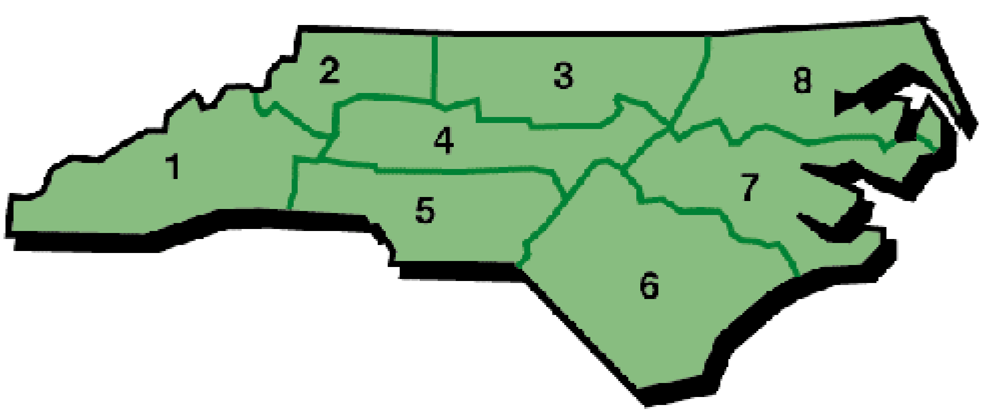


Figure (1): North Carolina Climate Divisions (Guttman and Quayle, 1996)

- **FLOODING**

Description

Flooding is a localized hazard that is generally the result of excessive precipitation. Floods can be generally considered in two categories: flash floods, the product of heavy localized precipitation in a short time period over a given location; and general floods, caused by precipitation over a longer time period and over a given river basin.

To be sure, flooding is the most common environmental hazard, due to the widespread geographical distribution of river valleys and coastal areas, and the attraction of human settlements to these areas. Most recent Presidential declarations of major disasters have been associated with flash and general floods.

Flash floods occur within a few minutes or hours of heavy amounts of rainfall, from a dam or levee failure, or from a sudden release of water held by an ice jam. Flash floods can destroy buildings and bridges, uproot trees, and scour out new drainage channels. Heavy rains that produce flash floods can also trigger mudslides. Most flash flooding is caused by slow-moving thunderstorms, repeated thunderstorms in a local area, or by heavy rains from hurricanes and tropical storms. Although flash flooding occurs often along mountain streams, it is also common in urban areas where much of the ground is covered by impervious surfaces. Roads and buildings generate greater amounts of runoff than typical forested land. Fixed drainage channels in urban areas may be unable to contain the runoff that is generated by relatively small but intense rainfall events.

The severity of a flooding event is determined by a combination of river basin physiography, local thunderstorm movement, past soil moisture conditions and the degree of vegetative clearing. Abnormal weather patterns may also contribute to flooding of a local area. Large-scale climatic events, such as the El Nino-Southern Oscillation in the Pacific have been linked to increased storm activity and flooding in the United States. Nationally, July is the month in which most flash flooding events occur, and nearly 90% of flash floods occur during the April through September period (Frazier, 1979).

While flash floods occur within hours of a rain event, general flooding is a longer-term event, and may last for several days. The primary types of flooding are **riverine flooding, coastal flooding** and **urban flooding**.

Periodic flooding of lands adjacent to non-tidal rivers and streams is a natural and inevitable occurrence. When stream flow exceeds the capacity of the normal water course, some of the above-normal stream flow spills over onto adjacent lands within the floodplain. **Riverine flooding** is a function of precipitation levels and water runoff volumes within the watershed of the stream or river. The recurrence interval of a flood is defined as the average time interval, in years, expected to take place between the occurrence of a flood of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence interval.

Floodplains are divisible into areas expected to be inundated by spillovers from stream flow levels associated with specific flood-return frequencies. A two-year return period event will generally inundate all of the two-year zone of the floodplain, and a 100-year flood will inundate the 100-year zone of that floodplain. Floodplains may be divided into as many as six levels of flood class, corresponding to six different hazard zones (A through F). Zone A represents the areas flooded by a 2-5 year flood; Zone B, a 5-10 year flood; Zone C, a 10-25 year flood; Zone D, a 25-50 year flood; Zone E, a 50-100 year flood; and Zone F, a greater than 100 year flood. The Army Corps of Engineers calls a 100-year flood an Intermediate Regional Flood, while a Standard Project flood describes a major flood that could be expected to occur from a combination of severe meteorological and hydrologic conditions (Griggs, 1983). Most dam and flood-related structures have been designed to meet 100-year flood conditions.

Coastal flooding is typically a result of storm surge, wind-driven waves, and heavy rainfall. These conditions are produced by hurricanes during the summer and fall, and nor'easters and other large coastal storms during the winter and spring. Storm surges may overrun barrier islands and push sea water up coastal rivers and inlets, blocking the downstream flow of inland runoff. Thousands of acres of crops and forest lands may be inundated by both saltwater and freshwater. Escape routes, particularly from barrier islands, may be cut off quickly, stranding residents in flooded areas and hampering rescue efforts.

Urban flooding occurs where there has been development within stream floodplains. This is partly a result of the use of waterways for transportation purposes in earlier times. Sites adjacent to rivers and coastal inlets provided convenient places to ship and receive commodities. The price of this accessibility was increased flooding of the ensuing urban areas. Urbanization increases the magnitude and frequency of floods by increasing impermeable surfaces, increasing the speed of drainage collection, reducing the carrying capacity of the land and, occasionally, overwhelming sewer systems.

Likelihood of Occurrence

Flood hazard varies by location and type of flooding. Coastal areas are most at risk from flooding caused by hurricanes, tropical storms and nor'easters. Low-lying coastal areas in close proximity to the shore, sounds or estuaries are exposed to the threat of flooding from storm surge and wind-driven waves, as well as from intense rainfall. Areas bordering rivers may also be affected by large discharges caused by heavy rainfall over upstream areas.

Inland areas are most at risk from flash flooding caused by intense rainfall over short periods of time. Mountain streams and urban areas are particularly susceptible to flash floods. Streams in the mountains typically lie in narrow valleys, which lack the ability to store and dissipate large amounts of water. Consequently, stream flow tends to increase rapidly. Large amounts of impervious surfaces in urban areas increase runoff amounts and decrease the lag time between the onset of rainfall and stream flooding. Manmade channels may also constrict stream flow and increase flow velocities.

Vulnerability

North Carolina is divided into thirteen river basins: Hiwassee, Upper Little Tennessee, Tuckasegee, Upper French Broad, Upper Broad, Upper New, Upper Yadkin, Upper Dan, Haw, Lumber, Upper Neuse, Upper Tar and Abemarle. These river basins are shown in *Figure (2).* State lines are in thick white, county lines are in thin white, streams are in thin gray, and river basin boundaries are in thick gray.

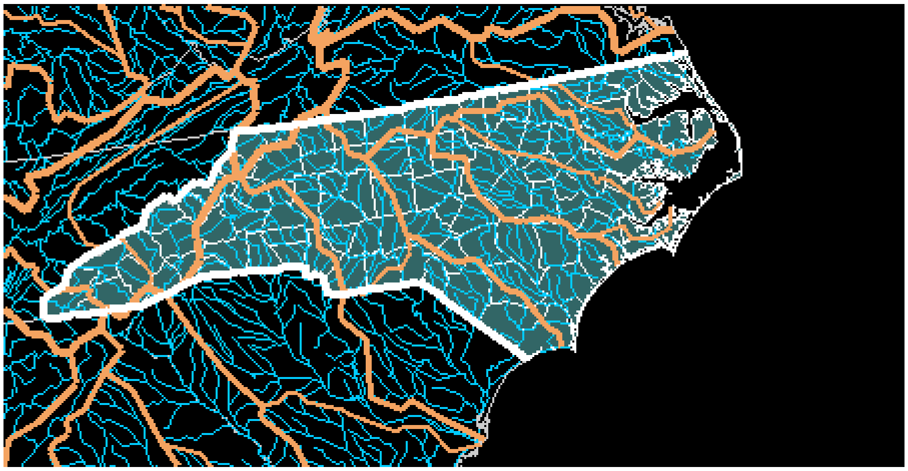


Figure (2) North Carolina River Basins (USGS, 1998)

The severity of a flooding event is determined by a number of local factors, including river basin physiography, precipitation patterns, recent soil moisture conditions and vegetative state. An assessment of flooding potential requires spatial information at the sub-county level. For coastal areas, flooding potential associated with hurricanes is mapped in Inundation Maps prepared as part of the Eastern North Carolina Hurricane Evacuation Study, areal photographs of the coastal area (updated at five-year intervals by the North Carolina Coastal Resources Commission), and flood maps prepared for the National Flood Insurance Program. Flood vulnerability for each of the one hundred counties in North Carolina is summarized in *Tables (10)* and *(11).*

Historical Impact

All parts of North Carolina have been flooded with rainfall associated with tropical storms and hurricanes. The mountains were devastated by hurricane-induced rains in 1916, 1928 and 1940; the Piedmont was impacted in those years plus 1945; and the Coastal Plain was adversely affected in 1945, 1954 and 1955 (USGS, 1991).

- **HURRICANES**

Description

According to Simpson and Reihl (1981), hurricanes are cyclonic storms that originate in tropical ocean waters poleward of about 5^{o} latitude. Basically, hurricanes are heat engines, fueled by the release of latent heat from the condensation of warm water. Their formation requires a low pressure disturbance, sufficiently warm sea surface temperature, rotational force from the spinning of the earth and the absence of wind shear in the lowest 50,000 feet of the atmosphere.

Hurricanes that impact North Carolina form in the so-called Atlantic Basin, from the west coast of Africa westward into the Caribbean Sea and Gulf of Mexico. Hurricanes in this basin generally form between June 1 and November 30, with a peak around mid-September. As an incipient hurricane develops, barometric pressure at its center falls and winds increase. Winds at or exceeding 39 mph result in the formation of a tropical storm, which is given a name and closely monitored by the NOAA National Hurricane Center in Miami, Florida. When winds are at or exceed 74 mph, the tropical storm is deemed a hurricane.

Hurricanes have the greatest potential to inflict damage as they cross the coastline from the ocean, which is called landfall. Because hurricanes derive their strength from warm ocean waters, they are generally subject to deterioration once they make landfall. The forward momentum of a hurricane can vary from just a few miles per hour to up to 40 mph. This forward motion, combined with a counterclockwise surface flow make the right front quadrant of the hurricane the location of the most potentially damaging winds.

Hurricane intensity is measured using the Saffir-Simpson Scale, ranging from 1 (minimal) to 5 (catastrophic). See *Table (1).* The scale categorizes hurricane intensity linearly based upon maximum sustained winds, minimum barometric pressure and storm surge potential, which are combined to estimate of the potential flooding and damage to property given a hurricane's estimated intensity.

Table (1): Saffir-Simpson Hurricane Scale (Simpson and Reihl, 1981)

Saffir-Simpson Scale

Saffir-Simpson Category	Maximum sustained wind speed			Minimum surface pressure	Storm surge	
	mph	meters/ sec	knots	Millibars (mb)	feet	meters
1	74-96	33-42	64-83	Greater than 980	3-5	1.0-1.7
2	97-111	43-49	84-96	979-965	6-8	1.8-2.6
3	112-131	50-58	97-113	964-945	9-12	2.7-3.8
4	132-155	59-69	114-135	944-920	13-18	3.9-5.6
5	156+	70+	136+	Less than 920	19+	5.7+

Damage

Cat.	Level	Description	Example
1	Minimal	Damage primarily to shrubbery, trees, foliage, and unanchored homes. No real damage to other structures. Some damage to poorly constructed signs. Low-lying coastal roads inundated, minor pier damage, some small craft in exposed anchorage torn from moorings.	Hurricane Jerry (1989)
2	Moderate	Considerable damage to shrubbery and tree foliage; some trees blown down. Major damage to exposed mobile homes. Extensive damage to poorly constructed signs. Some damage to roofing materials of buildings; some window and door damage. No major damage to buildings. Coast roads and low-lying escape routes inland cut by rising water 2 to 4 hours before arrival of hurricane center. Considerable damage to piers. Marinas flooded. Small craft in	Hurricane Bob (1991)

Cat.	Level	Description	Example
		unprotected anchorages torn from moorings. Evacuation of some shoreline residences and low-lying areas required.	
3	Extensive	Foliage torn from trees; large trees blown down. Practically all poorly constructed signs blown down. Some damage to roofing materials of buildings; some wind and door damage. Some structural damage to small buildings. Mobile homes destroyed. Serious flooding at coast and many smaller structures near coast destroyed; larger structures near coast damaged by battering waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Flat terrain 5 feet of less above sea level flooded inland 8 miles or more. Evacuation of low-lying residences within several blocks of shoreline possibly required.	Hurricane Gloria (1985)
4	Extreme	Shrubs and trees blown down; all signs down. Extensive damage to roofing materials, windows and doors. Complete failures of roofs on many small residences. Complete destruction of mobile homes. Flat terrain 10 feet of less above sea level flooded inland as far as 6 miles. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required, and of single- story residences within 2 miles of shore.	Hurricane Andrew (1992)
5	Catastrophic	Shrubs and trees blown down; considerable damage to roofs of buildings; all signs down. Very severe and extensive damage to windows and doors. Complete failure of roofs on many residences and industrial buildings. Extensive shattering of glass in windows and doors. Some complete building failures. Small buildings overturned or blown away. Complete destruction of mobile homes. Major damage to lower floors of all structures less than 15 feet above sea level within 500 yards of shore. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Massive evacuation of residential areas on low ground within 5 to 10 miles of shore possibly required.	Hurricane Camille (1969)

According to Landsea (1998), hurricanes can be categorized as major hurricanes (the most potentially dangerous) with a Saffir-Simpson classification of 3, 4 or 5. These intense hurricanes cause over 70% of the damage in the USA even though they account for only 20% of tropical cyclone landfalls.

Likelihood of Occurrence

By virtue of its position along the Atlantic Ocean adjacent to and protruding to the edge of the Gulf Stream, North Carolina is frequently impacted by hurricanes. In fact, North Carolina has experienced the fourth greatest number of hurricane landfalls of any state in the twentieth century (after Florida, Texas and Louisiana).

Vulnerability

The county-by-county frequency of hurricanes for both minor and major hurricanes, 1900-1996 (adapted from Jarrell et al. (1992)) is given in *Table (11).* Vulnerability to hurricanes for each North Carolina county based on general vulnerability areas and frequency in terms of low, moderate, or high is given in *Table (10).* All areas of the State are vulnerable to hurricane hazards, but *Tables (10)* and *(11)* show that the greatest impact associated with storm surge is limited to the eighteen counties bordering the shoreline and sounds.

Perhaps more than other natural hazards that impact North Carolina, hurricanes have the potential of threatening a large segment of non-residents. Summer populations of coastal areas can swell to many times the year-round population coincident with the first half of the hurricane season. Other important vulnerability factors for coastal areas include the number and vulnerability (to flooding) of evacuation routes, the percentage of dwellings in floodplains.

Another vulnerability to hurricanes is the population occupying mobile homes. These structures are particularly vulnerable to damage and destruction in high wind situations. Coastal counties with a high percentage of mobile home dwellings, such as Brunswick (38.3), Pender (33.0), Currituck (32.9) and Tyrell (31.3) face an enhanced level of vulnerability. Inland coastal plain counties with similarly high percentages of mobile homes include Hoke (36.3), Warren (32.9), Franklin (32.1) and Harnett (30.7).

Historical Impact

According to Barnes (1995), North Carolina has had an extensive hurricane history dating back to colonial times, with notable nineteenth century storms occurring in 1837, 1846, 1856, 1879, 1883 and 1899. From 1960 to 1990, there was a lull in landfalling major hurricanes, with only one (Hurricane Donna in 1960). The 1950s were a busy time for hurricanes in North Carolina, including Hazel, Connie, Diane and Ione. Recent years have proven busy as well, with Hugo (1989), Emily (1993), Opal (1995), Bertha (1996), Fran (1996) and Bonnie (1998) all leaving there mark from the coast to across the state.

Table (2): Significant Hurricanes in North Carolina 1879-1995 (Barnes, 1995)

Name/Date	**Category (in NC)**	**Maximum Wind**	**Pressure (in NC) inches Hg**	**NC Deaths**	**NC Damage (in Millions $)**
August 1879	4	168	N/A	40+	N/A
September 1883	3	100+	N/A	53	N/A
August 1899	4	140	N/A	25	N/A
September 1933	3	125	28.26	21	3
September 1944	3	110	27.97	1	1.5
Hazel, 1954	4	150	27.70	19	136
Ione, 1955	3	107	28.00	7	88
Donna, 1960	3	120	28.45	8	25
Diana, 1984	3	115	28.02	3	85
Gloria, 1985	3	100+	27.82	1	8
Hugo, 1989	3	100	28.88	7	1000
Emily, 1993	3	111	29.00	0	13

- **NOR'EASTERS**

Description

In the past decade, research meteorologists have come to recognize the damage potential of so-called nor'easters. Unlike hurricanes, these storms are extratropical, deriving their strength from horizontal gradients in temperature.

According to Cione et al. (1996), the presence of the Gulf Stream off the eastern seaboard during the winter season acts to dramatically enhance surface horizontal temperature gradients within the coastal zone. This is particularly true off the North Carolina coastline where, on average, the Gulf Stream is closest to land north of 32^{o} latitude. During winter offshore cold periods, these horizontal temperature gradients can result in rapid and intense destabilization of the atmospheric directly above and shoreward of the Gulf Stream. This air mass modification or conditioning period often precedes wintertime coastal extratropical cyclone development.

It is the temperature structure of the continental air mass and the position of the temperature gradient along the Gulf stream that drives this cyclone development (Cione et al., 1996). As a low pressure deepens, winds and waves can uninhibitedly increase and cause serious damage to coastal areas as the storm generally moves to the northeast. Davis and Dolan (1993) have proposed an intensity scale (Dolan-Davis Nor'easter Intensity Scale) that is based upon levels of coastal degradation. See *Table (3).*

Table (3): The Dolan-Davis Nor'easter Intensity Scale
(Davis and Dolan, 1993)

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

Likelihood of Occurrence

Analysis of nor'easter frequency by researchers reveals fewer nor'easters during the 1980s. However, the frequency of major nor'easters (class 4 and 5 of the Dolan-Davis scale) has increased in recent years. In the period 1987 to 1993, at least one class 4 or 5 storm has occurred each year along the Atlantic seaboard of the United States, a situation duplicated only once in the last 50 years.

Vulnerability

In North Carolina, the impact of the nor'easter is dramatized by the threatened state of the Cape Hatteras Lighthouse. The threat of the nor'easter can fundamentally be confined to those coastal counties of North Carolina that have experience hurricanes in this century, although its impact often reaches much further inland with large-scale events. This simplistic assessment of nor'easter hazard vulnerability is presented in *Table (11)* (1 = some vulnerability for coastal counties). *Table (10)* depicts county vulnerability to nor'easters in terms of low, moderate or high based on general vulnerability areas. Continued meteorological research will help spatially refine the vulnerability in the future.

The coastal counties of North Carolina are most vulnerable to the impacts of nor'easters. Since the storms often occur at night, and typically make landfall with less warning than hurricanes (due to their rapid formation right along the coast), residents may be caught at home unprepared. On the other hand, nor'easters typically occur during the off-season when fewer non-residents are visiting the coast. As with hurricanes, vulnerability is proportional to structural strength, with mobile homes particularly vulnerable.

Historical Impact

A number of notable nor'easters have impacted North Carolina in recent decades, including the Ash Wednesday Storm of March 1962, but they were typically only of local concern. One exception to this was the nor'easter of late October and early November 1990, which loosened a dredge barge that struck and destroyed approximately five roadway segments of the Bonner Bridge in Dare county. Another nor'easter struck the Outer Banks on Halloween, 1991, causing substantial beach erosion.

- **EARTHQUAKES**

Description

Earthquakes are geologic events that involve movement or shaking of the earth's crust. Earthquakes are usually caused by the release of stresses accumulated as a result of the rupture of rocks along opposing fault planes in the earth's outer crust. These fault planes are typically found along borders of the earth's ten tectonic plates. These plate borders generally follow the outlines of the continents, with the North American plate following the continental border with the Pacific Ocean in the west, but following the mid-Atlantic trench in the east. As earthquakes occurring in the mid-ocean trench usually pose little threat to humans, unlike earthquakes located along continental boundaries, the greatest earthquake threat in North America is along the Pacific coast.

The areas of greatest tectonic instability occur at the perimeters of the slowly moving plates, as these locations are subjected to the greatest strains from plates traveling in opposite directions and at different speeds. Deformation along plate boundaries causes strain in the rock and the consequent buildup of stored energy. When the built-up stress exceeds the rocks' strength, a rupture occurs. The rock on both sides of the fracture is snapped, releasing the stored energy and producing seismic waves, generating an earthquake.

Earthquakes are measured in terms of their magnitude and intensity. Magnitude is measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude. Each unit increase in magnitude on the Richter Scale corresponds to a ten-fold increase in wave amplitude, or a 244 - fold increase in energy (USGS, 1996). Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale (Bryant, 1991). It is a twelve-level scale based on direct and indirect measurements of seismic effects. The scale levels are typically described using roman numerals, with a I corresponding to imperceptible (instrumental) events, IV corresponding to moderate (felt by people awake), to XII for catastrophic (total destruction). A detailed description of the Modified Mercalli Scale of Earthquake Intensity (and its correspondence to the Richter Scale) is given in *Table (4)*

Table (4): Modified Mercalli Scale of Earthquake Intensity

Scale	**Intensity**	**Description of Effects**	**Maximum Acceleration (mm/sec)**	**Corresponding Richter Scale**
I	Instrumental	Detected only on seismographs	<10	
II	Feeble	Some people feel it	<25	<4.2
III	Slight	Felt by people resting; like a truck rumbling by	<50	
IV	Moderate	Felt by people walking	<100	
V	Slightly Strong	Sleepers awake; church bells ring	<250	<4.8
VI	Strong	Trees sway; suspended objects swing, objects fall off shelves	<500	<5.4
VII	Very Strong	Mild Alarm; walls crack; plaster falls	<1000	<6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged	<2500	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	<5000	<6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	<7500	<7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards	<9800	<8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	>9800	>8.1

Likelihood of Occurrence

Figure (3) shows the epicenters of earthquakes occurring in and around North Carolina from 1977 to 1996. Epicenters are generally concentrated in the active Eastern Tennessee Seismic Zone, which is second in activity in the eastern U.S. only to the New Madrid Fault (Snoke and Chapman, 1997).

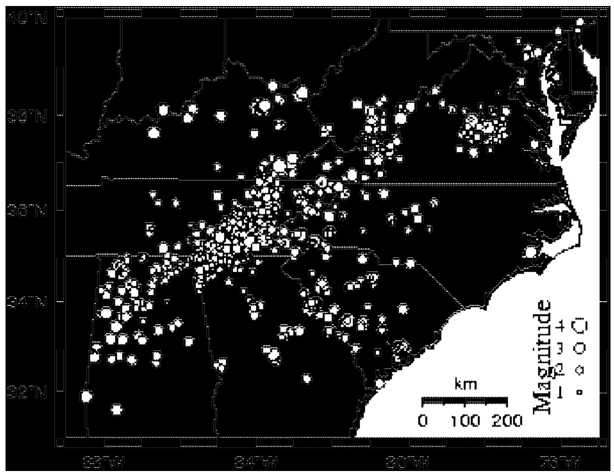


Figure (3). Shaded circles show the epicenters of earthquakes in the southeastern United States for the period 1977 through 1996 (Snoke and Chapman, 1997).

The Eastern Tennessee Seismic Zone is part of a crescent of moderate seismic activity risk extending from Charleston, South Carolina northwestward into eastern Tennessee and then curving northeastward into central Virginia. While there have not been any earthquakes with a MMI intensity greater than IV since 1928 in this area, it has the potential to produce an earthquake of significant intensity in the future.

North Carolina's vulnerability to earthquakes decreases from west to east in relation to the Eastern Tennessee Seismic Zone. Generally, there are three different zones of seismic risk in North Carolina that correspond to different effective peak velocity-related accelerations of ground movement. The eastern portion of the State faces minimal effects from seismic activity. Locations in the middle and southeastern areas of the State face a moderate hazard from seismic activity, while the area from Mecklenburg county west through the Blue Ridge faces the greatest risk from seismic activity. These different levels of risk correspond to proximity to areas with historical seismic activity and changes in topography.

The steep topography of western North Carolina exacerbates the potential for damage from this area of seismic activity. There could be significant ground movement on steep slopes from seismic activity, which could result in human injuries, damage to property, and road closures, which would add to the difficulty of bringing in relief supplies and fire protection equipment.

Vulnerability

A categorization of earthquake hazard vulnerability by county is provided in *Table (10)* (low, moderate or high) and in *Table (11)* (1-6, relative to coterminous United States). These categorizations generally correspond to the likelihood of earthquake activity as discussed in the previous section.

Historical Impact

Earthquakes are relatively infrequent but not uncommon in North Carolina. According to von Hake (1975), the earliest North Carolina earthquake on record is that of March 8, 1735, near Bath. This event was probably less than intensity V (Slightly strong; sleepers awake). The great earthquake of 1811 centered in the Mississippi Valley near New Madrid, Missouri, was felt throughout North Carolina. Intensity VI (Strong; trees sway) effects were observed in the western part of the State. The most property damage in North Carolina ever attributed to an earthquake, however, was caused by the August 31, 1886 Charleston, South Carolina shock. The quake left about 65 people dead in Charleston and led to chimney collapses, fallen plaster and cracked walls in Abbottsburg, Charlotte, Elizabethtown, Henderson, Hillsborough, Raleigh, Waynesville, and Whiteville. On February 21, 1916, the Asheville area was the center for a large intensity VI earthquake, which was felt in Alabama, Georgia, Kentucky, South Carolina, Tennessee, and Virginia - some 518,000 square kilometers in all. Subsequent minor earthquakes have caused damage in North Carolina in 1926, 1928, 1957, 1959, 1971, 1973 and 1976.

• LANDSLIDES

Description

According to the United States Geological Survey (USGS), landslides are a major geologic hazard that occur in all 50 states, cause $1-2 billion in damages and result in an average of more than 25 fatalities each year (USGS, 1997). Landslides are especially troubling because they often occur with other natural hazards, such as earthquakes and floods.

A deadly manifestation of landslides are debris flows. Gori and Burton (1996) explain that while some landslides move slowly and cause damage gradually, others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. The latter constitute debris flows (also referred to as mudslides, mudflows, or debris avalanches), which are a common type of fast-moving landslide that generally occurs during intense rainfall on water-saturated soil. They usually start on steep hillsides as soil slumps or slides that liquefy and accelerate to speeds as great as 35 miles per hour or more. They continue flowing down hills and into channels and deposit sand, mud, boulders, and organic material onto more gently sloping ground. 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.

Likelihood of Occurrence

In the eastern United States, landslides are common throughout the mountainous Appalachian region and New England, predominantly from sliding of clay-rich soils. The USGS identifies landslide incidence/susceptibility for the eastern United States by (1) classifying geographic areas by high, medium, or low landslide incidence and (2) evaluating geologic formations in these areas by high, medium, or low susceptibility to landsliding.

Susceptibility to landsliding is defined by the USGS as the probable degree of response of geologic formations to natural or artificial cutting, loading of slopes, or to unusually high precipitation. Generally, it is assumed that unusually high precipitation or changes in existing conditions can initiate landslide movement in areas where rocks and soils have experienced numerous landslides in the past.

Vulnerability

A categorization of landslide vulnerability by county is provided in *Table (10)* (low, moderate, or high) and in *Table (11)* (1-6, relative to coterminous United States). This categorization generally corresponds to the likelihood of earthquake activity as discussed in the previous section.

Tables (10) and *(11)* show values for landslide vulnerability are based upon a combination of landslide susceptibility and incidence, scaled between 1 and 6, and taken from the USGS National Landslide Overview Map as follows in *Table (5).*

Table (5): USGS Landslide Susceptibility/Incidence

Category	Incidence	Susceptibility	Category	Incidence	Susceptibility
1	Low	Low	4	Moderate	Moderate
2	Low	Moderate	5	Moderate	High
3	Low	High	6	High	High

High incidence means greater than 15 percent of a given area has been involved in landsliding, medium incidence means that 1.5 to 15 percent of an area has been involved, and low incidence means that less than 1.5 percent of an area has been involved. High, medium, and low susceptibility are delimited by the same percentages.

Historical Impact

According to Gori and Burton (1996), historical records suggest 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. During Hurricane Camille in 1969, such conditions generated debris flows in Nelson County, Virginia. The hurricane 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. Scientists have documented 51 historical debris-flow events between 1844 and 1985 in parts of the Appalachians -- most of them in the Blue Ridge area. Recent studies of deposits exposed in stream channels during the 1995 storms in Madison County, Virginia found evidence of prehistoric debris flows. Radiocarbon dating of plant remains from debris-flow deposits near Graves Mill, Virginia indicates that these processes have occurred there repeatedly over the last 34,000 years.

- **SEVERE WINTER STORMS**

Description

Severe winter storms can produce an array of hazardous weather conditions, including heavy snow, blizzards, freezing rain and ice pellets and extreme cold. Severe winter storms are extratropical cyclones fueled by strong temperature gradients and an active upper-level jet stream. The winter storms that impact North Carolina generally form in the Gulf of Mexico or off the southeast Atlantic Coast. Few of these storms result in blizzard conditions, defined by the presence of winds in excess of 35 mph, falling and blowing snow, and a maximum temperature of 20^{o} Fahrenheit.

While the frequency and magnitude of snow events are highest in the mountains due to elevation, the geographical orientation of the mountains and piedmont contribute to a regular occurrence of freezing precipitation events (e.g., ice pellets and freezing rain) in the piedmont. Such ice events (up to and including ice storms) are often the result of cold air damming (CAD). According to Hartfield et al. (1996), CAD is a shallow, surface-based layer of relatively cold, stably-stratified air entrenched against the eastern slopes of the Appalachian Mountains. With warmer air above, falling precipitation in the form of snow melts, then becomes either supercooled (liquid below the melting point of water) or re-freezes. In the former case, supercooled droplets can freeze on impact (freezing rain), while in the latter case, the re-frozen water particles are ice pellets (or sleet). *Figure (4)* shows the general location of cold air damming events. *Table (11)* notes the North Carolina counties that fall in this region where the potential for ice storms is heightened.

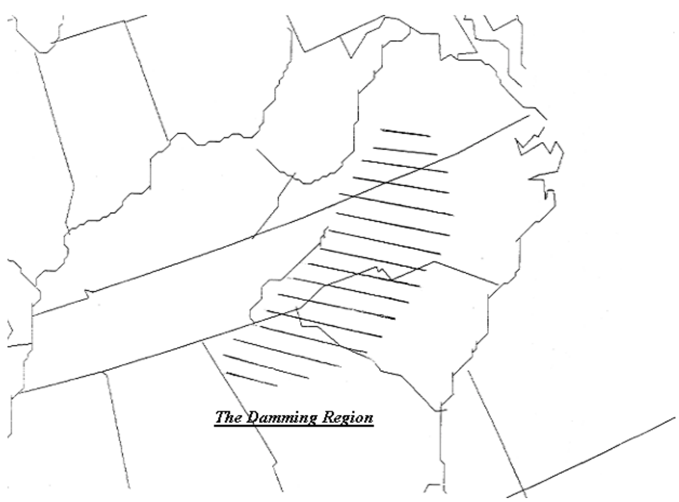


Figure (4) Region where cold air damming occurs in the eastern U.S. (Hartfield et al. 1996)

Likelihood of Occurrence

The entire State of North Carolina has a likelihood of experiencing severe winter weather. The threat varies by location and by type of storm. Coastal areas typically face their greatest threat from Nor'easters and other severe winter coastal storms. These storms can contain strong waves and result in extensive beach erosion and flooding. Freezing rain and ice storms typically occur once every several years at coastal locations, and sever snowstorms have been recorded occasionally in coastal areas.

As mentioned previously, cold air damming contributes to elevated freezing rain and ice storm events in the Piedmont of North Carolina. These events occur at least as often as moderate or severe snow events in this region.

The mountains of North Carolina usually receive several snowfalls of 4 to 6 inches in a given winter weather season. There has been at least one severe winter storm at some location in the mountains each year during the 1984-1993 period. The western area of the state is more likely to experience greater and more frequent snowfalls and blizzards than other locations in the state.

Vulnerability

The most obvious parameter in winter weather is snow. It is extreme snow that is the most potentially disruptive to society, for it can bring down power lines, trees and lead to roof collapses. FEMA commissioned the National Climatic Data Center (NCDC) to compile snowfall extreme statistics for the contiguous U.S. in 1997 (Heim, 1998). One-day observed maximum total snowfall amounts (in inches) were compiled for selected stations (many for the period 1948-1996). These values are consolidated into counties (where available) and are listed in *Table (11).* The average one-day extreme snowfall for each climate division, based on available county data, is shown in *Table (6).*

Table (6): Extreme Average Snowfall by Climate Division

Climate Division	Average	Climate Division	Average
1	14.39	5	11.62
2	15.06	6	10.69
3	11.62	7	12.38
4	11.56	8	12.24

Table (10) provides a county-by-county assessment of vulnerability to severe winter weather in terms of low, moderate or high.

The data above suggests that the mountains have the highest extreme one-day snowfall, followed by the northern coastal divisions (associated with coastal winter storms).

- **THUNDERSTORMS AND TORNADOES**

Description

Thunderstorms are the result of convection in the atmosphere. They are typically the by-product of atmospheric instability, which promotes the vigorous rising of air parcels that form cumulus and, eventually, the cumulonimbus (thunderstorm) cloud. Instability can be caused by either surface heating or upper-tropospheric (~50,000 feet) divergence of air (rising air parcels can also result from air flows over mountainous areas). Generally, the former "air mass" thunderstorms form on warm-season afternoons and are not severe. The latter "dynamically-driven" thunderstorms generally form in association with a cold front or other regional-scaled atmospheric disturbance. These storms can become severe, producing strong winds, frequent lightning, hail, downbursts and even tornadoes.

A typical thunderstorm may be three miles wide at its base, rise to between 40,000 to 60,000 feet in the troposphere, and contain half a million tons of condensed water (Frazier, 1979). Conglomerations of thunderstorms along cold fronts (with squall lines) can extend for hundreds of miles. Thunderstorms contain tremendous amounts of energy derived from condensation of water. The half million tons of condensed water release 300 trillion calories of energy, equivalent to about 100 million kilowatt-hours of electricity, or several Hiroshima-sized atomic bombs (Frazier, 1979).

Natural hazards vulnerability is disproportionately linked to severe thunderstorms. According to the National Weather Service, a severe thunderstorm is a thunderstorm which produces tornadoes, hail 0.75 inches or more in diameter, or winds of 50 knots (58 mph) or more. Structural wind damage may imply the occurrence of a severe thunderstorm.
Hail, formed by the accretion of supercooled liquid water on ice particles in a thunderstorm updraft, can pose a serious threat to agriculture and exposed objects. Likewise, strong winds can potentially wreak havoc on fragile or flimsy structures, or yield secondary damage through the downing of trees. The tornado, however, is by far the greatest natural hazard threat from a severe thunderstorm.

The National Weather Service defines a tornado as a violently rotating column of air in contact with the ground and extending from the base of a thunderstorm. A condensation funnel *does not need to reach to the ground* for a tornado to be present; a debris cloud beneath a thunderstorm is all that is needed to confirm the presence of a tornado, even without a condensation funnel.

Tornadoes are distinguishable from waterspouts, which are small, relatively weak rotating columns of air over water beneath a cumulonimbus or towering cumulus cloud. Waterspouts are most common over tropical or subtropical waters. The exact definition of waterspout is debatable. In most cases the term is reserved for small vortices over water that are not associated with storm-scale rotation (i.e., they are the water-based equivalent of landspouts). But there is sufficient justification for calling virtually any rotating column of air a waterspout if it is in contact with a water surface.

The intensity, path length and width of tornadoes are rated according to a scale developed by T. Theodore Fujita and Allen D. Pearson. The Fujita-Pearson Tornado Scale is presented in *Table (7)* Tornadoes classified as F0-F1 are considered weak tornadoes, those classified as F2-F3 are considered strong, while those classified as F4-F5 are considered violent.

Table (7): The Fujita-Pearson Tornado Scale

F-Scale	Damage	Winds (mph)	Path Length (miles)	Mean Width (miles)
F0	Light	40-72	<1	<0.01
F1	Moderate	73-112	1-3.1	0.01-0.03
F2	Considerable	113-157	3.2-9.9	0.04-0.09
F3	Severe	158-206	10-31	0.1-0.31
F4	Devastating	207-260	32-99	0.32-0.99
F5	Incredible	261-318	≥ 100	≥ 1.0

Likelihood of Occurrence

Thunderstorms are common throughout North Carolina, and have occurred in all months. Thunderstorm-related deaths and injuries in North Carolina (1959-1992) have peaked during July and August. Most tornadoes in North Carolina develop in areas of atmospheric disturbance, including along squall lines ahead of an advancing cold front; in an area where warm air masses converge; in some local summer thunderstorms; and in association with a tropical cyclone (Dutcher et al., 1992).

Of all tornadoes reported in North Carolina between 1953 and 1990, 71% have been classified as weak, 28% as strong, and about 1% as violent. Weak tornadoes have caused 3% of North Carolina tornado deaths, similar to the national figure. Strong tornadoes were responsible for 49% of North Carolina deaths (versus 30% nationwide), while violent tornadoes caused 48% of North Carolina deaths, compared to 70% for the nation. Based on state tornado statistics (SERCC, 1996), North Carolina ranks 22nd in total number of tornadoes and 18th in tornado deaths for the period 1953-1995.

Although tornadoes have been reported in North Carolina throughout the year, most of them have occurred in the spring, with 13% in March, 11% in April, 22% in May and 14% in June. The most severe tornadoes have also taken place during the spring, with more than half of all F2 or strongest storms occurring in that time period.

Vulnerability

Because mountainous areas disrupt the inflow of air near the surface of squall lines and individual thunderstorms, organized thunderstorm activity is generally not as strong in western North Carolina, and thus tornadic activity is muted in this region. Hurricane-induced tornadic activity generally occurs close to the coastline as a hurricane makes landfall.

Table (11) includes a county-by-county tornado count for the period 1953-1990. The frequency of occurrence per square mile by climate division is (values *1000):

Table (8) Tornado Density by Climate Division

Climate Division	Value	Climate Division	Value
1	5.70	5	14.51
2	5.42	6	15.26
3	7.87	7	14.66
4	11.32	8	14.56

Table (10) combines general vulnerability areas and frequency of tornadoes to assign county vulnerabilities of low, moderate or high.

The data above confirm the lower frequency of tornadoes in the mountains and northern piedmont of North Carolina that can be attributed to less favorable conditions for severe thunderstorm activity in those regions.

- **WILDFIRE**

Description

A wildfire is an uncontrolled burning of grasslands, brush or woodlands. The potential for wildfire depends upon surface fuel characteristics, recent climate conditions, current meteorological conditions and fire behavior. Hot, dry summers and dry vegetation increase susceptibility to fire in the fall, a particularly dangerous time of year for wildfire.

Likelihood of Occurrence

In North Carolina, wildfire potential has been assessed using State Forest Service records for the period 1950-1993. *Table (11)* shows a county-by-county categorization of wildfire potential as High (3), Moderate (2) or Low (1) for both number of fires and number of acres burned.

By summing the categorizations for the number of fires and number of acres burned, a combined categorization of 1-6 is produced. The average of this categorization for each climate division is:

Table (9) Average Wildfire Category by Climate Division

Climate Division	Average	Climate Division	Average
1	2	5	2.5
2	2	6	4
3	2	7	2.3
4	2.1	8	2.2

The data above suggests that the southern coastal plain is most vulnerable to the wildfire hazard.

Vulnerability

As development has spread into areas which were previously rural, new residents have been relatively unaware of the hazards posed by wildfires and have used highly flammable material for constructing buildings. This has not only increased the threat of loss of life and property, but has also resulted in a greater population of people less prepared to cope with wildfire hazards. *Table (11)* classifies the vulnerability of each North Carolina county based on number of wildfires and number of acres burned from 1950 to 1993. *Table (10)* categorizes county vulnerability to wildfires as low, moderate or high.

- **NORTH CAROLINA NATURAL HAZARDS SUMMARY ASSESSMENT**

Table (10): Natural Hazard Vulnerabilities by North Carolina County

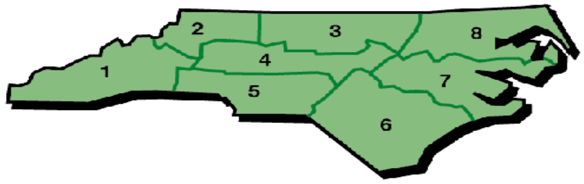
County	Climate Division (NOAA)	Earthquake	Landslide	Hurricane	Nor'easter	Tornado	Severe Winter Weather	Wildfire	Flood
Alamance	3	Low	Mod.	Low	Low	Mod.	Mod.	Low	Low
Alexander	4	Mod.	Mod.	Low	Low	Mod.	Mod.	Low	Mod.
Alleghany	2	Mod.	High	Low	Low	Low	High	Low	Mod.
Anson	5	Mod.	Low	Low	Low	Mod.	Mod.	Low	Mod.
Ashe	2	Mod.	High	Low	Low	Low	High	Low	High
Avery	2	Mod.	High	Low	Low	Low	High	Low	High
Beaufort	7	Low	Low	High	High	High	Low	Low	High
Bertie	8	Low	Low	High	Mod.	High	Low	Low	High
Bladen	6	Low	Low	Mod.	Mod.	Mod.	Low	Mod.	Mod.
Brunswick	6	Low	Low	High	High	High	Low	High	High
Buncombe	1	Mod.	High	Low	Low	Low	High	Low	High
Burke	1	Mod.	High	Low	Low	Low	High	Low	High
Cabarrus	5	Mod.	Mod.	Low	Low	High	Mod.	Low	Mod.
Caldwell	2	Mod.	High	Low	Low	Low	High	Low	High
Camden	8	Low	Low	High	High	Mod.	Low	Low	High
Carteret	7	Low	Low	High	High	High	Low	Mod.	High
Caswell	3	Low	Low	Low	Low	Mod.	Mod.	Low	Low
Catawba	4	Mod.	Mod.	Low	Low	High	Mod.	Low	Mod.
Chatham	4	Low	Low	Low	Low	Mod.	Mod.	Low	Mod.
Cherokee	1	Mod.	High	Low	Low	Low	High	Low	High
Chowan	8	Low	Low	High	High	Mod.	Low	Low	High
Clay	1	Mod.	High	Low	Low	Low	High	Low	High
Cleveland	5	Mod.	Mod.	Low	Low	Mod.	Mod.	Low	Mod.
Columbus	6	Low	Low	Mod.	Mod.	High	Low	High	Mod.
Craven	7	Low	Low	Mod.	Mod.	Mod.	Low	Low	Mod.
Cumberland	6	Low	Low	Mod.	Mod.	High	Low	High	High
Currituck	8	Low	Low	High	High	Mod.	Low	Low	High

County	Climate Division (NOAA)	Earthquake	Landslide	Hurricane	Nor'easter	Tornado	Severe Winter Weather	Wildfire	Flood
Dare	8	Low	Low	High	High	High	Low	Mod.	High
Davidson	4	Low	Low	Low	Low	High	Mod.	Low	Low
Davie	4	Low	Low	Low	Low	Mod.	Mod.	Low	Mod.
Duplin	6	Low	Low	Mod.	Mod.	High	Low	Low	Mod.
Durham	3	Low	Mod.	Low	Low	Mod.	Mod.	Low	Mod.
Edgecombe	8	Low	Low	Mod.	Mod.	Mod.	Low	Low	Mod.
Forsyth	3	Low	Low	Low	Low	High	Mod.	Low	Mod.
Franklin	3	Low	Low	Low	Low	Mod.	Mod.	Low	Mod.
Gaston	5	Mod.	Low	Low	Low	Mod.	Mod.	Low	Mod.
Gates	8	Low	Low	Mod.	Mod.	Mod.	Low	Low	Mod.
Graham	1	Mod.	High	Low	Low	Low	High	Low	High
Granville	3	Low	Low	Low	Low	Mod.	Mod.	Low	Low
Greene	7	Low	Low	Mod.	Mod.	Mod.	Low	Low	Mod.
Guilford	3	Low	Low	Low	Low	High	Mod.	Low	Low
Halifax	8	Low	Low	Mod.	Mod.	Mod.	Low	Low	Mod.
Harnett	6	Low	Low	Mod.	Mod.	High	Low	Mod.	Mod.
Haywood	1	Mod.	High	Low	Low	Low	High	Low	High
Henderson	1	Mod.	High	Low	Low	Low	High	Low	High
Hertford	8	Low	Low	Mod.	Mod.	Mod.	Low	Low	Mod.
Hoke	6	Low	Low	Mod.	Mod.	Mod.	Low	Mod.	Mod.
Hyde	7	Low	Low	High	High	High	Low	Mod.	High
Iredell	4	Mod.	Mod.	Low	Low	Mod.	Mod.	Low	Mod.
Jackson	1	Mod.	High	Low	Low	Low	High	Low	High
Johnston	7	Low	Low	Mod.	Mod.	Mod.	Low	Low	High
Jones	7	Low	Low	Mod.	Mod.	Mod.	Low	Low	Mod.
Lee	4	Low	Low	Low	Low	Mod.	Mod.	Low	Mod.
Lenoir	7	Low	Low	Mod.	Mod.	High	Low	Low	Mod.
Lincoln	5	Mod.	Mod.	Low	Low	Mod.	Mod.	Low	Mod.
McDowell	1	Mod.	High	Low	Low	Low	High	Low	High
Macon	1	Mod.	High	Low	Low	Low	High	Low	High
Madison	1	Mod.	High	Low	Low	Low	High	Low	Mod.
Martin	8	Low	Low	Mod.	Mod.	Mod.	Low	Low	Mod.
Mecklenburg	5	Mod.	Low	Low	Low	High	Mod.	Mod.	Mod.
Mitchell	1	Mod.	High	Low	Low	Low	High	Low	Mod.
Montgomery	5	Low	Low	Low	Low	Mod.	Mod.	Low	Mod.
Moore	5	Low	Low	Low	Low	High	Mod.	Low	Mod.
Nash	8	Low	Low	Mod.	Mod.	High	Low	Low	Mod.
New Hanover	6	Low	Low	High	High	Mod.	Low	Mod.	High
Northampton	8	Low	Low	Mod.	Mod.	High	Low	Low	Low

County	Climate Division (NOAA)	Earthquake	Landslide	Hurricane	Nor'easter	Tornado	Severe Winter Weather	Wildfire	Flood
Onslow	6	Low	Low	High	High	High	Low	High	High
Orange	3	Low	Mod.	Low	Low	Mod.	Mod.	Low	Low
Pamlico	7	Low	Low	High	High	Mod.	Low	Low	High
Pasquotank	8	Low	Low	High	High	Mod.	Low	Low	High
Pender	6	Low	Low	High	High	High	Low	High	High
Perquimans	8	Low	Low	High	High	Mod.	Low	Low	High
Person	3	Low	Low	Low	Low	Mod.	Mod.	Low	Low
Pitt	7	Low	Low	Mod.	Mod.	High	Low	Low	Mod.
Polk	1	Mod.	Mod.	Low	Low	Low	High	Low	High
Randolph	4	Low	Low	Low	Low	High	Mod.	Low	Low
Richmond	5	Mod.	Low	Low	Low	Mod.	Mod.	Mod.	Mod.
Robeson	6	Low	Low	Mod.	Mod.	High	Low	High	High
Rockingham	3	Low	Mod.	Low	Low	Mod.	Mod.	Low	Mod.
Rowan	4	Mod.	Low	Low	Low	Mod.	Mod.	Low	Mod.
Rutherford	1	Mod.	Mod.	Low	Low	Low	High	Low	High
Sampson	6	Low	Low	Mod.	Mod.	High	Low	Mod.	High
Scotland	6	Low	Low	Mod.	Mod.	High	Low	Mod.	Mod.
Stanly	5	Mod.	Mod.	Low	Low	High	Mod.	Low	Mod.
Stokes	3	Low	Mod.	Low	Low	Mod.	Mod.	Low	Low
Surry	2	Low	High	Low	Low	Low	High	Low	Mod.
Swain	1	Mod.	High	Low	Low	Low	High	Low	High
Transylvania	1	Mod.	High	Low	Low	Low	High	Low	High
Tyrell	8	Low	Low	High	High	Mod.	Low	Mod.	High
Union	5	Mod.	Low	Low	Low	High	Mod.	Mod.	Mod.
Vance	3	Low	Low	Low	Low	Mod.	Mod.	Low	Low
Wake	4	Low	Low	Low	Low	High	Mod.	Mod.	Mod.
Warren	3	Low	Low	Low	Low	Mod.	Mod.	Low	Low
Washington	8	Low	Low	High	High	Mod.	Low	Mod.	High
Watauga	2	Mod.	High	Low	Low	Low	High	Low	High
Wayne	7	Low	Low	Mod.	Mod.	High	Low	Low	High
Wilkes	2	Mod.	Mod.	Low	Low	Low	High	Low	High
Wilson	8	Low	Low	Mod.	Mod.	Mod.	Low	Low	Mod.
Yadkin	2	Low	Low	Low	Low	Low	High	Low	Mod.
Yancey	1	Mod.	High	Low	Low	Low	High	Low	High

Methodology:

Each of the one hundred counties in North Carolina was categorized into one of three levels of vulnerability, "Low", "Mod.", and "High" for seven natural hazards. Some assignments were made, in part, using the Climate Division (formulated by the National Climatic Data Center (Guttman and Quayle, 1995)) to which the county was assigned. The Climate Division number in the table corresponds to the following map:



Explanation of Vulnerability Categorizations:

- Earthquake: Based on 1-6 (low to high) general seismic hazard vulnerability for buildings in the conterminous U.S. (Leyendecker et al., 1995). Low = 1 or 2; Mod. = 3 or 4; High = 5 or 6.
- Landslide: Based on 1-6 (low to high) national landslide susceptibility and incidence map for the conterminous U.S. (USGS, 1997). Low = 1 or 2; Mod. = 3 or 4; High = 5 or 6.
- Hurricane: Combination of general vulnerability areas and frequency of hurricanes, 1900-1996 by county (Jarrell et al., 1992). Climate divisions 6, 7 and 8 were assigned a "Mod." vulnerability, while climate divisions 1-5 were assigned a "Low" vulnerability. Then, if a county experienced any direct strikes from hurricanes between 1900 and 1996, it was assigned a "High" vulnerability.
- Nor'easter: Based on general vulnerability areas.. Climate divisions 6, 7 and 8 were assigned a "Mod." vulnerability, while climate divisions 1-5 were assigned a "Low" vulnerability. Then, all counties on the coast were assigned a "High" vulnerability.
- Tornado: Combination of general vulnerability areas and frequency of tornadoes, 1953-1995 by county (Dutcher et al., 1990). Climate divisions 3-8 were assigned a "Mod." vulnerability, while climate divisions 1 and 2 were assigned a "Low" vulnerability. Then, all counties that experienced a frequency of tornado activity at or above the 75th percentile of the SERCC data set (number of tornadoes > 6) were upgraded from "Mod." to "High" or "Low" to "Mod.."
- Severe Winter Weather: Based on general vulnerability areas. For the potential for heavy snow, climate divisions 1 and 2 were assigned a "Mod." vulnerability, climate divisions 3 and 4 were assigned a "Mod." vulnerability, and climate divisions 3-8 were assigned a "Low" vulnerability. Then, all counties classified "Low" were upgraded to "Mod." if they fell within the regional where cold air damming occurs in the eastern U.S. (Hartfield et al., 1996).
- Wildfire: Based on North Carolina State Forest Service records for number of wildfires by county and the number of acres burned, 1950-1993. Each of these data sets was categorized 1-3 (low to high). They were then averaged and rounded, with 1= "Low", 2 = "Mod., and 3 = "High".
- Flood: Flood vulnerability was assessed using several data sources. The USGS (1997b) provided average precipitation and surface runoff data for 1951-1980, which was of primary importance. Flash flood incidence for 1986-1995, provided by FEMA, was considered with hurricane threatened areas as secondary in importance. Finally, the threat of urban flooding

was considered using 1996 county populations.

Flood potential = 3* (P+R) + 2* (F+H) + U, where

P=Categorized Average Annual Precipitation (1=<46", 2=46-52", 3=>52")
R=Categorized Average Annual Percentage Runoff (1=<30.4%, 2=30.4-38.1%, 3=>38.1%)
F=Categorized Flash Flood Incidence, 1986-1995: 1: Low (<6), 2: Mod. (6-10), 3: High (>10).
H=Categorized Hurricane Flood Potential: 1=Climate Divisions 1-5, 2=Climate Divisions 6-8, 3=Category 2 Plus Hurricane Incidence (Column 3 of Appendix A)
U=Categorized Urban Flood Potential: 1=1996 population < 50000, 2=1996 population 50000-100000, 3=1996 population > 100000.

Flood value (range= 11 to 33) is then categorized for Table 1 as follows:

High (3) = >20
Mod. (2) = 14-20
Low (1) = <14

- **NATURAL HAZARDS DATA BY NORTH CAROLINA COUNTY**

Column Key

Column	**Content**	**Range**
A	1996 County Population	
B	NOAA Climate Division in North Carolina	1-8 as shown in Figure 5
1	Earthquake Vulnerability, relative to conterminous U.S.	Lowest=1, Highest=6
2	Landslide Vulnerability, relative to conterminous U.S.	Lowest=1, Highest=6.
3	Frequency of All Hurricanes, 1900-1996	Saffir-Simpson Class 1-5
3a	Frequency of Minor Hurricanes, 1900-1996	Saffir-Simpson Class 1 or 2
3b	Frequency of Major Hurricanes, 1900-1996	Saffir-Simpson Class 3, 4 or 5
4	Nor'easter Vulnerability:	1 = Some direct vulnerability
5	Frequency of Tornadoes, 1953-1995	
6a	Extreme 1-day snowfall, averaged for FEMA study station(s) in county.	N/A= not available.
6b	Cold Air Damming Vulnerability:	1 = Some vulnerability.
7a	Classification based on number of wildfires, 1950-1993:	Low =1, Mod. = 2, High = 3
7b	Classification based on number of acres burned, 1950-1993:	Low =1, Mod. = 2, High = 3

Table 11: Natural Hazards Data by County

County	**A**	**B**	**1**	**2**	**3**	**3a**	**3b**	**4**	**5**	**6a**	**6b**	**7a**	**7b**
Alamance	117,823	3	2	3	0	0	0	0	3	N/A	1	1	1
Alexander	30,584	4	3	4	0	0	0	0	0	N/A	1	1	1
Alleghany	9,610	2	3	6	0	0	0	0	1	N/A	0	1	1
Anson	23,791	5	3	2	0	0	0	0	3	N/A	1	1	1

Ashe	23,483	2	3	6	0	0	0	0	0	N/A	0	1	1
County	**A**	**B**	**1**	**2**	**3**	**3a**	**3b**	**4**	**5**	**6a**	**6b**	**7a**	**7b**
Avery	15,229	2	3	6	0	0	0	0	1	N/A	0	1	1
Beaufort	43,210	7	1	1	6	5	1	1	12	N/A	0	1	1
Bertie	20,532	8	1	1	1	1	0	0	10	N/A	0	1	1
Bladen	30,090	6	2	1	0	0	0	0	6	N/A	0	2	2
Brunswick	62,856	6	2	1	10	6	4	1	8	N/A	0	2	3
Buncombe	190,852	1	3	5	0	0	0	0	4	10.5	1	1	1
Burke	82,486	1	3	5	0	0	0	0	2	13	1	1	1
Cabarrus	113,598	5	3	3	0	0	0	0	7	9	1	1	1
Caldwell	74,265	2	3	5	0	0	0	0	4	14.5	1	1	1
Camden	6,356	8	1	1	7	5	2	1	1	N/A	0	1	1
Carteret	58,341	7	1	1	15	13	2	1	16	17	0	1	2
Caswell	21,451	3	2	2	0	0	0	0	1	N/A	1	1	1
Catawba	128,055	4	3	4	0	0	0	0	7	13	1	1	1
Chatham	44,380	4	2	2	0	0	0	0	5	11.6	1	1	1
Cherokee	22,070	1	3	5	0	0	0	0	5	16.5	0	1	1
Chowan	14,152	8	1	1	3	3	0	1	5	11	0	1	1
Clay	7,840	1	3	5	0	0	0	0	3	N/A	0	1	1
Cleveland	90,306	5	3	4	0	0	0	0	6	13.5	1	1	1
Columbus	51,852	6	2	1	0	0	0	0	7	15	0	3	2
Craven	87,174	7	1	1	0	0	0	0	6	12.5	0	1	1
Cumberland	294,195	6	2	1	0	0	0	0	16	9.7	0	3	2
Currituck	16,372	8	1	1	13	11	2	1	2	N/A	0	1	1
Dare	26,542	8	1	1	21	14	7	1	18	9.6	0	1	2
Davidson	138,718	4	2	2	0	0	0	0	7	10.8	1	1	1
Davie	30,590	4	2	2	0	0	0	0	1	11.5	1	1	1
Duplin	43,535	6	2	1	0	0	0	0	16	10	0	1	1
Durham	194,956	3	2	3	0	0	0	0	4	10.5	1	1	1
Edgecombe	56,054	8	1	1	0	0	0	0	5	11.3	0	1	1
Forsyth	284,188	3	2	2	0	0	0	0	10	N/A	1	1	1
Franklin	42,738	3	1	1	0	0	0	0	5	9	0	1	1
Gaston	179,184	5	3	2	0	0	0	0	4	15	1	1	1
Gates	9,864	8	1	1	0	0	0	0	2	N/A	0	1	1
Graham	7,538	1	3	6	0	0	0	0	1	12	0	1	1
Granville	41,921	3	1	1	0	0	0	0	3	11.2	1	1	1
Greene	17,180	7	1	1	0	0	0	0	6	N/A	0	1	1
Guilford	377,722	3	2	2	0	0	0	0	7	11	1	1	1
Halifax	56,523	8	1	1	0	0	0	0	6	9.5	0	1	1
Harnett	79,488	6	2	1	0	0	0	0	11	7.2	0	2	1
Haywood	50,639	1	3	6	0	0	0	0	1	14.7	0	1	1
Henderson	77,558	1	3	5	0	0	0	0	3	16	1	1	1
Hertford	22,214	8	1	1	0	0	0	0	6	N/A	0	1	1

Hoke	28,144	6	2	1	0	0	0	0	5	N/A	0	2	1
County	**A**	**B**	**1**	**2**	**3**	**3a**	**3b**	**4**	**5**	**6a**	**6b**	**7a**	**7b**
Hyde	5,191	7	1	1	17	10	7	1	7	7	0	1	3
Iredell	106,233	4	3	3	0	0	0	0	6	13.5	1	1	1
Jackson	29,238	1	3	6	0	0	0	0	2	17	0	1	1
Johnston	99,215	7	2	1	0	0	0	0	2	10	0	1	1
Jones	9,322	7	1	1	0	0	0	0	4	14.6	0	1	1
Lee	47,402	4	2	2	0	0	0	0	1	10.5	1	1	1
Lenoir	59,262	7	1	1	0	0	0	0	7	10.5	0	1	1
Lincoln	56,808	5	3	4	0	0	0	0	5	14.5	1	1	1
McDowell	38,317	1	3	5	0	0	0	0	6	N/A	1	1	1
Macon	27,050	1	3	5	0	0	0	0	0	15.1	0	1	1
Madison	18,194	1	3	6	0	0	0	0	2	18	0	1	1
Martin	25,762	8	1	1	0	0	0	0	3	17	0	1	1
Mecklenburg	593,514	5	3	2	0	0	0	0	14	12.1	1	3	1
Mitchell	14,652	1	3	6	0	0	0	0	0	N/A	0	1	1
Montgomery	24,382	5	2	2	0	0	0	0	5	9.5	1	1	1
Moore	68,126	5	2	2	0	0	0	0	7	11.5	1	1	1
Nash	86,026	8	1	1	0	0	0	0	10	13.5	0	1	1
New Hanover	143,430	6	2	1	10	7	3	1	6	13.6	0	2	1
Northampton	20,858	8	1	1	0	0	0	0	9	10	0	1	1
Onslow	150,216	6	1	1	9	7	2	1	15	12	0	2	3
Orange	106,045	3	2	3	0	0	0	0	1	10.5	1	1	1
Pamlico	12,010	7	1	1	10	8	2	1	5	18	0	1	1
Pasquotank	33,848	8	1	1	6	5	1	1	6	15	0	1	1
Pender	35,978	6	2	1	9	6	3	1	11	12	0	2	3
Perquimans	10,756	8	1	1	6	5	1	1	4	N/A	0	1	1
Person	32,514	3	2	2	0	0	0	0	3	11.5	1	1	1
Pitt	119,236	7	1	1	0	0	0	0	11	12.8	0	1	1
Polk	16,195	1	3	4	0	0	0	0	1	15	1	1	1
Randolph	118,722	4	2	2	0	0	0	0	10	12	1	1	1
Richmond	45,840	5	3	2	0	0	0	0	2	N/A	1	2	1
Robeson	112,005	6	2	1	0	0	0	0	20	8.4	0	3	2
Rockingham	89,250	3	2	3	0	0	0	0	4	9	1	1	1
Rowan	121,003	4	3	2	0	0	0	0	5	11	1	1	1
Rutherford	59,334	1	3	4	0	0	0	0	4	11	1	1	1
Sampson	51,498	6	2	1	0	0	0	0	12	10	0	2	2
Scotland	35,030	6	2	1	0	0	0	0	7	9	0	2	1
Stanly	54,588	5	3	3	0	0	0	0	9	12	1	1	1
Stokes	42,222	3	2	3	0	0	0	0	2	12	1	1	1
Surry	65,866	2	2	5	0	0	0	0	4	12	1	1	1
Swain	11,847	1	3	6	0	0	0	0	2	11	0	1	1

Transylvania	27,558	1	3	6	0	0	0	0	3	14.7	1	1	1
County	**A**	**B**	**1**	**2**	**3**	**3a**	**3b**	**4**	**5**	**6a**	**6b**	**7a**	**7b**
Tyrell	3,671	8	1	1	9	8	1	1	4	N/A	0	1	2
Union	102,083	5	3	2	0	0	0	0	14	7.5	1	3	1
Vance	40,621	3	1	1	0	0	0	0	0	18	0	1	1
Wake	539,187	4	2	1	0	0	0	0	16	10.1	1	2	1
Warren	18,183	3	1	1	0	0	0	0	2	13.5	0	1	1
Washington	13,504	8	1	1	4	3	1	1	5	10.5	0	1	2
Watauga	40,451	2	3	6	0	0	0	0	0	19.8	0	1	1
Wayne	112,386	7	1	1	0	0	0	0	14	9	0	1	1
Wilkes	62,762	2	3	4	0	0	0	0	4	13	1	1	1
Wilson	68,460	8	1	1	0	0	0	0	3	15	0	1	1
Yadkin	34,737	2	2	2	0	0	0	0	4	16	1	1	1
Yancey	16,248	1	3	6	0	0	0	0	2	17	0	1	1

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